

**A Psychometric Examination of a Modified 8-item Version of the Children's Eating
Disorder Examination**

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Abstract

Eating and body image disturbances in children are typically assessed using the Children's Eating Disorder Examination (ChEDE), however support for the reliability and validity of scores on this measure is mixed. Furthermore, previous studies suggest that scores obtained from a simplified 8-item version of the ChEDE may be more reliable and useful for research purposes than scores obtained from the full scale. The present study sought to psychometrically evaluate the reliability and factor structure of this brief 8-item model. Two separate community-based samples of 6- to 11-year-olds ($N = 535$) were administered the ChEDE as part of a broader assessment battery. The brief 8-item model provided a good fit to the data, as determined by confirmatory factor analysis. Results also suggested that scores obtained from the 8-item model, as well as a global ChEDE score, provided reliable measures of a child's eating disorder symptoms, and were superior to the original four subscales in both healthy-weight and overweight/obese samples. The brief 8-item scale may therefore be used by researchers who want a reliable and valid index of global eating disorder psychopathology without doing a full interview.

Keywords: Eating Disorder Examination, children, reliability

A Psychometric Examination of a Modified 8-item Version of the Children's Eating Disorder Examination

Recent studies have reported significant body image disturbance and eating disorder symptomatology in children aged 5 to 13, including food avoidance, preoccupation with weight and shape, fear of weight gain, and self-induced vomiting (Madden, Morris, Zurynski, Kohn, & Elliot, 2009; Pinhas, Morris, Crosby, & Katzman, 2011). The Children's Eating Disorder Examination (ChEDE; Bryant-Waugh, Cooper, Taylor, & Lask, 1996) is a comprehensive, semi-structured clinical interview designed to assess the full range of eating disorder symptomatology, behaviours, and attitudes in young children. Adapted from the Eating Disorder Examination (the widely used "gold-standard" assessment measure for eating disorders in adults; Fairburn & Cooper, 1993) the child version has been modified by Bryant-Waugh et al. (1996) to assess the intent associated with disordered eating behaviours as well as the behaviour itself. Modifications included the simplification of language for use in children, the use of a practical sorting task to assess overevaluation of weight and shape, and more detailed explanation at the beginning of the interview of the time frame to which the questions refer. The original four-subscale structure of Restraint, Eating Concern, Shape Concern, and Weight Concern is retained in the ChEDE, along with diagnostic items that can be used to arrive at a clinical diagnosis of an eating disorder.

Support for the reliability and validity of ChEDE scores has been mixed. In an evaluation by Watkins, Frampton, Lask, and Bryant-Waugh (2005) of 60 children aged 8 to 14 from a specialist outpatient eating disorder clinic, reliability was good to excellent with internal consistencies of .80, .91, .90, and .88 for the Restraint, Eating Concern, Weight Concern, and Shape Concern subscale scores respectively. In addition, scale scores were found to discriminate well between individuals with an eating disorder and those without, as well as between those with Anorexia Nervosa and 'other' eating disturbances, such as

Selective Eating or Food Avoidance Emotional Disorder, supporting the sensitive known groups validity of scores on this measure. By contrast, a study by Decaluwé and Braet (2004) using an English-to-Dutch translated version of the ChEDE on 139 treatment-seeking obese children aged 10 to 16, observed poor internal consistency coefficients for the three subscales of Restraint (.53), Eating Concern (.59), Weight Concern (.62), but good reliability for Shape Concern (.84).

Using a much larger community-based sample of 409 Australian girls aged 9 to 13, Wade, Byrne, and Bryant-Waugh (2008) found internal reliabilities of .68 for Restraint, .63 for Eating Concern, .79 for Weight Concern, .88 for Shape Concern, and .93 for a Global score. In an exploratory factor analysis, Wade et al. (2008) observed that a much simpler one-factor model consisting of 8 items loading predominantly on the Weight Concern and Shape Concern subscales was more stable than the original four-factor model, and had excellent internal reliability at .91. In a replication of this finding on the EDE in 158 eating disordered, 170 treatment-seeking obese, and 329 non-eating disordered community-based adult females by Byrne, Allen, Lampard, Dove, and Fursland (2010), the one-factor, 8-item model proposed by Wade et al. (2008) fit the data more satisfactorily than other proposed factor models. Furthermore, the reliability of scores obtained from the one-factor 8-item model, as well as scores obtained from the ChEDE Global scale, was superior to the reliability of scores on the other subscales in both community-based and overweight/obese samples, with internal consistencies of .88 and .86 for the 8-item model and global score in the community-based sample, and internal consistencies of .82 and .86 for the 8-item model and global score in the overweight/obese sample.

Although these findings support the utility of the brief 8-item scale, the Byrne et al. (2010) study was conducted on the EDE and their sample consisted of adults. An examination of the utility (i.e., reliability and validity) of scores on the brief 8-item scale in

children using the ChEDE does not appear to have been conducted. An examination of the 8-item scale in children would be useful, particularly for those in research-based settings who would like a measure of eating disorder attitudes but must also attend to child participants who become easily fatigued and distracted during long assessments (Ricciardelli & McCabe, 2001).

Accordingly, to extend previous research in this area, the present study sought to psychometrically evaluate the fit, reliability, and construct validity of a brief 8-item model of the ChEDE in two community-based samples of boys and girls. If the reliability results observed in previous studies can be replicated in a younger sample using the ChEDE, this would be of benefit to researchers who want a reliable and valid index of global eating disorder psychopathology without having to conduct the time-intensive full interview. As little attention has been paid to the comparability of the ChEDE between boys and girls, the present study also sought to investigate gender differences in reliability of ChEDE scores as well the comparability of the brief 8-item model. Finally, in order to examine the consistency of the brief 8-item model across developmental phase, factorial invariance across age groups was also investigated.

Method

Participants

Sample 1. Following ethical approval from the University's Human Research Ethics Committee and the respective ethics committees for private and state schools in Western Australia, 253 children (109 boys and 144 girls) were recruited from nine metropolitan primary schools in Perth, Western Australia. The schools were drawn from a broad geographical area and represented a range of socioeconomic classifications. After approval from school principals was granted, a letter of introduction describing the purpose and

procedures of the study was sent to the parents of all children in Grades 1 to 5, inviting their children into the study and requesting parental approval. Assent forms for children were attached to this invitation. Children who received parental consent and provided assent forms were recruited into the study. The consent rate from this process was approximately 10%. Participants ranged in age from 6 to 11 years, with a mean age of 8.30 ($SD = 1.45$). Of these children, 85% were healthy-weight, 13% were overweight, and 2% were obese.

Sample 2. Children from the second participant group were participants of the Growth and Development (GAD) Study, a population-based cohort study being conducted in Western Australia that has a central focus on the development and persistence of childhood obesity, and a secondary focus on eating disorder symptoms and psychological difficulties in healthy-weight and overweight and obese children. Therefore overweight and obese children were recruited as well as a healthy-weight sample matched for age and gender. Children were recruited from 10 metropolitan primary schools in Perth, Western Australia. The schools were drawn from a broad geographical area and represented a range of socioeconomic classifications. Ethical approval for this research was obtained from the necessary ethics committees. For further information regarding recruitment procedures for the GAD Study, please refer to Gibson et al. (2007).

Children were aged between 6 and 13 years at the time of recruitment, however only baseline data from children that were aged between 8 and 11 in the first wave of data collection were used in the present study. In total, data from 288 participants (125 boys and 163 girls) were used. Participants had a mean age of 9.04 ($SD = 1.13$). Of these children, 51% were healthy-weight, 30% were overweight, and 19% were obese.

Sample 1 and Sample 2 did not differ with respect to gender, both having slightly more girls than boys. Sample 2 was, however, significantly older than Sample 1, $t(466.03) =$

6.41, $p < .001$, Cohen's $d = 0.56$. As expected, the samples also differed significantly in terms of weight classification, with Sample 2 having significantly more overweight, $\chi^2(1) = 21.16$, $p < .001$, and obese, $\chi^2(1) = 37.21$, $p < .001$, participants compared to Sample 1.

Measures

The following description of measures for weight and height and the ChEDE applies to both samples. The description of measures for the Children's Body Image Scale (CBIS) and Modified Objectified Body Consciousness Scale for Youth (OBC-Y) applies only to Sample 1.

Weight and height. Children were weighed (to the nearest 0.01kg) and measured (to the nearest millimetre) in light clothing and without shoes with a regularly calibrated set of Tanita Digital Medical Scales and a regularly calibrated portable Harpenden stadiometer. Body Mass Index (BMI), a valid reflection of adiposity (Garrow & Webster, 1985), was calculated from height and weight using the formula kg/m^2 . Weight status was defined using the Cole, Bellizzi, Flegal, and Dietz (2000) international age- and gender-specific BMI cut-offs for categorising children as healthy-weight, overweight, or obese.

Children's Eating Disorder Examination. The ChEDE, as described in the introduction, is a comprehensive, semistructured clinical interview designed to assess the full range of eating disorder symptomatology, behaviours, and attitudes in young children. Individual items are averaged to generate four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. Subscale items are rated on a 7-point, forced-choice scale ranging from 0 (*no restraint/concern*) to 6 (*restraint present everyday/extreme concern*), thus higher scores indicate greater severity or frequency. Additional questions assess diagnostic

features of eating disorders such as self-induced vomiting, excessive exercise, and binge-eating. Scores for these items reflect the number of episodes reported over the preceding four weeks.

As described in the introduction, in addition to the traditional scoring system of averaging the four subscales, the present study evaluated the ChEDE Global scale as well as a brief 8-item scale. The items used in the calculation of each of the scoring methods are presented in Table 1. Scores on the Global scale are calculated by summing the four subscales and then averaging. Scores on the 8-item scale are calculated by summing the 8-items presented in Table 1 and then averaging.

INSERT TABLE 1 ABOUT HERE

Children's Body Image Scale. Body dissatisfaction was measured using the Children's Body Image Scale (CBIS; Truby & Paxton, 2002), which calculates the discrepancy between respondents' perceived body size and their ideal body size. This discrepancy is considered one of the best measures of body dissatisfaction in children (Gardner, Friedman, & Jackson, 1999). The CBIS was developed using photographs of Australian children of varying BMI and consists of seven figures ranging from the 3rd to the 97th BMI percentile for 10-year-old children. Separate scales are provided for boys and girls, and each individual figure corresponds to a specific BMI range. Children were asked to select the figures that best represent their perceived and ideal body shapes. Body dissatisfaction was calculated as the difference between perceived and ideal figure ratings with possible dissatisfaction scores ranging from -6 to +6. A score of zero indicates body satisfaction, a negative score indicates body dissatisfaction in the direction of desiring a larger figure, and a positive score indicates body dissatisfaction in the direction of desiring a thinner figure.

Modified Objectified Body Consciousness Scale for Youth. Body shame was measured using the 5-item Body Shame subscale of a modified version of the Objectified Body Consciousness Scale for Youth (OBC-Y; Lindberg, Hyde, & McKinley, 2006). The OBC-Y is a 14-item measure designed to assess the degree to which adolescent youth view themselves as objects to be looked at and evaluated by others. The Body Shame subscale examines how ashamed individuals are of their body when it does not conform to cultural standards (e.g., *When I'm not the size I think I should be, I feel ashamed*). Participants indicated their agreement to each of the 5 items by responding on a 4-point scale of 2 (*yes*), 1 (*sometimes*), 0 (*no*) or *not sure* (rated as missing). The *not sure* response was included as an option as suggested by Huon, Godden, and Brown (1997). Total scores ranged from 0 to 10, with higher scores indicative of greater body shame.

Procedure

Participants from both samples were individually and privately assessed by interviewers thoroughly trained by a ChEDE certified trainer to ensure standardized administration and scoring of the interview. Participants were firstly weighed and measured by the interviewers, positioned on the stadiometer so that their heels and buttocks were against the vertical support of the stadiometer and their head facing forward. Children in Sample 1 were then administered the ChEDE, CBIS, and OBC-Y as part of a broader battery of verbally administered measures. Children in Sample 2 were administered the ChEDE as part of a broader battery of verbally administered measures. Each interview took approximately 30-60 minutes. Interviews were conducted by doctors, psychologists, and fourth year or higher psychology students. Ongoing supervision was provided to all involved in the assessments by a certified ChEDE trainer to ensure assessment fidelity. This

supervision involved scheduled meetings to discuss any difficulties associated with the administration of the ChEDE. Peer supervision was also used to ensure assessment fidelity. This involved the observation of several ChEDE administrations and was followed by a review of the assessment process and scoring. Lastly, all ChEDE scores obtained with Sample 1 were checked and entered by the first author (MJ), and all ChEDE scores obtained with Sample 2 were checked and entered by the fourth author (KA). If any scoring decisions required clarification, scores were checked with the interviewer prior to data entry.

Statistical Analysis

The psychometric properties of the ChEDE were evaluated through confirmatory factor analysis (CFA), inspection of Cronbach's alpha, and inspection of correlations between the ChEDE, CBIS, and OBC-Y. The CFA was conducted in Mplus 6.0 (Muthén & Muthén, 1998 – 2011) and Cronbach's alpha coefficients and correlations were generated in SPSS. The following criteria were utilised in the classification of internal consistency coefficients: Values $\geq .90$ were considered excellent, values $\geq .80$ were considered good, values $\geq .70$ were considered adequate, values $\geq .60$ were considered questionable, values $\geq .50$ were considered poor, and values $< .50$ were considered unacceptable (Kline, 2011, George & Mallery, 2003). As subscales of the ChEDE were significantly skewed (skew > 2 , kurtosis > 4), a square root transformation was performed as per the recommendations of Kline (2011). These transformed scores were used in the assessment of construct validity. The assessment of construct validity was conducted on scores from Sample 1 only as measures of body dissatisfaction and body shame were not available for Sample 2. Construct validity was assessed by correlating scores on the original ChEDE Global scale and the brief 8-item scale with scores on the CBIS and OBC-Y.

Given the small proportion of overweight participants and obese participants relative to healthy-weight participants in Sample 2, the overweight and obese groups were combined to form one overweight/obese group ($n = 141$). The healthy-weight group and overweight/obese group differed significantly with respect to BMI (healthy-weight group: $M = 16.72$, $SD = 1.41$; overweight/obese group: $M = 23.17$, $SD = 4.11$), $t(168.28) = -17.55$, $p < .001$, $d = 2.34$.

Prior to conducting the CFA, suitable estimation methods were examined. As data for the ChEDE were significantly skewed and therefore non-normal, the weighted least squares mean and variance adjusted (WLSMV) estimator implemented in the Mplus program was used to fit the factor model. WLSMV is a robust estimation method that uses a matrix of polychoric correlations and is capable of providing accurate parameter estimates and standard errors in analyses involving multivariate non-normal variables.

Model fit was evaluated using the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Weighted Root Mean Square Residual (WRMR), and chi square (χ^2). With RMSEA, values ≤ 0.06 indicate good model fit (Hu & Bentler, 1999). With CFI and TLI, values $> .95$ indicate a close fit and values $> .90$ indicate an acceptable fit (Hu & Bentler, 1999). Values for WRMR should be < 0.90 (Muthén & Muthén, 1998 – 2011), and chi-square should be small relative to the degrees of freedom and non-significant. Although chi-square is the traditional measure for assessing model fit, there are a number of limitations in its use (for a detailed account of these limitations see Hooper, Coughlan, & Mullen, 2008). As such, the present study also evaluated model fit using Wheaton, Muthén, Alwin, and Summers' (1977) relative chi-square, which examines chi square relative to model degrees of freedom (χ^2/df). As per the recommendations of Ullman (2007), the present study will consider a ratio of 2.00 or less as indicative of acceptable ratio fit.

In order to examine gender differences, multiple-group analysis was conducted to compare an unconstrained version of the brief 8-item model with increasingly constrained versions that fixed factor loadings and intercepts to be equal across boys and girls. Given it is widely accepted that the testing of equality constraints bearing on error variances and covariances is excessively stringent and rarely achieved (Hair, Black, Babin, & Anderson, 2010; Selig, Card, & Little, 2008), only configural invariance, metric invariance, and scalar invariance was tested. If the constrained and unconstrained models were significantly different, follow-up analyses were conducted with partially constrained models to determine the degree of model stability across each sample. This process was repeated to assess age-group differences.

Missing values on the ChEDE (Sample 1 = 10; Sample 2 = 41) were imputed with the mean of their specified subscale as per the instructions of Fairburn, Cooper, and O' Connor (2008). Whilst this contrasts to recommended data imputation techniques (Enders, 2010; Rubin, 1996; Schafer & Graham, 2002), it may be viewed as appropriate for the ChEDE because it converges with the recommendations of the developers. Missing values predominantly arose on item 145 (*Feelings of Fatness*) as overweight participants were not asked this question pertaining to fatness as specified in the ChEDE administration protocol.

Six participants from Sample 1 were dropped from analyses for not completing the assessment battery due to having English as a second language. Finally, data were explored to ensure they met the assumptions required for a CFA. The sample size to estimated parameters ratio was acceptable for Sample 1 ($16:247 = 15.44$) and Sample 2 ($16:288 = 18$).

Results

Internal Consistency

Values obtained for Cronbach's alpha are shown in Table 2. This table shows the Cronbach's alpha of all ChEDE subscales, the ChEDE Global scale, and the brief 8-item scale for the combined samples (Sample 1 and Sample 2). Additionally, for Sample 1, Cronbach's alpha is shown in the overall sample and for boys and girls separately. For Sample 2, Cronbach's alpha is shown in the overall sample, for boys and girls separately, and for healthy-weight and overweight/obese children separately.

The superior reliability of scores on both the Global scale and the brief 8-item scale can be seen in the combined sample, and in the overall samples of both Sample 1 and Sample 2, with internal consistency values ranging from good to excellent. Although the reliability of these scores remained good to excellent in girls, reliability differed in boys. Specifically, internal consistency of the brief 8-item scale was adequate for boys in Sample 1 and good for boys in Sample 2. With the exception of the Shape Concern subscale, the reliability of scores on all other ChEDE subscales ranged from unacceptable to adequate across the subgroups, although reliability of these subscale scores in girls and in overweight/obese children was mostly adequate.

INSERT TABLE 2 HERE

Construct Validity

As a test of construct validity, the ChEDE Global scale and brief 8-item scale were compared to measures of body dissatisfaction and body shame. Pearson bivariate correlations showed that CBIS body dissatisfaction scores were significantly and positively correlated with scores on the ChEDE Global scale ($r = .30, p < .001$) and brief 8-item scale ($r = .32, p < .001$). Similar results were obtained for body shame, with correlations of $.44 (p < .001)$ for the Global scale and $.45 (p < .001)$ for the 8-item score. These findings were replicated in

both boys and girls for the ChEDE Global scale (body dissatisfaction boys: $r = .21, p < .05$; body shame boys: $r = .39, p < .001$; body dissatisfaction girls: $r = .32, p < .001$; body shame girls: $r = .50, p < .001$), and the brief 8-item scale (body dissatisfaction boys: $r = .22, p < .05$; body shame boys: $r = .31, p < .01$; body dissatisfaction girls: $r = .34, p < .001$; body shame girls: $r = .56, p < .001$).

Confirmatory Factor Analysis

When the one-factor 8-item model of the ChEDE was fitted to the data from Sample 1, a converged, admissible solution was obtained. The chi square statistic was significant, $\chi^2(20) = 108.46, p < .001$. Relative chi square was 5.42, exceeding the critical ratio of 2.00 stipulated for this study. Fit indices for this model (Table 3) indicate that the hypothesised factor model of the ChEDE was a poor fit to the data with RMSEA $> .05$ and WRMR > 0.90 .

INSERT TABLE 3 HERE

All individual parameters, however, loaded strongly and significantly with loadings between .54 and .90. Modification indices suggested multiple covariances among the observed variables, notably the inclusion of a covariance pathway between the importance of shape and the importance of weight items (MI value = 85.96). These items assess the importance of shape and weight respectively, and both items are answered according to the outcome of a practical sorting task. Given this methodological link between the two items, and the link between weight and shape, the inclusion of this pathway is theoretically justified and was employed. When the covariance pathway was added to the model, a converged admissible solution was obtained. The modified model provided an excellent fit to the data, $\chi^2(19) = 24.02, p = .20$. Relative chi square was 1.26, and fit indices for this model (Table 3)

indicate that the modified model was an excellent fit to the data with RMSEA $< .05$, TLI and CFI $> .98$, and WRMR < 0.90 . Additionally, all individual parameters continued to load strongly and significantly with loadings between $.56$ and $.93$ (Figure 1). The added covariance pathway was also significant.

Given that the modification to the model was data-driven, the modified model was fitted to the data of Sample 2 to cross-validate the results. The modified model chi square statistic was significant, $\chi^2(19) = 36.31, p < .01$, however relative chi-square, calculated as 1.90 , was less than the critical ratio of 2.00 , and fit indices for this model indicate that the modified model was an adequate to excellent fit to the data with an RMSEA of $.06$, TLI and CFI of 1.00 , and WRMR of 0.47 . Additionally, all individual parameters loaded strongly and significantly with loadings between $.60$ and $.95$. The added covariance pathway was also significant.

INSERT FIGURE 1 HERE

CFA gender differences. Given the low cell counts for higher scores on the ChEDE, multiple-group measurement invariance tests could not be run using the WLSMV estimator. As such, these analyses were conducted using the maximum likelihood estimation with robust standard errors (MLR) as this estimator is robust to violations of normality. Given the use of the MLR estimator, the Standardized Root Mean Square Residual (SRMR) was used instead of the WRMR. A value < 0.08 is indicative of adequate fit for the SRMR (Hu & Bentler, 1999).

As a preliminary analysis, the model depicted in Figure 1 was assessed separately for boys and girls. The measurement model, with all indicators freely estimated and factor variances set to 1, was an adequate fit in both genders, though a better fit in girls (boys:

$\chi^2(19) = 31.15, p = .04, \chi^2/df = 1.64, CFI = .96, TLI = .94, RMSEA = 0.05$ [90% CI = 0.01, 0.09], SRMR = .06; girls: $\chi^2(19) = 21.74, p = .30, \chi^2/df = 1.14, CFI = 1.00, TLI = .99, RMSEA = 0.02$ [90% CI = 0.00, 0.06], SRMR = .02). Additionally, inspection of the factor loadings for both boys and girls revealed that each indicator loaded significantly on its specified latent. Given this consistency, formal testing could proceed.

First, a baseline model was specified in which all parameters were freely estimated. The latent variables were fixed to 1.00 and the latent variable means were fixed to 0 in each group for identification purposes. The fit indices and model chi-square resulting from this specification are presented in Table 4. As can be seen, the model with all parameters freely estimated across genders fit the data well although overall chi-square was significant. The central requirement that the same item must be an indicator of the same latent factor in each group was met.

Second, to test for metric invariance, the chi-square from the baseline model was compared to a model where only factor loadings were constrained to be equal across groups. Fit indices and model chi-square from this constrained model can be seen in Table 4. When the difference between this model and the baseline model was evaluated statistically via the hand-calculated MLR chi-square difference test, a significant difference in fit was found, $\chi^2(8) = 18.07, p < .02$, indicating a significant drop in model fit for the full metric invariance model in comparison to the baseline model. The modification indices, however, did not suggest any points of localized misfit for the constrained factor loadings. As such, the freely estimated factor loadings from the baseline model were examined for large absolute differences between boys and girls. Item ChEDE144 (*Avoidance of Exposure*) had the largest overall difference between boys and girls. As such, this variable was freely estimated and the metric invariance model compared once more to the baseline model. No difference in fit

between the baseline model and the partially invariant metric invariance model was found, $\chi^2(7) = 11.91, p = .10$.

Given that only one indicator was found to be non-invariant across boys and girls, the degree of partial measurement invariance was sufficient to carry out further invariance analyses (Brown, 2006; Hair et al., 2010). The extent to which the commonly specified residual covariance between ChEDE140 and ChEDE141 was invariant across groups was therefore examined. The chi-square from the baseline model was compared to a model where both factor loadings (with the exception of ChEDE144) and the residual covariance were constrained to be equal across groups. Fit indices for this model can be seen in Table 4. No difference in fit was found, $\chi^2(8) = 12.71, p = .12$. The modification indices did not suggest any points of localized misfit for the constrained intercepts.

Finally, scalar invariance was examined. To test for scalar invariance, the chi-square from the baseline model was compared to a model where both factor loadings (with the exception of ChEDE144) and variable intercepts were constrained to be equal across groups. Fit indices for this model can be seen in Table 4. When the difference between this model and the baseline model was evaluated statistically, a significant difference in fit was found, $\chi^2(16) = 29.39, p = .02$. The modification indices did not suggest any points of localized misfit for the constrained intercepts. As such, freely estimated intercepts from the baseline model were examined for large absolute differences between boys and girls. The intercept for Item ChEDE141 (*Importance of Weight*) had the largest overall difference between boys and girls. When this variable was freely estimated and the partial scalar invariance model compared to the baseline model, a significant difference in fit was still found, albeit the difference was reduced ($\chi^2(15) = 28.30, p = .02$). Fit indices for this model can be seen in Table 4. Additional intercepts were therefore freed one at a time, however the drop in chi-square was minimal for each change in degrees of freedom and other fit indices did not significantly

improve. As such, in line with Byrne (2012), the partially scalar invariant model with ChEDE141 freely estimated was considered to appropriately represent the final test of intercepts related to the ChEDE.

INSERT TABLE 4 ABOUT HERE

CFA age differences. The procedure outlined above for invariance testing across genders was replicated for invariance testing across age groups. Participants were split into two age groups (6- to 8-year-olds and 9- to 11-year-olds).

As a preliminary analysis, the model depicted in Figure 1 was assessed separately for these age groups. The measurement model, with all indicators freely estimated and factor variances set to 1, was a better fit in the 9- to 11-year-olds ($\chi^2(19) = 30.77, p = .04, \chi^2/df = 1.62, CFI = .98, TLI = .97, RMSEA = 0.05$ [90% CI = 0.01, 0.08], SRMR = .03) than in the 6- to 8-year-olds: $\chi^2(19) = 49.22, p < .001, \chi^2/df = 1.14, CFI = .94, TLI = .91, RMSEA = 0.07$ [90% CI = 0.05, 0.10], SRMR = .05). As inspection of the factor loadings for both age groups revealed that each indicator loaded significantly on its specified latent, formal testing could proceed.

The fit indices and model chi-square resulting from a baseline model in which all parameters were freely estimated are presented in Table 5. As can be seen, the model with all parameters freely estimated across age groups provided an adequate fit to the data although overall chi-square was significant. The central requirement that the same item must be an indicator of the same latent factor in each group was met.

The fit indices and model chi-square resulting from a metric invariance model in which only factor loadings were constrained to be equal across groups are presented in Table 5. When the difference between this model and the baseline model was evaluated statistically

via the hand-calculated MLR chi-square difference test, a significant difference in fit was found, $\chi^2(8) = 33.31, p < .001$, indicating a significant drop in model fit for the full metric invariance model in comparison to the baseline model. Inspection of modification indices revealed that item ChEDE138 (*Dissatisfaction with Shape*) was particularly problematic. This variable was freely estimated and the metric invariance model compared once more to the baseline model. A significant difference between the baseline model and the partially invariant metric invariance model remained, $\chi^2(7) = 16.52, p = .02$, however the modification indices did not suggest any further points of localized misfit for the constrained factor loadings. As the model was found to be non-invariant across age-groups at the metric level, further analyses were not conducted.

INSERT TABLE 5 ABOUT HERE

Discussion

The present study sought to psychometrically evaluate the ChEDE by examining the reliability and factor structure of its scores in two community-based samples of children, one including overweight and obese children. The reliabilities obtained for all subscales in the present study are comparable to those obtained by Wade et al. (2008). In the combined sample of participants, and in Sample 1 and Sample 2 overall, the brief 8-item scale demonstrated good reliability, and the Global scale demonstrated excellent reliability. The reliability of these two scales was superior to all other subscales, supporting previous research by Byrne et al. (2010) and Wade et al. (2008).

When the reliability of the brief 8-item scale was examined separately in boys and girls, a varied picture emerged. Cronbach's alpha was good to excellent in both samples of girls in the present study. Additionally, the alpha of .90 obtained when girls of both samples

were combined is consistent with previous research by Wade et al. (2008) who obtained a Cronbach's alpha of .91 in their female sample. The consistency across samples, and across studies, suggests that this brief 8-item scale is a reliable measure of eating disorder symptoms in girls. In boys however, reliability was mixed (albeit still adequate) across both samples used in the present study suggesting that further research into the applicability of this 8-item scale in boys is warranted. Scores on the Global scale, however, were good to excellent in boys and girls of both samples, and the Cronbach's alpha obtained for the combined two samples of girls (.93) is comparable to the alpha of .91 obtained by Wade et al. (2008). As such, in settings where assessment lengths are not problematic and administration of the entire ChEDE protocol is feasible, use of the Global scale as an index of eating disorders symptoms over the brief 8-item scale is recommended.

The superior reliability of the 8-item scale and Global scale was also demonstrated in each of the weight classification categories of Sample 2. In healthy-weight and overweight/obese participants, these scales demonstrated superior reliability in comparison to the Weight Concern and Shape Concern subscales, supporting previous research by Byrne et al. (2010). It is important to note however, that in healthy-weight participants, the brief 8-item scale was only bordering on acceptability. Indeed, all subscale reliabilities were significantly lower in healthy-weight participants. This result is not surprising given the ChEDE was originally intended for use as a diagnostic tool in clinical populations.

Results from the CFA provide some support for these reliability findings. Although the initial specification of the one-factor 8-item model did not provide an acceptable fit to the data for the first community-based sample, the inclusion of a covariance pathway between two highly related items assessing the importance of shape and importance of weight respectively substantially improved the fit of this model. When this data-driven model was fitted to the data from the second community-based sample, fit indices suggested excellent

fit, although model chi square was significant suggesting further replication is required. These findings are comparable however, to those of Allen, Byrne, Lampard, Watson, and Fursland (2011) who conducted a confirmatory factor analysis of the Eating Disorder Examination Questionnaire (EDE-Q) in a community-based and an eating-disordered sample of adults. In their study assessing several proposed factor structures of the EDE-Q, the only model to provide an acceptable fit to the data was the brief 8-item factor model. This model demonstrated acceptable fit to the data in both the eating disorder and community samples. It was also the only model, of the three retained for multiple-group analysis, to demonstrate measurement stability across groups. Combined with the results from the present study, this suggests that the brief 8-item one-factor model should be retained over other suggested factor structures.

The measurement invariance testing process demonstrated that the one-factor 8-item factor model of the ChEDE was partially invariant across genders, with boys and girls differing on the avoidance of exposure item. Factor loadings suggested that this parameter estimate was larger in girls than in boys. Although this suggests that comparing boys and girls on the 8-item ChEDE measure may be problematic, the item in question did significantly load on the latent variable for both boys and girls. As such, researchers may still compare boys and girls on this measure, however further investigation of the avoidance of exposure item is recommended as this item may be useful for researchers wanting to explore differences in the presentation of eating disorders across boys and girls.

Measurement testing examining invariance across age groups demonstrated that the brief 8-item model of the ChEDE significantly differed across age groups, providing a better fit to the data in the older children (9- to 11-year-olds). This brings into question the stability of the measure when used with very young participants. Researchers should therefore be cautious when comparing children of different age groups and at different developmental

stages as items of the ChEDE may have a different meaning and may or may not be sufficiently stable depending on the age of participants being examined. It is also worth noting that Sample 2 comprised children age 8 – 11 years. By contrast, Sample 1 comprised children aged 6 – 11 years. It is therefore possible that the invariance demonstrated across age groups may have been due to sample differences in addition to age differences. Further investigation of measurement invariance across age groups is therefore needed.

Finally, tests of construct validity revealed that the brief 8-item scale correlated significantly with measures of body dissatisfaction and body shame. This is not surprising given the 8-item scale comprises items from the Weight and Shape Concern subscales of the ChEDE. As such, although these validity findings support the use of the 8-item scale as a cognitive and affective measure of eating disorder symptoms, comparison of this scale to other scales that assess both cognitive and behavioural eating disorders symptoms (such as the Eating Attitudes Test; Garner & Garfinkel, 1979), is warranted.

Strengths and Limitations

The large sample size of the present study allowed for the use of CFA to test the theoretical model in two separate samples. The use of CFA as a statistical technique gave several advantages over regression modelling, including its more flexible assumptions, its ability to test models overall rather than coefficients individually, and its ability to offer an index of how well the proposed model fit the given data set. This constituted a significant strength of this present study. However the present study had some limitations that need to be taken into account when interpreting the findings. First, the requirement of active parental consent resulted in a low participation rate of approximately 10% for Sample 1. Although it is typical for consent rates of studies requiring active consent to be significantly lower than those requiring passive consent (Pokorny, Jason, Schoeny, Townsend, & Curie, 2001), it

cannot be assumed that the sample was representative of the population from which it was drawn.

Second, particularly with respect to the ChEDE, the poor reliability coefficients obtained for the subscales and the significant covariance found between the importance of shape and importance of weight items may be due to the limited cognitive abilities in this young age group. Specifically, children may not be able understand certain aspects of the ChEDE, such as the distinction between weight and shape. They may also struggle with the conceptually difficult items that contain both a cognitive and a behavioural element, requiring children to make distinctions between intending to (“wanting”), attempting to (“trying”), and actually performing a behaviour (Goldschmidt, Doyle, & Wilfley, 2007). This is reflected in the multiple-group CFA whereby the 8-item model of the ChEDE provided a significantly better fit to the data in older children than in younger children. Despite this, an advantage of the ChEDE is that the interview process provides the opportunity for the interviewer to ensure the participant has a clear understanding of the different concepts by explaining each question clearly, increasing the chances that the child understands the complex nuances of some items. However, it is also important to note the possibility that results of the present study were influenced by the reliability of ChEDE administrations. Although care was taken to ensure assessment fidelity, and scores obtained by participants on the ChEDE were checked with the interviewer in the event of an unclear rating, inter-rater reliability ratings were not examined. As such, it is possible that the degree of variability in ChEDE administration, particularly given the range of training and clinical experience of interviewers, may have influenced the outcomes of the present analyses.

Finally, the use of a community-based sample precluded generalisation to children diagnosed with an eating disorder. The reporting of dietary restraint and the use of extreme methods of weight control in the first sample of participants was very uncommon, resulting in

little variance on the subscales. Larger reliabilities on the ChEDE may have been found if there was a greater severity of symptoms or greater variability in responses. Despite this, the finding that reliability was good to excellent for the brief 8-item scale and Global scale in this community-based sample suggests that the use of the scale can extend to non-clinical settings.

Conclusion

In summary, results provide support for the retention of a one-factor, 8-item model of the ChEDE and a global score based on all subscale items. Given the consistency across studies, it can be suggested that the brief 8-item model of the ChEDE may be useful, particularly when scores on the specific subscales are not needed. In clinical settings where the administration of the entire scale is important, a global score based on all subscale items has consistently been found to be more reliable than the original subscale scores. Additional research is required to extend and replicate these findings, particularly in boys, and with a broader range of young children diagnosed with Anorexia Nervosa, Bulimia Nervosa and the various forms of Eating Disorder Not Otherwise Specified.

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Table 1

Items Used in the Calculation of Each of the Examined ChEDE Scoring Methods

Scoring method	Item
Four subscale	
Restraint	(102 Restraint over eating + 103 Avoidance of eating + 104 Empty stomach + 105 Food avoidance + 106 Dietary rules)/5
Eating Concern	(107 Preoccupation with food + 108 Fear of losing control + 118 Social eating + 119 Eating in secret + 120 Guilt about eating)/5
Weight Concern	(135 Dissatisfaction with weight + 136 Strong desire to lose weight + 137 Reactions to prescribed weighing + 139 Preoccupation with shape/weight + 141 Importance of weight)/5
Shape Concern	(138 Dissatisfaction with shape + 139 Preoccupation with shape/weight + 140 Importance of shape + 142 Fear of weight gain + 143 Discomfort seeing body + 144 Avoidance of exposure + 145 Feeling of fatness + 146 Flat stomach)/8
Global score	(Restraint + Eating Concern + Weight Concern + Shape Concern) /4
Brief 8-item	(135 Dissatisfaction with weight + 137 Reaction to prescribed weighing + 138 Dissatisfaction with shape + 140 Importance of shape + 141 Importance of weight + 143 Discomfort seeing body + 144 Avoidance of exposure + 145 Feelings of fatness)/8

Table 2

Internal Consistency Reliabilities (Cronbach's Alpha) for the ChEDE Subscales in Both Samples

	<i>Combined</i>	<i>Sample 1</i>			<i>Sample 2</i>				
	O	O	B	G	O	B	G	H	Ov/Ob
ChEDE	<i>N</i> = 535	<i>N</i> = 247	<i>n</i> = 106	<i>n</i> = 141	<i>N</i> = 288	<i>n</i> = 125	<i>n</i> = 163	<i>n</i> = 147	<i>n</i> = 141
Restraint	.68	.64	.66	.62	.70	.67	.72	.27	.72
Eating Conc.	.59	.34	.03	.43	.67	.25	.76	.54	.65
Weight Conc.	.76	.73	.33	.77	.75	.73	.76	.33	.76
Shape Conc.	.88	.86	.62	.89	.89	.86	.90	.64	.89
Brief 8-item	.89	.88	.70	.90	.89	.88	.89	.69	.90
Global Score	.91	.89	.80	.91	.92	.90	.93	.73	.92

Note. O = Overall, B = Boys, G = Girls, H = Healthy-weight, Ov/Ob = Overweight/Obese

Table 3

Fit Indices for the One-factor ChEDE Model and Modified One-factor ChEDE Model

	Goodness of fit statistics			
	CFI	TLI	WRMR	RMSEA
One factor ChEDE model	.96	.94	0.99	0.13
Modified one factor ChEDE model	1.00	1.00	0.42	0.03

Note. TLI = Tucker-Lewis Index, CFI = Comparative Fit Index, WRMR = Weighted Root Mean Square Residual, RMSEA = Root Mean Square Error of Approximation.

Table 4

Summary of Mplus Tests for Measurement Invariance Across Gender

Model	χ^2	<i>df</i>	χ^2/df	CFI	TLI	RMSEA [90% CI]	SRMR
1. Baseline Model	53.22	38	1.40	.98	.98	0.04 [0.00, 0.06]	0.04
2. Metric Invariance	74.38	46	1.62	.97	.96	0.05 [0.03, 0.07]	0.14
3. Partial Metric Invariance (ChEDE144 loading freely estimated)	66.02	45	1.47	.98	.97	0.04 [0.02, 0.06]	0.11
4. Partial Metric Invariance Residual Covariance Invariance	66.48	46	1.45	.98	.97	0.04 [0.02, 0.06]	0.11
5. Scalar Invariance	82.44	54	1.53	.97	.97	0.04 [0.02, 0.06]	0.12
6. Partial Scalar Invariance (ChEDE141 intercept freely estimated)	81.52	53	1.54	.97	.97	0.05 [0.02, 0.06]	0.12

Note. TLI = Tucker-Lewis Index, CFI = Comparative Fit Index, RMSEA = Root Mean

Square Error of Approximation. SRMR = Standardized Root Mean Square Residual.

Table 5

Summary of Mplus Tests for Measurement Invariance Across Age Groups

Model	χ^2	<i>df</i>	χ^2/df	CFI	TLI	RMSEA [90% CI]	SRMR
1. Baseline Model	78.94	38	2.08	.96	.94	0.06 [0.04, 0.08]	0.04
2. Metric Invariance	118.33	46	2.57	.93	.91	0.08 [0.06, 0.09]	0.16
3. Partial Metric Invariance (ChEDE138 factor loading freely estimated)	96.08	45	2.14	.95	.94	0.07 [0.05, 0.08]	0.12

Note. TLI = Tucker-Lewis Index, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation. SRMR = Standardized Root Mean Square Residual.

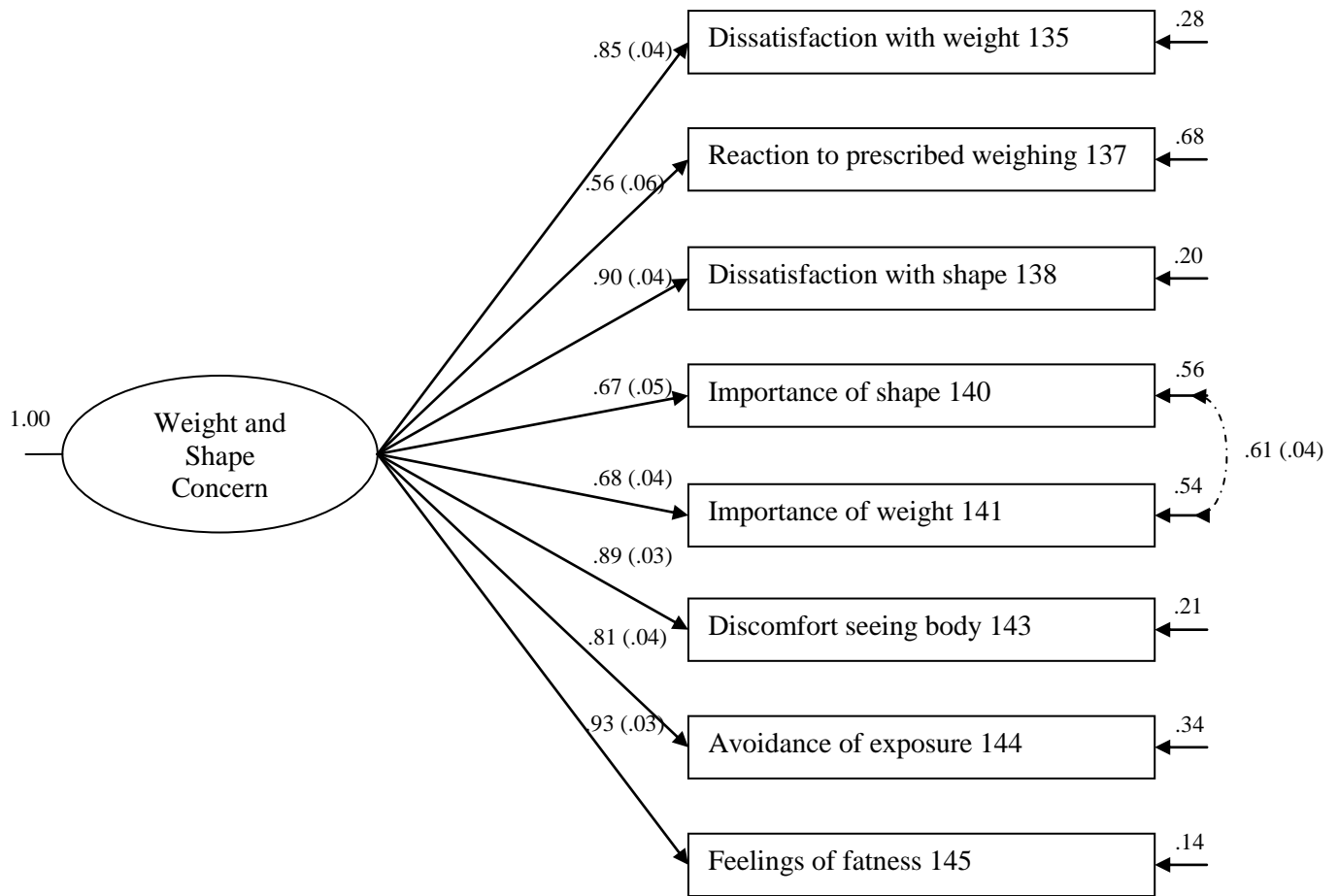


Figure 1. Standardised item coefficients (and standard errors) for a modified one-factor 8-item model of the ChEDE in Sample 1. The covariance pathway added following modification to the model is depicted by the broken line.