Psychometric Evaluation of Disordered Eating Measures in Bariatric Surgery Candidates

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Abstract

Introduction Assessment of disordered eating is common in bariatric surgery candidates, yet psychometric properties of disordered eating measures in this population are largely unknown.

Methods Measures were completed by 405 adult bariatric surgery candidates at pre-surgical consultation. Fit of the original scale structures was tested using Confirmatory Factor Analysis (CFA) and alternative factor solutions were generated using Exploratory Factor Analysis (EFA). Reliability (internal consistency), construct validity (convergent and divergent) and criterion validity (with the EDE as criterion) were assessed.

Materials Eating Disorder Examination Questionnaire (EDE-Q; n=405), Three Factor Eating Questionnaire (TFEQ; n=405), Questionnaire of Eating and Weight Patterns Revised (QEWP-R; n=204), Clinical Impairment Assessment (CIA; n=204), and the Eating Disorder Examination clinical interview (EDE; n=131).

Results CFA revealed adequate fit for only the CIA in its current form (CFI=0.925, RMSEA=0.096). EFA produced revised scales with improved reliability for the EDE, EDE-Q and TFEQ. Reliability of revised subscales was improved (original scales α=0.43-0.82; revised scales α=0.67-0.93). Correlational analyses of the CIA and revised versions of remaining scales with measures of psychological wellbeing and impairment revealed adequate convergent validity. All measures differentiated an EDE-classified disordered eating group from a non-disordered eating group (criterion validity). Diagnostic concordance between the EDE, EDE-Q and QEWP-R was low and identification of disordered eating behaviours was inconsistent across measures.

Conclusions Findings highlight the limitations of existing disordered eating questionnaires in bariatric surgery candidates. Results suggest revised assessments are required to overcome

these limitations and ensure that measures informing clinical recommendations regarding patient care are reliable and valid.

Keywords psychometrics, reliability, validity, disordered eating, eating disorder, bariatric surgery, LAGB, questionnaire, clinical interview.

Introduction

Pre-surgical assessment of bariatric surgery candidates often includes evaluation of disordered eating [1-3]. Comorbidities including Binge Eating Disorder (BED) and disordered eating behaviour (e.g., binge eating, disinhibition, emotional eating) are prevalent in bariatric surgery candidates [1, 4]. While these behaviours are associated with less weight loss [5] significant weight loss is still achieved individuals with these conditions [5, 6]. Consequently, guidelines suggest that disordered eating is not necessarily a contraindication to surgery [2, 3, 7]. Rather, it is regarded as a poor prognostic indicator for post-surgical outcomes and it is therefore recommended that assessment and treatment of disordered eating are commenced prior to surgery where possible [2, 7]. The purpose of disordered eating assessment prior to surgery is: to assess suitability for surgery; to provide a baseline measurement to enable evaluation of change and identification of outcome predictors; and to identify those who may benefit from treatment for disordered eating. As disordered eating measures are used to inform clinical recommendations regarding patient care, it is critical that they are reliable and valid in the bariatric surgery population.

Pre-surgical assessment is most frequently conducted via self-report measures, although more thorough evaluations also employ structured clinical interviews [8]. One of the limitations of current assessment practice is that measures initially developed for the purpose of assessing traditional eating disorder patients (i.e., Anorexia Nervosa and Bulimia Nervosa) are frequently used to identify disordered eating in the bariatric surgery population. This occurs despite a reported prevalence of 0% for *current* Anorexia Nervosa and Bulimia Nervosa bariatric surgery candidates in published studies using structured clinical interviews with DSM-IV diagnostic criteria [9-11]. Thus these measures assess disordered eating features that may not be relevant to the bariatric surgery population (e.g., fasting, compensatory behaviours) and they have no or very limited psychometric evaluation (i.e.,

evaluation of reliability and validity) in this population [8]. As reliability and validity of a measure is dependent on the population of interest [12], it is critical that tools are psychometrically evaluated within the population in which they are to be applied. Based on their frequency of use in bariatric surgery candidates [8] and assessment of a range of domains (i.e., disordered eating cognitions, behaviours and impact), the measures prioritised for evaluation are the Eating Disorder Examination (EDE) [13], Eating Disorder Examination Questionnaire (EDE-Q) [14], Three Factor Eating Questionnaire (TFEQ) [15], Questionnaire of Eating and Weight Patterns Revised (QEWP-R) [16], and the Clinical Impairment Assessment (CIA) [17].

Only two studies have investigated the factor structure of any of these measures in bariatric surgery candidates [18, 19]. Evaluation of the EDE-Q by Hrabosky et al. [18] did not support the original four factors (Restraint, Eating Concern, Shape Concern and Weight Concern), instead revealing a psychometrically sound 12-item four-factor model (Dietary Restraint, Eating Disturbance, Appearance Concern and Shape/Weight Overvaluation). Similarly, the original factor structure was not supported by Grilo et al. [19], who identified a seven-item three-factor model (Dietary Restraint, Body Dissatisfaction and Shape/Weight Overvaluation). Findings from both studies are consistent with multiple factor analyses of the EDE-Q in non-bariatric surgery samples which have also failed to replicate the original four-factor structure and suggested alternative factors [20-22]. No other disordered eating measures have undergone factor analysis in bariatric surgery candidates [8].

Typically, efforts to evaluate these measures in non-surgical samples have also failed to validate the original factor structures. For example, factor analyses of the EDE interview in clinical eating disorder, obese and non-eating disorder community samples have failed to replicate the original four-factor structure [23-25]. For the 51-item TFEQ, two studies have reported EFA in obese and non-obese community samples and both were unable to validate

the original three factors (Cognitive Restraint, Disinhibition and Hunger) [26, 27]. The only exception is the CIA, for which the three factors have been confirmed in an eating disorder sample [28] and a female non-clinical community sample [29].

Thus, although pre-surgical assessment of disordered eating in bariatric surgery candidates is a routine occurrence, the reliability and validity of assessments remains largely undetermined. Consequently, there is a paucity of assessments with demonstrated psychometric properties on which to base recommendations. The aim of this study was to comprehensively assess the psychometric properties of commonly used measures of disordered eating in bariatric surgery candidates. This will provide evidence to inform the use of current measures of disordered eating, and guide the development of new improved measures for this population where required. Three research aims were addressed. Firstly, to evaluate the original factor structures of disordered eating measures in bariatric surgery candidates; secondly, to determine best-fit factor solutions for bariatric surgery candidates; and thirdly, to identify measures that meet adequate reliability and validity criteria in bariatric surgery candidates.

Methods

Participants

Consecutive candidates for Laparoscopic Adjustable Gastric Banding (LAGB) were recruited from a bariatric surgery clinic that specialises in gastric bands in Melbourne, Australia. Candidates were excluded from the study if they did not meet criteria for surgery eligibility (aged 18 to 70 years, body mass index (BMI) greater than or equal to 30kg/m^2, and no previous history of bariatric surgery). The total sample comprised 405 adults seeking LAGB for obesity who were recruited from two studies (study one n=201; study two n=204). Participants were aged 20 to 69 years (*M*=43.8; *SD*=11.6) with a BMI ranging from 30.2 to

71.5 kg/m^2 (*M*=42.5; *SD*=7.4) and weight ranging from 73.0 to 221.8 kg (*M*=119.0; *SD*=24.9). The majority of the sample was female (79.3%), ethnicity was not recorded.

Materials

Assessment included measures of disordered eating thoughts, feelings and behaviours, disordered eating clinical impairment, and measures of body image, depression and quality of life (complete list of measures below). Height and weight were measured by the clinic nurse. In study one participants were administered all measures except the Eating Disorder Examination, Questionnaire of Eating and Weight Patterns Revised, Clinical Impairment Assessment and Impact of Weight on Quality of Life Lite; study two participants were administered all measures. The behavioural items from the EDE, EDE-Q and QEWP-R (i.e., those assessing frequency of binge eating and compensatory behaviours) are single items not contributing to scale scores, therefore were not included in factor analyses. Items assessing compensatory behaviours (e.g., vomiting, fasting, exercise and use of laxatives, diuretics or diet pills) were not the focus of this paper due to differences between measures in the wording of these items that mean they are not directly comparable.

Disordered Eating Measures

Eating Disorder Examination (EDE 16.0) [13]. The EDE was used as the criterion for the diagnosis of eating disorders based on its status as the gold-standard measure in non-bariatric surgery populations [30] and frequent use in bariatric surgery candidates [8]. It assesses eating disorders according to Diagnostic and Statistical Manual (DSM) criteria [31] and provides frequency and duration data for behavioural components of disordered eating including objective overeating episodes (OOEs, i.e., consumption of an objectively large amount of food without a sense of lack of control), objective binge episodes (OBEs, i.e., consumption of an objectively large amount of food accompanied by a sense of lack of control) and subjective binge episodes (SBEs, i.e., a sense of lack of control while consuming

an amount of food not regarded as unusually large). The EDE provides assessment information to inform treatment and assesses four domains of Dietary Restraint, Eating Concern, Shape Concern and Weight Concern to provide an indication of severity. Higher scores indicate greater severity.

Eating Disorder Examination Questionnaire (EDE-Q) [14]. Adapted from the EDE, the 28-item EDE-Q assesses behavioural components of disordered eating and the four domains of Dietary Restraint, Eating Concern, Shape Concern and Weight Concern where higher scores indicate greater severity. It was selected based on its relationship to the EDE and is a more comprehensive and relevant assessment for the bariatric surgery population compared to measures such as the Binge Eating Scale (BES) [33], which focuses solely on binge eating but does not assess diagnostic criteria (refer to [34, 35] for psychometric evaluation), or the Eating Disorder Inventory [36], which focuses on assessment of factors relevant to Anorexia Nervosa.

Questionnaire of Eating and Weight Patterns Revised (QEWP-R) [16]. The 28-item QEWP-R assesses behavioural components of disordered eating, including frequency of OBEs and diagnostic information. It is the most frequently used questionnaire in bariatric surgery candidates [8] and was administered to provide some cross-validation with the EDE and EDE-Q. Items assessing SBEs and grazing (i.e., eating or nibbling continuously) were added to the EDE-Q and QEWP-R administered to study two participants. These items were derived from previous additions to disordered eating measures for bariatric surgery patients [5, 37].

Clinical Impairment Assessment Questionnaire (CIA) [17]. The 16-item CIA assesses the severity of psychosocial impairment due to eating disorder features across three domains (Personal Impairment, Social Impairment and Cognitive Impairment), where higher scores indicate a greater level of impairment. It was selected as a measure of disordered eating-specific functional impairment.

Three Factor Eating Questionnaire (TFEQ) [15]. The 51-item TFEQ assesses three scales of Cognitive Restraint of eating, Disinhibition and Hunger. It is a measure of eating behaviours and cognitions that are associated with eating pathology. While these behaviours (e.g., restraint) are consistently associated with disordered eating in non-bariatric surgery samples, restraint has been associated with greater weight loss after surgery. Higher scores indicate higher levels of the factor. It was selected instead of the similar Dutch Eating Behaviour Questionnaire [38] due to its greater frequency of use in the bariatric surgery population.

Validation Measures

Multidimensional Body Self Relations Questionnaire - Appearance Scales (MBSRQ-AS) [39]. The 34-item MBSRQ-AS assesses perceived body image via five scales: Appearance Evaluation, Appearance Orientation, Body Areas Satisfaction, Overweight Preoccupation and Self-classified Weight. The MBSRQ-AS has been reported to have high internal consistency, strong one-month temporal reliability, and good convergent validity in a non-clinical community sample [39].

Beck Depression Inventory - II (BDI-II) [40]. The 21-item BDI-II assesses the presence and severity of depressive symptoms. The BDI-II has demonstrated adequate internal consistency, temporal reliability and construct validity in community and clinical samples [40-42].

Short Form-36 (SF-36) [43]. The SF-36 assesses health-related quality of life, including physical and mental health factors. It includes eight scales of functioning (Physical Functioning, Physical Role, Bodily Pain, General Health, Vitality, Social Functioning, Emotional Role and Mental Health) and two aggregated scales (Physical Component Summary and Mental Component Summary). Higher scores indicate a better health quality rating. The Physical Component Summary and Mental Component Summary have shown

high internal consistency, moderate to high temporal reliability and moderate to strong construct validity in community and clinical samples [43, 44].

Impact of Weight on Quality of Life - Lite (IWQOL-Lite) [45]. The 31-item IWQOL-Lite is an obesity-specific measure of quality of life. It assesses the impact of weight across five domains (Physical Function, Self-esteem, Sexual Life, Public Distress and Work) and an aggregated total score, where higher scores indicate a better quality of life rating. The IWQOL-Lite has demonstrated high internal consistency and temporal reliability and is sensitive to treatment-seeking status, degree of obesity and weight loss [45-48].

Procedures

This research was approved by the Monash University Human Research Ethics Committee and all participants provided informed written consent for involvement. Data were collected across two studies. In study one a questionnaire package was provided to patients at a pre-surgical consultation as part of standard clinical care. A total of 217 questionnaire packages were distributed, with 201 (92.6%) returned with consent for data to be used for research purposes. For study two, interview assessments were conducted in-person at either the bariatric surgery clinic or the Centre for Obesity Research and Education (CORE) in Melbourne, or via telephone. All clinical interviews were conducted by doctoral level clinical psychology researchers trained in the administration of the EDE. The questionnaire package was administered with the option of online or hard-copy responding. Three hundred and sixty new patients were invited to participate, of which 204 (56.7%) completed at least one aspect of the study. One hundred and twenty-two (59.8%) participants completed the interview and questionnaire, 73 (35.8%) completed the questionnaire only, and nine (4.4%) completed the interview only.

Statistical Analyses

Data from the two studies were pooled based on use of the same participant source and inclusion/exclusion criteria. Measures completed in both studies were the EDE-Q, TFEQ, MBSRQ-AS, BDI-II and SF-36. Analysis was preceded by data cleaning and assumption testing that demonstrated normality and non-violation of assumptions. Raw data were used for individual item analyses and missing data were imputed for scale analyses. In cases of missing data, estimation maximisation methods were used to impute item data for cases with less than 30% of items missing [49]. CFA was conducted using Amos 21.0 [50] and MPlus 7.0 [51], all other analyses were conducted using SPSS 20.0 [52].

Results

Confirmatory Factor Analyses CFA was performed to assess the original factor structure of the EDE, EDE-Q, and CIA. CFAs were based on Maximum Likelihood estimation and a bootstrapping procedure was used to address non-normality. The recommended estimator for categorical variables when running CFAs in Amos is Weighted Least Squares, however as this estimator does not perform well for small or medium sample sizes [53], it was not used for the TFEQ. As such the TFEQ was analysed using MPlus 7.0 [51] using the estimator Weighted Least Squares Means and Variance Adjusted (not available through Amos [53]). For each analysis, model fit was evaluated using a χ^2 test (a non-significant test is sought and indicates the observed data is not different to the expected data [53]). However, as this test is more likely to be significant with larger sample sizes [53], additional fit statistics were also used. These included the Root Mean Square Error of Approximation (RMSEA; <.05 indicates good fit [53], <.1 adequate fit [54]) and Comparative Fit Index (CFI; >.95 indicates good fit, >.90 adequate fit [54]).

Exploratory Factor Analyses Where the original factor structures were not supported by CFA, EFA was conducted to explore alternative factors solutions and identify which similar items group together (data-driven). Factorability of the correlation matrices was determined

by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Principal-axis factor extraction and direct oblimin rotation were used as data were non-normally distributed and relationships among factors were expected [55, 56]. The number of factors to retain and rotate was determined by examining scree plots, eigenvalues, and eigenvalues from Monte Carlo PCA for parallel analysis [57]. Items were deleted if they had factor loadings of ≤ .32 or cross-loadings of ≥ .32 [49, 55], or if scale reliability analysis (using Cronbach's alpha) suggested improvement if item deleted.

Reliability Internal consistency was assessed to determine the degree to which the items in a scale are consistent [12]. It was evaluated using Cronbach's coefficient alphas and item-total correlations.

Construct Validity Construct validity was tested to determine whether the scales perform in line with their conceptual definition (i.e., are correlated with measures of similar constructs (convergent validity) and not correlated with measures of theoretically unrelated constructs (divergent validity) [12]) and was evaluated via correlational analyses.

Criterion Validity Criterion validity was tested to determine each scale's relationship with a criterion (i.e., testing the ability to predict an outcome) [12]. It was evaluated via comparison to the EDE [13] and using the known-groups method in order to compare those with different disordered eating categorisations using one-way ANOVA.

Results of the psychometric evaluation are reported by scale. The CFA fit statistics for all measures are presented in Table 1. The scale descriptive scores and Cronbach's alphas (α) for all recommended versions of measures are reported in Table 2.

Eating Disorder Examination and Eating Disorder Examination Questionnaire

CFA Given the poor original factor structure of the EDE and EDE-Q evident in this study and reported in previous studies [18-20, 23], a three-factor model was tested as outlined by Byrne et al. [23]/Allen et al. [20] (in eating disorder and community samples). The 22-item model

proposed by Byrne et al. [23]/Allen et al. [20] was interpreted as Restraint, Eating Concern and Weight and Shape Concern. An alternative four-factor model proposed by Hrabosky et al. [18] was not tested as it included additional behavioural frequency items that were not part of the original scales. A seven-item three-factor model proposed by Grilo et al [19] was not tested due to the substantial item reduction and loss of one of the underlying constructs. An eight-item one-factor model proposed by Wade and colleagues [58] that has been previously tested [20, 23] was not assessed as the reduction to one factor substantially altered the measure to the extent that underlying constructs were not distinguishable.

EDE The original four-factor solution for the EDE could not be estimated due to a covariance matrix that was not positive definite. On inspection it appeared this was due to a linear dependency between the subscales *Shape Concern* and *Weight Concern* (*r*= .99). Given the aim of the CFA was to test whether the original factor structure was valid in bariatric surgery candidates, modifications to the factor structure (i.e., combining the subscales) were not made using CFA. For the three-factor model presented by Byrne et al. [23], fit statistics indicated that the model did not fit the data well and standardised factor loading estimates revealed that not all indicators were strongly related to the latent factors (range= .214 to .782).

EDE-Q The original four-factor solution could not be estimated due to a covariance matrix that was not positive definite, which appeared to be due to a linear dependency between the subscales *Shape Concern* and *Weight Concern* (*r*= 1.00) and is a common finding for these scales [18-20]. Based on the same rationale applied to the four-factor solution for the EDE, these subscales were not combined using CFA. For the three-factor model based on scoring presented by Allen et al. [20], fit statistics indicated that the model did not fit the data well, and standardised factor loading estimates revealed that not all indicators were strongly related to the latent factors (range= .269 to .875).

EFA EFA of the EDE and EDE-Q was performed in an attempt to identify a factor solution that was replicable for both measures. The KMO measure of sampling adequacy and Bartlett's test for the EDE (.77; χ^2 (231) = 968.35, p <.001) and EDE-Q (.80; χ^2 (231) = 3325.71, p <.001) indicated that the correlation matrices were appropriate for analysis [49]. After exploring two, three, four and five-factor solutions, a four-factor solution was selected as it demonstrated the simplest structure, had the least cross-loadings and explained acceptable variance [49]. Eight items were removed based on the criteria specified above. The item 'definite fear that you might gain weight' was also removed as it did not load on a conceptually meaningful scale. In the interests of obtaining a replicable scale for the EDE and EDE-Q, the item 'fear of losing control over eating' was retained (despite not meeting factor loading criteria on the EDE) as it was deemed to be conceptually significant, and the item 'importance of shape' was retained as the cross-loading on the EDE was >.15 difference from the item's highest loading [49]. The four factors were interpreted as Dietary Restraint, Eating Concern, Shape/Weight Overvaluation and Appearance Concern and explained 51.1% of the variance for the EDE and 56.7% for the EDE-Q. The Dietary Restraint factor included three of the five original items, the original Eating Concern scale was retained, the original Shape Concern and Weight Concern factors were collapsed into the two-item Shape/Weight Overvaluation, and four of the original Shape Concern and Weight Concern items were combined to create the Appearance Concern factor. The factor loadings for the final solution are presented in Table S1.

Reliability Cronbach's alpha values for the revised scales of the EDE and EDE-Q demonstrated improved internal consistency compared to the original scales (Table S2) and exceed the minimally acceptable value of .65 [59], indicating adequate internal consistency (Table 2). The exception was the EDE Eating Concern scale, which had an alpha of .64 and

was retained in its original form for consistency with the EDE-Q Eating Concern scale (α= .77).

Construct Validity Correlational analyses were conducted to explore the convergence between the EDE and EDE-Q and other indicators of disordered eating and psychological wellbeing. The revised four-factor EDE and EDE-Q were selected for evaluation given that the structure was replicated for the interview and questionnaire and no other models demonstrated acceptable fit, and internal consistency was retained or improved compared to the original scales. The Pearson correlation coefficients presented in Table 3 demonstrate similar and expected patterns of correlations for the revised EDE and EDE-Q scales with other disordered eating and psychological indicators, suggesting the EDE and EDE-Q scales measure similar constructs. Some minor differences were observed in the strength of correlations between the EDE and EDE-Q Eating Concern, Shape/Weight Overvaluation and Appearance Concern scales with other measures, but overall patterns were similar for the EDE and EDE-Q (see Table 3). Although the EDE and EDE-Q subscales can be used to generate a global score, the global score was not reported given that the primary purpose of this paper was to factor analyse these measures to determine their component subscales.

Criterion Validity The EDE was the criterion measure [8]. Pearson's correlations between the respective Dietary Restraint, Eating Concern, Shape/Weight Overvaluation and Appearance Concern scales of the revised EDE and EDE-Q indicated significant (p<.01) strong relationships; from r = .54 (Eating Concern) to .64 (Dietary Restraint). Mean scale score comparison of the revised EDE and EDE-Q demonstrated significantly higher ratings on the EDE-Q for all scales except Dietary Restraint (Table S3). The mean number of OBEs reported on the EDE-Q (M=6.51, SD=7.90) was significantly higher than the EDE (M=1.28, SD=3.18), although there was no difference for SBEs (Table S3).

Table 4 presents the identification of disordered eating cases across measures, in which respondents could endorse more than one form of disordered eating. Frequency cut-offs were selected based on the DSM-5 criteria of at least one OBE per week [60]. A higher proportion of participants were identified as BED using the QEWP-R compared to the EDE. The EDE-Q was not used to provide a diagnosis of BED as it does not assess all the behavioural indicators or the duration required for diagnosis. For OBEs and SBEs, a higher proportion of cases were identified on the questionnaires than the EDE, with the EDE-Q identifying the most OBE cases and the QEWP-R identifying the most SBE cases. Grazing was only assessed via questionnaire, with higher reports on the QEWP-R than the EDE-Q. Although grazing is not a diagnostic feature of eating disorders, it is included here to enable comparison to post-surgical samples in which grazing has been identified as a possible form of post-surgical binge eating that is more easily accommodated by the modified gastrointestinal system [5, 61].

Table 5 presents the diagnostic concordance with the EDE for the EDE-Q and QEWP-R when participants were classified as objective or subjective binge eaters based on a once-weekly cut-off [60]. Participants who reported OBEs or SBEs less than once per week were classified subthreshold and those who reported no binge eating were classified no disordered eating (NDE).

Known groups comparisons between disordered eating groups as identified by the EDE are presented in Table 6. Due to the reduced sample size when participants who completed the EDE (N=131) were divided into sub-groups, for analysis purposes the disordered eating (DE) groups (BED/OBE and SBE) were combined and compared to both the subthreshold group and the non-disordered eating group using independent samples Analysis of Variance (ANOVA). The EDE Eating Concern, Shape/Weight Overvaluation and Appearance Concern scales differentiated disordered and non-disordered eating groups. The

EDE Dietary Restraint scale did not differentiate between any of the groups. For the EDE-Q, the Eating Concern and Shape/Weight Overvaluation scales differentiated disordered and non-disordered eating groups. The Dietary Restraint and Appearance Concern scales did not differentiate between any of the groups. None of the EDE or EDE-Q scales differentiated the disordered eating and subthreshold groups or the subthreshold and non-disordered eating groups.

Clinical Impairment Assessment

CFA The original three-factor model of Personal Impairment, Social Impairment and Cognitive Impairment [62] was an adequate fit for the data and standardised factor loading estimates revealed that all indicators were strongly related to the latent factors (range= .590 to .909). The CFA path diagram and factor loadings are presented in Figure S1 and Table S4.

Reliability All Cronbach's alpha values for the CIA scales were at least .87, indicating very good internal consistency (Table 2).

Construct Validity The three CIA scales showed significant relationships in the expected direction with conceptually similar scales (Table 3).

Criterion Validity The CIA Personal Impairment scale differentiated disordered and non-disordered eating groups on the EDE. None of the CIA scales differentiated the disordered eating and subthreshold groups or the subthreshold and non-disordered eating groups (Table 6).

Three Factor Eating Questionnaire

CFA The original three-factor Stunkard and Messick [15] model of Cognitive Restraint, Disinhibition and Hunger was tested, along with the revised 18-item three-factor model proposed by Karlsson et al. [27]. Fit statistics for the original three-factor model indicated that the model did not fit the data well, and standardised factor loading estimates revealed that not all indicators were strongly related to the latent factors (range= -.030 to .939). For the

three-factor model (Cognitive Restraint, Uncontrolled Eating, Emotional Eating) based on the items and scoring presented by Karlsson et al. [27], fit statistics indicated that the model was a good fit for the data and standardised factor loading estimates revealed that all indicators were adequately related to the latent factors (range= .390 to .977). The CFA path diagram and factor loadings are presented in Figure S2 and Table S5.

EFA An EFA of the original TFEQ was conducted to explore alternative factor structures. The KMO measure of sampling adequacy (.84) and Bartlett's test (χ^2 (1275) = 5280.23, p <.001) indicated that the correlation matrix was appropriate for analysis [49]. After exploring two, three, and four-factor solutions, a three-factor solution was selected. Twenty-seven items were removed based on the criteria specified above or if all item inter-correlations for an item were < .3. The three resultant factors were interpreted as Cognitive Restraint, Uncontrolled Eating and Emotional Eating and explained 33.8% of the variance. The factor loadings for the final solution are presented in Table S6.

Reliability The Cognitive Restraint scale of the Karlsson et al. [27] model assessed via CFA had an alpha value below the minimally acceptable value of .65 [59], therefore this model was not evaluated further. In contrast, the three revised scales from the EFA demonstrated very good internal consistency (Table 2), which was improved compared to the original scales (Table S2).

Construct Validity The revised TFEQ from the EFA was selected for evaluation based on improved internal consistency and simple factor structures. The TFEQ Cognitive Restraint scale was not related to conceptually distinct scales (divergent validity), and was inversely related to Uncontrolled Eating and Emotional Eating. Of the three TFEQ scales, Uncontrolled Eating demonstrated the strongest correlations with conceptually similar validation scales in this population (convergent validity) (Table 3).

Criterion Validity The revised TFEQ Uncontrolled Eating scale differentiated disordered and

non-disordered eating groups on the EDE. None of the TFEQ scales differentiated the disordered eating and subthreshold groups or the subthreshold and non-disordered eating groups (Table 6).

Discussion

This study examined the psychometric properties of commonly used disordered eating measures in bariatric surgery candidates. The only measure demonstrating psychometric adequacy in its current form was the CIA. This is notable given that the CIA is conceptually different from the other measures evaluated as it is assesses the impact of disordered eating rather than disordered eating per se. This finding aligns with previous research that has reported the original factor structures of the EDE, EDE-Q and TFEQ are not well supported, even in the populations they were designed to assess (e.g., eating disorder samples) [20-24, 27, 63].

EFA was also performed to explore alternative factor structures, resulting in a revised 14-item four-factor version of the EDE and EDE-Q and 24-item three-factor TFEQ, and all measures of disordered eating were evaluated for reliability and validity. The revised scales demonstrated improved reliability compared to their original structure. Construct validity for the original CIA and revised measures was established via convergence among similar and related measures. Criterion validity, assessed by comparing scale scores across disordered eating and non-disordered eating groups, was not established for the use of the EDE-Q and QEWP-R to diagnose disordered eating.

Eating Disorder Examination and Eating Disorder Examination Questionnaire The EFA produced an alternative reduced item four-factor structure comprising Dietary Restraint, Eating Concern, Shape/Weight Overvaluation and Appearance Concern. The three-item Dietary Restraint and two-item Shape/Weight Overvaluation factors reproduced those reported previously in bariatric surgery candidates [18, 19], and the four-item Appearance

Concern factor replicated that found by Hrabosky et al. [18], which was an extended version of the Body Dissatisfaction factor reported by Grilo et al. [19]. In the interests of obtaining replicable interview and questionnaire versions, the five Eating Concern items were retained for both measures. Combined, results suggest that the psychometric properties of the EDE and EDE-Q can be improved by reduction of the Dietary Restraint factor and re-conceptualisation of the Shape Concern and Weight Concern factors to Shape/Weight Overvaluation and Appearance Concern.

Reliability evaluation of the revised EDE and EDE-Q scales showed improved internal consistency, and construct validity was demonstrated as revised scales correlated as expected with other scales of disordered eating and measures of psychological distress. The lack of relationship between the Dietary Restraint scale and impairment, depression or psychological quality of life, along with no differences in Dietary Restraint scores between the disordered eating group and subthreshold and non-disordered eating group supports the suggestion that restraint may be interpreted as adaptive in bariatric surgery candidates [18]. Evaluation of the diagnostic concordance between the EDE-Q and EDE showed poor agreement for identification of disordered eating behaviours (i.e., OBE, SBE, subthreshold binge eating or no disordered eating), as noted in previous literature [67]. Consistent with research in non-obese populations [66], the EDE-Q overestimated OBEs and SBEs, which parallels the higher EDE-Q subscale ratings. Prevalence estimates between measures were more disparate for OBEs than for SBEs, and the frequency of reported OBEs (but not SBEs) was also significantly greater on the EDE-Q than the EDE. Taken together these findings suggest that the loss of control aspect of binge eating may be easier to consistently identify (by interviewers and individuals) than the quantity of food consumed component.

Questionnaire of Eating and Weight Patterns Revised This is the first study to compare the QEWP-R and EDE in bariatric surgery candidates. The QEWP-R identified a larger number

of individuals across BED, OBE, SBE and grazing categories than the EDE and diagnostic concordance with the EDE was low. These findings support previous research reporting only fair concordance between the QEWP-R and Structured Clinical Interview for DSM (SCID) in bariatric surgery candidates [68] and moderate concordance in an obese sample [69]. Results also indicate that like the EDE-Q, the QEWP-R overestimated OBEs and SBEs and has a tendency to classify episodes as OBEs when EDE diagnosis suggested an SBE classification would have been more accurate.

Clinical Impairment Assessment CFA results supported the original three-factors [62] and are encouraging for the use of the CIA as a measure of impairment in this population. The CIA also demonstrated very good internal consistency and evidence of construct validity. The CIA Personal Impairment scale also demonstrated the ability to differentiate disordered and non-disordered eating groups, indicating good criterion validity. The Social Impairment and Cognitive Impairment scales demonstrated a trend for greater impairment in the disordered eating group, although this did not reach statistical significance.

Three Factor Eating Questionnaire Previous evaluation of the TFEQ in obese and community samples has failed to replicate the original factors, instead suggesting a Cognitive Restraint factor, combined Disinhibition and Hunger factor (interpreted as Uncontrolled Eating), and brief Emotional Eating factor [26, 27] may provide a better structure. Results from the CFA and EFA of this study support previous findings and suggest the revised structure is also applicable to bariatric surgery candidates. The TFEQ Cognitive Restraint factor demonstrated a negative relationship with Uncontrolled Eating and Emotional Eating, providing further support for the suggestion that restraint may be adaptive in this population. Good criterion validity was established for the Uncontrolled Eating scale, which differentiated disordered and non-disordered eating groups.

These findings highlight that the most frequently used disordered eating measures have limited reliability and validity in bariatric surgery candidates when administered and interpreted in their original form, with the exception of the CIA. Consequently, the revised EDE, EDE-Q and TFEQ are recommended for use in future clinical and research assessments of bariatric surgery candidates. Based on the evidence that the original measures are psychometrically-limited even in non-surgical populations [20-24, 27, 63], these revisions may also be relevant to other populations.

The current reliance on measures that were not designed for the bariatric surgery population and do not provide consistent or valid measurement of disordered eating in this population has significant implications for assessment and subsequent clinical recommendations. Specifically, inaccurate assessment may result in bariatric surgery candidates receiving inadequate or misguided clinical care prior to surgery, and may fail to identify or over identify patients at risk for post-surgical disordered eating and associated negative surgical and psychosocial outcomes [1, 5, 70, 71].

Evaluation of the diagnostic properties of the EDE, EDE-Q and QEWP-R suggest limited utility of the questionnaires for the purposes of obtaining diagnostic information. This affirms the need to differentiate between the use of measures for the diagnosis of eating disorders versus the assessment of severity of disordered eating symptoms [8, 20]. Consistent with findings from a recent systematic literature review [8], a clinical interview (the EDE) is recommended for diagnosis in bariatric surgery candidates. Given the EDE can be resource-intensive to administer and requires interviewer training and evaluation of inter-rater consistency [13], it may be reasonable to generate diagnoses via brief interview using EDE diagnostic items only.

In summary, this study provides the most comprehensive evaluation to date of disordered eating measures in bariatric surgery candidates. Results indicate that the CIA is

acceptable for use in its original form, but revised versions of the EDE, EDE-Q and TFEQ are required to provide reliable and valid assessment of disordered eating in this population. Assessment will be improved through use of the recommended revised measures and further development and psychometric evaluation of disordered eating measures for bariatric surgery candidates. These improvements are central to the accurate identification of disordered eating and the provision of evidence-based clinical recommendations and treatment for bariatric surgery candidates experiencing disordered eating. Future research could consider the development of new items or measures, tailored to the unique needs of the bariatric surgery population, using established processes for scale development and conduct thorough psychometric evaluation of new items and constructs [12, 59]. Measures also require an update to be consistent with the recently released DSM-5 criteria [60].

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Sarah Mitchell - No conflict of interest.

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

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

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Figures

Figure S1. Path Diagram for CIA with Standardised Item Coefficients, Error Terms and Factor Correlations.

Figure S2. Path Diagram for TFEQ with Standardised Item Coefficients, Error Terms and Factor Correlations.

Table 1. *Fit statistics for Confirmatory Factor Analyses*.

Measure	Factors	Chi-square (df)	RMSEA	CFI
EDE	3 [23]	397.276 (206)***	.085	.769
EDE-Q	3 [20]	1253.927 (206)***	.116	.682
CIA	3	274.277 (101) ***	.096	.925
TFEQ	3	7106.888 (1275)***	.053	.769
TFEQ	3 [27]	269.122 (132)***	.052	.946

Note: CFI: Comparative Fit Index; CIA: Clinical Impairment Assessment; EDE: Eating Disorder Examination; EDE-Q: Eating Disorder Examination Questionnaire; RMSEA: Root Mean Square Error of Approximation; TFEQ: Three Factor Eating Questionnaire.
***p*<.01
****p*<.001

Table 2. *Disordered Eating Scale Scores and Internal Consistency.*

Scale	n	*M*	*SD*	No. items	α
Revised EDE (from EFA)					
Dietary Restraint	131	2.31	2.14	3	.77
Eating Concern	131	1.24	1.28	4	.67
Eating Concern*	131	1.24	1.20	5	.64
Shape/Weight Overvaluation	131	3.94	1.55	2	.78
Appearance Concern	131	4.18	1.54	4	.84
Revised EDE-Q (from EFA)					
Dietary Restraint	395	2.28	1.83	3	.85
Eating Concern	382	2.29	1.51	5	.77
Shape/Weight Overvaluation	381	4.51	1.68	2	.93
Appearance Concern	381	5.58	0.79	4	.80
Original CIA					
Personal Impairment	189	10.49	5.33	6	.94
Social Impairment	189	5.73	4.25	5	.89
Cognitive Impairment	189	3.48	3.27	5	.87
CIA total	189	19.70	11.33	16	.95
Revised TFEQ (from EFA)					
Cognitive Restraint	389	1.58	1.73	6	.75
Uncontrolled Eating	390	8.81	3.99	15	.83
Emotional Eating	390	2.13	1.16	3	.82

*EFA of the EDE suggested a four-item Eating Concern scale, however five items were retained for consistency with the EDE-Q.

Table 3. *Correlations among Disordered Eating Measures and Indicators of Psychological Wellbeing.*

	EDE Revised				EDE-Q Revised				CIA			TFEQ Revised		
Scale	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Personal Impairment	Social Impairment	Cognitive Impairment	Cognitive Restraint	Uncontrolled Eating	Emotional Eating
EDE Dietary Restraint														
EDE Eating Concern	.178*													
EDE Shape/Weight Overvaluation	.098	.370**												
EDE Appearance Concern	.192*	.399**	.608**											
EDEQ Dietary Restraint	.641**	.141	.135	.215*										
EDEQ Eating Concern	.049	.541**	.336**	.319**	.085									
EDEQ Shape/Weight Overvaluation	.016	.325**	.547**	.506**	.070	.457**								
EDEQ Appearance Concern	-.028	.163	.389**	.558**	-.004	.334**	.512**							
CIA Personal Impairment	.006	.426**	.491**	.459**	.094	.657**	.676**	.525**						
CIA Social Impairment	.134	.453**	.450**	.535**	.061	.551**	.606**	.461**	.769**					
CIA Cognitive Impairment	-.022	.389**	.339**	.310**	.005	.455**	.381**	.309**	.564**	.606**				
TFEQ Cognitive Restraint	-.072	-.124	-.213*	-.049	.172**	-.161**	-.038	-.070	-.100	-.110	-.044			
TFEQ Uncontrolled Eating	.023	.450**	.162	.155	-.083	.554**	.265**	.227**	.364**	.358**	.333**	-.323**		
TFEQ Emotional Eating	.163	.204*	.221*	.185*	.031	.275**	.133**	.274**	.185*	.245**	.131	-.310**	.381**	
BDI	-.020	.410**	.322**	.364**	-.001	.487**	.419**	.360**	.672**	.684**	.595**	-.049	.310**	.207**
MBSRQ Appearance Evaluation	.041	-.190*	-.263**	-.351**	.031	-.260**	-.373**	-.379**	-.489**	-.460**	-.236**	.044	-.215**	-.026

	EDE Revised				EDE-Q Revised				CIA			TFEQ Revised		
Scale	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Personal Impairment	Social Impairment	Cognitive Impairment	Cognitive Restraint	Uncontrolled Eating	Emotional Eating
MBSRQ Appearance Orientation	.063	.095	.155	.080	.151**	.220**	.210**	.237**	.184*	.116	.073	.068	-.032	.052
MBSRQ Body Areas Satisfaction	-.093	-.288**	-.330**	-.427**	.037	-.268**	-.308**	-.420**	-.452**	-.463**	-.286**	.114*	-.195**	-.259**
MBSRQ Overweight Preoccupation	.297**	.217*	.404**	.307**	.188**	.321**	.265**	.225**	.445**	.400**	.290**	-.006	.155**	.096
MBSRQ Self-classified Weight	-.077	.135	.044	.170	-.045	.075	.098	.172**	.246**	.290**	.191**	-.043	.056	.078
SF36 Physical Component Summary	-.193*	-.021	.014	-.086	.064	-.012	.068	-.096	-.110	-.227**	-.268**	.063	-.082	-.113*
SF36 Mental Component Summary	.055	-.437**	-.361**	-.357**	.033	-.417**	-.457**	-.348**	-.643**	-.653**	-.583**	.049	-.262**	-.175**
IWQOL Physical Function	-.052	-.164	-.140	-.272**	.134	-.192**	-.266**	-.282**	-.283**	-.363**	-.403**	.058	-.198**	-.175*
IWQOL Self Esteem	-.060	-.362**	-.576**	-.636**	-.034	-.456**	-.675**	-.641**	-.728**	-.699**	-.511**	.031	-.263**	-.209**
IWQOL Sexual Life	.032	-.191*	-.204*	-.348**	.052	-.251**	-.253**	-.277**	-.357**	-.446**	-.385**	.063	-.079	-.111
IWQOL Public Distress	-.049	-.170	-.079	-.226*	.028	-.274**	-.226**	-.249**	-.320**	-.363**	-.310**	-.039	-.194**	-.099
IWQOL Work	-.105	-.366**	-.190*	-.328**	.078	-.320**	-.325**	-.337**	-.449**	-.536**	-.499**	.018	-.211**	-.151*
IWQOL Total	-.068	-.315**	-.327**	-.482**	.087	-.373**	-.461**	-.490**	-.555**	-.604**	-.540**	.051	-.212**	-.188*

*p<.05; **p<.01

Table 4. *Disordered Eating Descriptive Characteristics across Measures.*

Measure	BED (DSM-5)	OBE (≥1/wk)	SBE (≥1/wk)	Grazing (≥1/wk)
EDE	17 (13.0%)	18 (13.7%)	33 (25.2%)	n/a
EDE-Q	n/a	187 (49.5%)	58 (32.8%)	70 (41.9%)
QEWP-R	43 (25.1%)	66 (34.9%)	85 (49.7%)	81 (49.4%)

Table 5. *Disordered Eating Diagnostic Concordance using the EDE, EDE-Q and QEWP-R.*

	EDE						
EDE-Q	OBE	SBE	Subthreshold	NDE	Total	Sensitivity (%)	Specificity (%)
OBE	14 (12.0%)	16 (13.7%)	9 (7.7%)	13 (11.1%)	52 (44.4%)	87.5	62.4
SBE	1 (0.9%)	4 (3.4%)	1 (0.9%)	8 (6.8%)	14 (12.0%)	16.0	89.1
Subthreshold	0 (0.0%)	3 (2.6%)	3 (2.6%)	12 (10.3%)	18 (15.4%)	20.0	85.3
NDE	1 (0.9%)	2 (1.7%)	2 (1.7%)	28 (23.9%)	33 (28.2%)	45.9	91.1
Total	16 (13.7%)	25 (21.4%)	15 (12.8%)	61 (52.1%)	117 (100%)		
QEWP-R							
OBE	10 (9.9%)	11 (10.9%)	6 (5.9%)	14 (13.9%)	41 (40.6%)	71.4	64.4
SBE	2 (2.0%)	6 (5.9%)	2 (2.0%)	7 (6.9%)	17 (16.8%)	25.0	85.7
Subthreshold	1 (1.0%)	3 (3.0%)	1 (1.0%)	6 (5.9%)	11 (10.9%)	6.7	88.4
NDE	1 (1.0%)	4 (4.0%)	6 (5.9%)	21 (20.8%)	32 (31.7%)	43.8	79.2
Total	14 (13.9%)	24 (23.8%)	15 (14.9%)	48 (47.5%)	101 (100%)		

Table 6. *Scale Comparisons between Disordered Eating Subgroups as Categorised by the EDE.*

Scale	BED (N=18) M (SD)	SBE (N=30) M (SD)	Subthreshold (N=17) M (SD)	NDE (N=66) M (SD)	F	Effect size (η^2)
	DE group		Subthreshold	NDE		
EDE Dietary Restraint	2.02 (1.85)	2.46 (2.42)	2.29 (1.89)	2.34 (2.18)	0.14	.00
EDE Eating Concern	1.86 (1.34) [a]	1.78 (1.35) [a]	1.36 (1.05)	0.81 (0.97) [b]	10.57**	.14
EDE Shape/Weight Overvaluation	4.47 (1.11) [a]	4.67 (1.39) [a]	3.91 (1.79)	3.45 (1.50) [b]	8.94**	.12
EDE Appearance Concern	4.84 (1.34) [a]	4.64 (1.40) [a]	4.16 (1.65)	3.79 (1.54) [b]	5.94**	.08
EDEQ Dietary Restraint	1.98 (1.51)	2.30 (2.27)	2.96 (2.00)	2.03 (1.79)	1.52	.03
EDEQ Eating Concern	2.68 (1.41) [a]	2.78 (1.51) [a]	2.32 (1.32)	1.46 (1.28) [b]	10.90**	.17
EDEQ Shape/Weight Overvaluation	5.20 (1.37) [a]	4.96 (1.48) [a]	4.64 (1.69)	3.92 (1.88) [b]	5.31**	.09
EDEQ Appearance Concern	5.67 (0.58)	5.72 (0.54)	5.32 (0.98)	5.28 (1.10)	2.66	.05
CIA Personal Impairment	12.13 (5.03) [a]	11.73 (5.02) [a]	10.87 (4.60)	8.35 (4.96) [b]	6.69**	.11
CIA Social Impairment	6.75 (3.61)	5.99 (4.32)	5.00 (3.95)	4.37 (3.88)	2.93	.05
CIA Cognitive Impairment	4.06 (2.54)	3.54 (2.79)	3.13 (2.79)	2.45 (2.92)	2.57	.04
TFEQ Cognitive Restraint	1.81 (2.43)	1.65 (2.11)	2.79 (2.36)	2.58 (2.01)	2.53	.04
TFEQ Uncontrolled Eating	9.75 (4.09) [a]	10.17 (4.12) [a]	8.71 (4.23)	7.49 (3.81) [b]	5.16**	.08
TFEQ Emotional Eating	1.88 (1.50)	2.22 (1.25)	1.71 (1.43)	1.73 (1.19)	1.17	.02

Note: BED and SBE based on a cut-off of ≥1 OBE or SBE per week. *p<.05; **p<.01. [a,b] Means with different superscript letters differ significantly

Table 1. *Fit statistics for Confirmatory Factor Analyses*.

Measure	Factors	Chi-square (df)	RMSEA	CFI
EDE	3 [20]	397.276 (206)***	.085	.769
EDE-Q	3 [17]	1253.927 (206)***	.116	.682
CIA	3	274.277 (101) ***	.096	.925
TFEQ	3	7106.888 (1275)***	.053	.769
TFEQ	3 [24]	269.122 (132)***	.052	.946

Note: CFI: Comparative Fit Index; CIA: Clinical Impairment Assessment; EDE: Eating Disorder Examination; EDE-Q: Eating Disorder Examination Questionnaire; RMSEA: Root Mean Square Error of Approximation; TFEQ: Three Factor Eating Questionnaire.
**p<.01
***p<.001

Table 2. *Disordered Eating Scale Scores and Internal Consistency.*

Scale	n	*M*	*SD*	No. items	α
Revised EDE (from EFA)					
Dietary Restraint	131	2.31	2.14	3	.77
Eating Concern	131	1.24	1.28	4	.67
Eating Concern*	131	1.24	1.20	5	.64
Shape/Weight Overvaluation	131	3.94	1.55	2	.78
Appearance Concern	131	4.18	1.54	4	.84
Revised EDE-Q (from EFA)					
Dietary Restraint	395	2.28	1.83	3	.85
Eating Concern	382	2.29	1.51	5	.77
Shape/Weight Overvaluation	381	4.51	1.68	2	.93
Appearance Concern	381	5.58	0.79	4	.80
Original CIA					
Personal Impairment	189	10.49	5.33	6	.94
Social Impairment	189	5.73	4.25	5	.89
Cognitive Impairment	189	3.48	3.27	5	.87
CIA total	189	19.70	11.33	16	.95
Revised TFEQ (from EFA)					
Cognitive Restraint	389	1.58	1.73	6	.75
Uncontrolled Eating	390	8.81	3.99	15	.83
Emotional Eating	390	2.13	1.16	3	.82

*EFA of the EDE suggested a four-item Eating Concern scale, however five items were retained for consistency with the EDE-Q.

Table 3. *Correlations among Disordered Eating Measures and Indicators of Psychological Wellbeing.*

	EDE Revised				EDE-Q Revised				CIA			TFEQ Revised		
Scale	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Personal Impairment	Social Impairment	Cognitive Impairment	Cognitive Restraint	Uncontrolled Eating	Emotional Eating
EDE Dietary Restraint														
EDE Eating Concern	.178*													
EDE Shape/Weight Overvaluation	.098	.370**												
EDE Appearance Concern	.192*	.399**	.608**											
EDEQ Dietary Restraint	.641**	.141	.135	.215*										
EDEQ Eating Concern	.049	.541**	.336**	.319**	.085									
EDEQ Shape/Weight Overvaluation	.016	.325**	.547**	.506**	.070	.457**								
EDEQ Appearance Concern	-.028	.163	.389**	.558**	-.004	.334**	.512**							
CIA Personal Impairment	.006	.426**	.491**	.459**	.094	.657**	.676**	.525**						
CIA Social Impairment	.134	.453**	.450**	.535**	.061	.551**	.606**	.461**	.769**					
CIA Cognitive Impairment	-.022	.389**	.339**	.310**	.005	.455**	.381**	.309**	.564**	.606**				
TFEQ Cognitive Restraint	-.072	-.124	-.213*	-.049	.172**	-.161**	-.038	-.070	-.100	-.110	-.044			
TFEQ Uncontrolled Eating	.023	.450**	.162	.155	-.083	.554**	.265**	.227**	.364**	.358**	.333**	-.323**		
TFEQ Emotional Eating	.163	.204*	.221*	.185*	.031	.275**	.133**	.274**	.185*	.245**	.131	-.310**	.381**	
BDI	-.020	.410**	.322**	.364**	-.001	.487**	.419**	.360**	.672**	.684**	.595**	-.049	.310**	.207**
MBSRQ Appearance Evaluation	.041	-.190*	-.263**	-.351**	.031	-.260**	-.373**	-.379**	-.489**	-.460**	-.236**	.044	-.215**	-.026

	EDE Revised				EDE-Q Revised				CIA			TFEQ Revised		
Scale	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Dietary Restraint	Eating Concern	Shape/Weight Overvaluation	Appearance Concern	Personal Impairment	Social Impairment	Cognitive Impairment	Cognitive Restraint	Uncontrolled Eating	Emotional Eating
MBSRQ Appearance Orientation	.063	.095	.155	.080	.151**	.220**	.210**	.237**	.184*	.116	.073	.068	-.032	.052
MBSRQ Body Areas Satisfaction	-.093	-.288**	-.330**	-.427**	.037	-.268**	-.308**	-.420**	-.452**	-.463**	-.286**	.114*	-.195**	-.259**
MBSRQ Overweight Preoccupation	.297**	.217*	.404**	.307**	.188**	.321**	.265**	.225**	.445**	.400**	.290**	-.006	.155**	.096
MBSRQ Self-classified Weight	-.077	.135	.044	.170	-.045	.075	.098	.172**	.246**	.290**	.191**	-.043	.056	.078
SF36 Physical Component Summary	-.193*	-.021	.014	-.086	.064	-.012	.068	-.096	-.110	-.227**	-.268**	.063	-.082	-.113*
SF36 Mental Component Summary	.055	-.437**	-.361**	-.357**	.033	-.417**	-.457**	-.348**	-.643**	-.653**	-.583**	.049	-.262**	-.175**
IWQOL Physical Function	-.052	-.164	-.140	-.272**	.134	-.192**	-.266**	-.282**	-.283**	-.363**	-.403**	.058	-.198**	-.175*
IWQOL Self Esteem	-.060	-.362**	-.576**	-.636**	-.034	-.456**	-.675**	-.641**	-.728**	-.699**	-.511**	.031	-.263**	-.209**
IWQOL Sexual Life	.032	-.191*	-.204*	-.348**	.052	-.251**	-.253**	-.277**	-.357**	-.446**	-.385**	.063	-.079	-.111
IWQOL Public Distress	-.049	-.170	-.079	-.226*	.028	-.274**	-.226**	-.249**	-.320**	-.363**	-.310**	-.039	-.194**	-.099
IWQOL Work	-.105	-.366**	-.190*	-.328**	.078	-.320**	-.325**	-.337**	-.449**	-.536**	-.499**	.018	-.211**	-.151*
IWQOL Total	-.068	-.315**	-.327**	-.482**	.087	-.373**	-.461**	-.490**	-.555**	-.604**	-.540**	.051	-.212**	-.188*

*p<.05; **p<.01

Table 4. *Disordered Eating Descriptive Characteristics across Measures.*

Measure	BED (DSM-5)	OBE (≥1/wk)	SBE (≥1/wk)	Grazing (≥1/wk)
EDE	17 (13.0%)	18 (13.7%)	33 (25.2%)	n/a
EDE-Q	n/a	187 (49.5%)	58 (32.8%)	70 (41.9%)
QEWP-R	43 (25.1%)	66 (34.9%)	85 (49.7%)	81 (49.4%)

Table 5. *Disordered Eating Diagnostic Concordance using the EDE, EDE-Q and QEWP-R.*

	EDE						
EDE-Q	OBE	SBE	Subthreshold	NDE	Total	Sensitivity (%)	Specificity (%)
OBE	14 (12.0%)	16 (13.7%)	9 (7.7%)	13 (11.1%)	52 (44.4%)	87.5	62.4
SBE	1 (0.9%)	4 (3.4%)	1 (0.9%)	8 (6.8%)	14 (12.0%)	16.0	89.1
Subthreshold	0 (0.0%)	3 (2.6%)	3 (2.6%)	12 (10.3%)	18 (15.4%)	20.0	85.3
NDE	1 (0.9%)	2 (1.7%)	2 (1.7%)	28 (23.9%)	33 (28.2%)	45.9	91.1
Total	16 (13.7%)	25 (21.4%)	15 (12.8%)	61 (52.1%)	117 (100%)		
QEWP-R							
OBE	10 (9.9%)	11 (10.9%)	6 (5.9%)	14 (13.9%)	41 (40.6%)	71.4	64.4
SBE	2 (2.0%)	6 (5.9%)	2 (2.0%)	7 (6.9%)	17 (16.8%)	25.0	85.7
Subthreshold	1 (1.0%)	3 (3.0%)	1 (1.0%)	6 (5.9%)	11 (10.9%)	6.7	88.4
NDE	1 (1.0%)	4 (4.0%)	6 (5.9%)	21 (20.8%)	32 (31.7%)	43.8	79.2
Total	14 (13.9%)	24 (23.8%)	15 (14.9%)	48 (47.5%)	101 (100%)		

Table 6. *Scale Comparisons between Disordered Eating Subgroups as Categorised by the EDE.*

Scale	BED (N=18) M (SD)	SBE (N=30) M (SD)	Subthreshold (N=17) M (SD)	NDE (N=66) M (SD)	F	Effect size (η^2)
	DE group		Subthreshold	NDE		
EDE Dietary Restraint	2.02 (1.85)	2.46 (2.42)	2.29 (1.89)	2.34 (2.18)	0.14	.00
EDE Eating Concern	1.86 (1.34) [a]	1.78 (1.35) [a]	1.36 (1.05)	0.81 (0.97) [b]	10.57**	.14
EDE Shape/Weight Overvaluation	4.47 (1.11) [a]	4.67 (1.39) [a]	3.91 (1.79)	3.45 (1.50) [b]	8.94**	.12
EDE Appearance Concern	4.84 (1.34) [a]	4.64 (1.40) [a]	4.16 (1.65)	3.79 (1.54) [b]	5.94**	.08
EDEQ Dietary Restraint	1.98 (1.51)	2.30 (2.27)	2.96 (2.00)	2.03 (1.79)	1.52	.03
EDEQ Eating Concern	2.68 (1.41) [a]	2.78 (1.51) [a]	2.32 (1.32)	1.46 (1.28) [b]	10.90**	.17
EDEQ Shape/Weight Overvaluation	5.20 (1.37) [a]	4.96 (1.48) [a]	4.64 (1.69)	3.92 (1.88) [b]	5.31**	.09
EDEQ Appearance Concern	5.67 (0.58)	5.72 (0.54)	5.32 (0.98)	5.28 (1.10)	2.66	.05
CIA Personal Impairment	12.13 (5.03) [a]	11.73 (5.02) [a]	10.87 (4.60)	8.35 (4.96) [b]	6.69**	.11
CIA Social Impairment	6.75 (3.61)	5.99 (4.32)	5.00 (3.95)	4.37 (3.88)	2.93	.05
CIA Cognitive Impairment	4.06 (2.54)	3.54 (2.79)	3.13 (2.79)	2.45 (2.92)	2.57	.04
TFEQ Cognitive Restraint	1.81 (2.43)	1.65 (2.11)	2.79 (2.36)	2.58 (2.01)	2.53	.04
TFEQ Uncontrolled Eating	9.75 (4.09) [a]	10.17 (4.12) [a]	8.71 (4.23)	7.49 (3.81) [b]	5.16**	.08
TFEQ Emotional Eating	1.88 (1.50)	2.22 (1.25)	1.71 (1.43)	1.73 (1.19)	1.17	.02

Note: BED and SBE based on a cut-off of ≥1 OBE or SBE per week. *p<.05; **p<.01. [a,b] Means with different superscript letters differ significantly

Table S1. *EFA Factor Loadings for the EDE and EDE-Q.*

Item	Dietary Restraint		Eating Concern		Appearance Concern		Shape/Weight Overvaluation	
	EDE	EDE-Q	EDE	EDE-Q	EDE	EDE-Q	EDE	EDE-Q
Restraint over eating	.797	.799						
Food avoidance	.695	.886						
Dietary rules	.705	.731						
Eaten in secret			.727	.655				
Felt guilty			.597	.707				
Thinking about food, eating or calories			.582	.513				
Concerned about others seeing you eat			.386	.681				
Fear of losing control over eating			-	.566				
Dissatisfaction with shape					.628	.774		
Dissatisfaction with weight					.436	.629		
Uncomfortable seeing your body					.780	.765		
Uncomfortable about others seeing your body					.841	.637		
Importance of shape							.635	-.943
Importance of weight							.712	-.871

Table S2. *Original Disordered Eating Scale Scores and Internal Consistency.*

Scale	n	*M*	*SD*	No. items	α
Original EDE					
Restraint	131	1.59	1.45	5	.70
Eating Concern	131	1.24	1.20	5	.64
Shape Concern	131	3.40	1.31	8	.79
Weight Concern	131	3.14	1.15	5	.59
Original EDEQ					
Restraint	395	1.69	1.36	5	.76
Eating Concern	382	2.29	1.51	5	.77
Shape Concern	381	4.47	0.98	8	.71
Weight Concern	381	4.05	1.03	5	.56
Original TFEQ					
Cognitive Restraint	389	8.68	3.87	21	.74
Disinhibition	390	10.83	3.76	16	.82
Hunger	389	8.20	3.47	14	.78

Table S3. *Comparison of Mean Scale Scores and Diagnostic Indicators for the Revised EDE and EDE-Q.*

Subscale	EDE *M* (SD)	EDE-Q *M* (SD)	Difference *M*	*t*
Dietary Restraint	2.31 (2.14)	2.28 (1.83)	0.03	0.32
Eating Concern	1.24 (1.20)	2.29 (1.51)	1.06	13.70**
Shape/Weight Overvaluation	3.94 (1.55)	4.51 (1.68)	0.57	6.63**
Appearance Concern	4.18 (1.54)	5.58 (0.79)	1.40	34.62**
OBE	1.28 (3.18)	6.51 (7.90)	5.22	12.86**
SBE	3.73 (7.41)	3.70 (6.10)	0.04	0.06

**$p<.001$

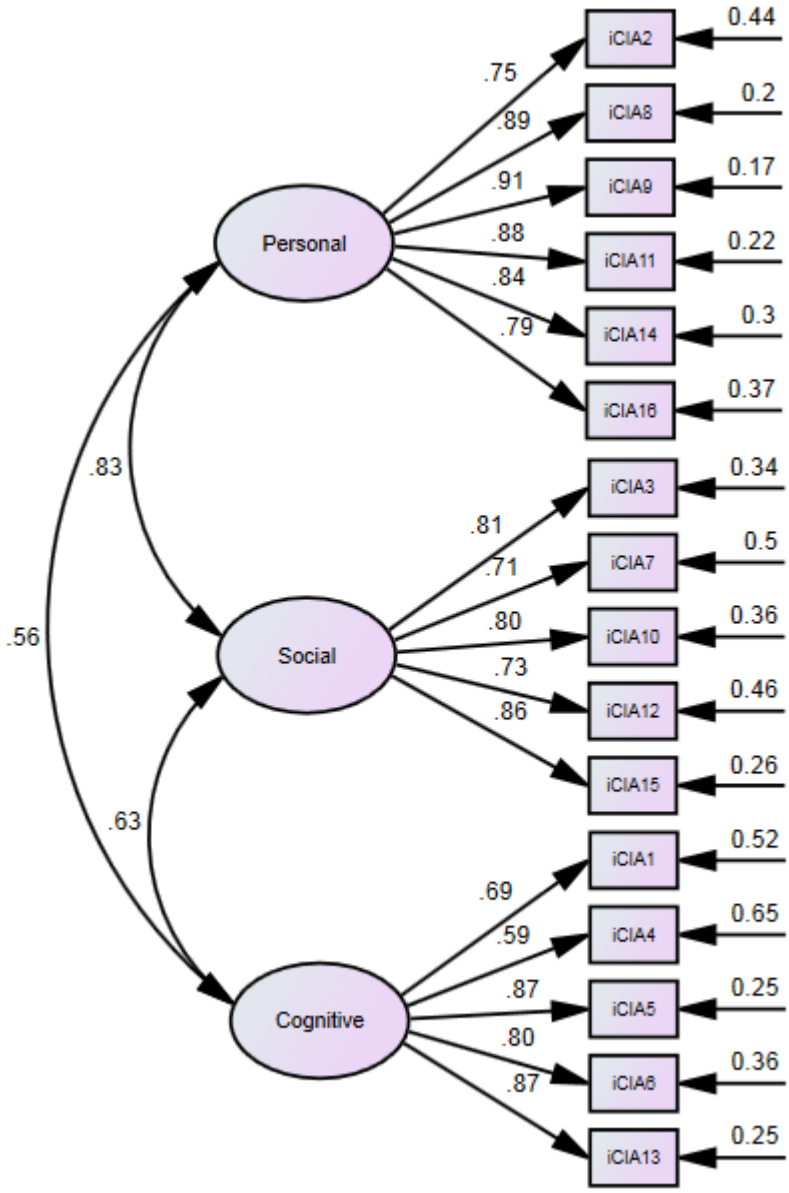

Figure S2. *Path Diagram for CIA with Standardised Item Coefficients, Error Terms and Factor Correlations.*

Table S4. *CFA Factor Loadings for the CIA.*

Item	Personal Impairment	Social Impairment	Cognitive Impairment
Made you feel ashamed of yourself	.909		
Made you upset	.894		
Made you feel critical of yourself	.750		
Made you feel guilty	.883		
Made you feel a failure	.838		
Made you worry	.795		
Stopped you going out with others		.810	
Interfered with meals with family or friends		.708	
Made it difficult to eat out with others		.797	
Interfered with you doing things you used to enjoy		.732	
Interfered with your relationships with others		.858	
Affected your work performance			.590
Made it difficult to concentrate			.695
Made you forgetful			.869
Affected your ability to make everyday decisions			.799
Made you absent-minded			.865

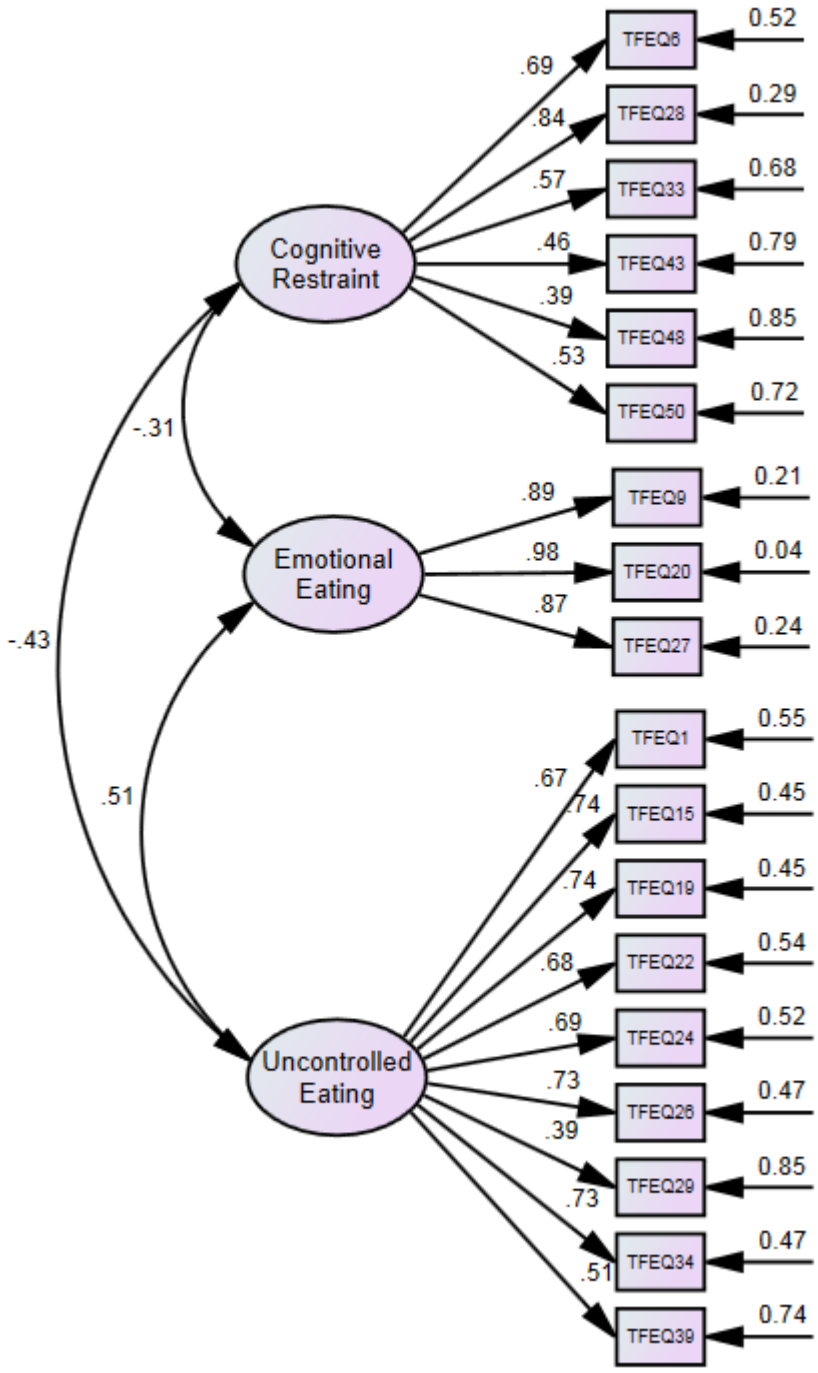

Figure S3. *Path Diagram for TFEQ with Standardised Item Coefficients, Error Terms and Factor Correlations.*

Table S5. *CFA Factor Loadings for the TFEQ.*

Item	Cognitive Restraint	Uncontrolled Eating	Emotional Eating
I deliberately take small helpings as a means of controlling my weight	.691		
I consciously hold back at meals in order not to gain weight	.839		
I do not eat some foods because they make me fat	.571		
How frequently do you avoid 'stocking up' on tempting foods	.455		
How likely are you to consciously eat less than you want	.392		
Self-rated restraint in eating	.525		
When I smell a sizzling steak or see my favourite food, I find it very difficult to keep from eating, even if I have just finished a meal		.667	
Sometimes when I start eating, I just can't seem to stop		.738	
Being with someone who is eating often makes me feel hungry enough to eat also		.737	
When I see a real delicacy, I often get so hungry that I have to eat right away		.677	
I get so hungry that my stomach often feels like a bottomless pit		.690	
I am always hungry so it is hard for me to stop eating before I finish the food on my plate		.730	
I sometimes get very hungry late in the evening or at night		.390	
I am always hungry enough to eat at any time		.726	
How often do you feel hungry		.510	
When I feel anxious, I find myself eating			.890
When I feel blue, I often overeat			.977
When I feel lonely, I console myself by eating			.874

Table S6. *EFA Factor Loadings for the TFEQ.*

Item	Uncontrolled Eating	Cognitive Restraint	Emotional Eating
Always hungry so hard for me to stop eating before I finish food on my plate	.671		
Hungry enough to eat at any time	.663		
Get so hungry my stomach feels like a bottomless pit	.594		
How often do you feel hungry	.551		
So hungry that I eat more than three times a day	.523		
When I start eating, I just can't seem to stop	.469		
When I see a real delicacy, I get so hungry I have to eat right away	.439		
I find it very difficult to keep from eating	.434		
Often so hungry that I just have to eat something	.433		
When with someone who is overeating, I usually overeat too	.420		
Being with someone eating makes me feel hungry enough to eat	.411		
How difficult would it be to stop eating halfway through dinner and not eat for hours	.390		
Do you eat sensibly in front of others and splurge alone	.380		
Do you go on eating binges though you are not hungry	.352		
Dieting failure	.336		
Consciously hold back at meals in order not to gain weight		.698	
Deliberately take small helpings		.652	
Count calories as a conscious means of controlling my weight		.641	
Often stop eating when I am not really full		.523	
When eaten quota of calories good about not eating more		.495	
Do not eat some foods because they make me fat		.376	
When I feel blue, I often overeat			.846
When I feel lonely, I console myself by eating			.695
When I feel anxious, I find myself eating			.689