Maternal report of young children's eating styles: Validation of the Children's Eating Behaviour Questionnaire in three ethnically diverse Australian samples

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Abstract

The aim of this study was to validate the Children's Eating Behaviour Questionnaire (CEBQ) in three ethnically and culturally diverse samples of mothers in Australia. Confirmatory factor analysis utilising structural equation modelling examined whether the established 8-factor model of the CEBQ was supported in our three populations: (i) a community sample of first-time mothers allocated to the control group of the NOURISH trial (mean child age=24 months [SD=1]; N=244); (ii) a sample of immigrant Indian mothers of children aged 1-5 years (mean age=34 months [SD=14]; N=203), and (iii) a sample of immigrant Chinese mothers of children aged 1-4 years (mean age=36 months [SD=14]; N=216). The original 8-factor model provided an acceptable fit to the data in the NOURISH sample with minor *post hoc* re-specifications (two error covariances on Satiety Responsiveness and an item-factor covariance to account for a cross-loading of an item (Fussiness) on Satiety Responsiveness). The re-specified model showed reasonable fit in both the Indian and Chinese samples. Cronbach's α estimates ranged from .73— .91 in the Australian sample and .61—.88 in the immigrant samples. This study supports the appropriateness of the CEBQ in the multicultural Australian context.

The capacity to regulate food (energy) intake to maintain energy balance is key to preventing excess weight gain. Infants are born with an innate capacity to self regulate energy intake (DiSantis, Hodges, Johnson, & Fisher, 2011) but individual differences in appetite (Parkinson, Drewett, Le Couteur, & Adamson, 2010) and eating behaviours (Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2011) emerge during infancy and co-evolve throughout childhood and beyond (Ashcroft, Semmler, Carnell, Van Jaarsveld, & Wardle, 2007). Both genetic and environmental influences are thought to be important (Lillycrop & Burdge, 2011). Although physical activity contributes to energy balance, food intake is a pernicious contributor to weight gain. There is strong evidence that children's eating behaviours (often grouped as food approach/responsive vs. food avoidance/satiety responsive) are important determinants of individual variability in children's weight status (Birch & Fisher, 1998; DiSantis et al., 2011; Sleddens, Kremers, & Thijs, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). Early environmental influences including parental feeding practices such as excessive control (Birch & Fisher, 1998; Johnson & Birch, 1994) and emotional use of food (e.g., as a reward or to calm/comfort) (Chan, Magarey, & Daniels, 2010) potentially override this intrinsic regulation and compromise children's ability to effectively use hunger and satiety signals. Nevertheless, the relationship between children's eating behaviours and parental feeding practices is likely to be bi-directional (Farrow, Galloway, & Fraser, 2009; Gregory, Paxton, & Brozovic, 2010; Webber, Cooke, Hill, & Wardle, 2010). Thus, children's eating behaviours appear to be an important determinant of children's food intake and resultant weight gain (inadequate/adequate/excess), and may also correlate to parents' feeding practices.

The capacity to reliably and validly measure children's eating behaviours has both practical (e.g., early identification of high risk eating behaviours) and theoretical implications (e.g., important mediator or moderator in theoretical models of relationship between various parent feeding practices and weight outcomes (Ventura & Birch, 2008)). Moreover, measurement methods that are feasible at a population level, and sensitive to cultural and/or ethnic differences, are critical for understanding both individual- and group-based differences in resilience/susceptibility to excess weight gain in the context of an obesogenic environment. Direct observation may be considered the ideal method for the measurement of individual eating styles/behaviours. However, direct observation methods are extremely costly, particularly in large community samples and are not without difficulties such as potential to influence the behaviour of interest and limitations in capturing "usual" behaviour. The Children's Eating Behaviour Questionnaire (CEBQ; Wardle, Guthrie, Sanderson, & Rapoport, 2001) is a widely-used parent-report tool that assesses children's eating styles related to both obesity risk and under-eating.

The CEBQ was developed by Wardle et al. (2001) to assess "food approach" (Food Responsiveness, Enjoyment of Food, Desire for Drinks, and Emotional Overeating) and "food avoid" (Satiety Responsiveness, Slowness in Eating, Fussiness, and Emotional Undereating) eating behaviours. A cyclic process of testing and culling items from a large pool was conducted in three samples of families in the UK with children aged between 2-9 years (N=131; N=187, N=218) to produce the final 35-item instrument. The factor structure of the final questionnaire was explored in the third sample via Principal Components Analysis (PCA). Although postulated constructs were likely to be correlated, and resulting subscales were significantly so (*r* values= -.61 to .55), a varimax (rather than an oblique) rotation solution was utilised. In this solution, items from both the Satiety Responsiveness and Slowness in Eating subscales loaded onto a single factor. Nevertheless, the authors argued to retain these constructs as separate subscales due to their theoretical distinctiveness and the reasoning that these constructs might be more distinguishable in older children.

Subsequently, the same researchers demonstrated moderate convergent validity of selected subscales of the CEBQ in a UK sample of 4-5 year old children (N=111). Eating without hunger, mean eating rate and mean total energy intake were found to account for 56%, 33% and 40% of the variance in Satiety Responsiveness/Slowness in Eating, Food Responsiveness, and Enjoyment of Food subscales, respectively (Carnell & Wardle, 2007).

A number of studies have assessed the applicability of the CEBQ in populations other than the one in which it was developed (i.e., well-educated parents of children aged 2-9 years living in the UK). For example, the factor structure of the CEBQ and/or relationship with child weight have been explored in Dutch children 6-7 years of age (Sleddens, Kremers, De Vries, & Thijs, 2010); Swedish children 1-6 years (Svennson et al., 2011); Portuguese children 3-13 years (Viana, Sinde, & Saxton, 2008), and Chinese children 12-18 months (Cao et al., 2012). Problems at both the item and factor level have emerged in these studies. For instance, Cao et al. (2012) indicated that the CEBQ in its original form may be not be applicable to some non-Western cultures (i.e., Chinese) and proposed (based on PCA) an alternative 19-item version of the tool. In these studies, the extant factor structure of the CEBQ was assessed either by considering estimates of the internal reliability of the subscales (e.g., Cronbach's α) and the subscale inter-correlations, or via PCA.

Confirmatory Factor Analysis (CFA) is considered to be the 'gold standard' for validating hypothesised factor structures ('models') and has been used to validate parent-report questionnaires commonly used in the context of childhood obesity research (e.g., Child Feeding Questionnaire; Birch et al., 2001). Although convergent validity (e.g., correlation with child weight or behavioural measures of eating) of a sub-set of the CEBQ subscales (factors) has been examined (Carnell & Wardle, 2007), CFA of the CEBQ factor structure had not been undertaken until very recently (Sparks & Radnitz, 2012). This recent CFA did not replicate the hypothesised factor structure of the CEBQ in low-income, predominantly

Hispanic (57%) or African American (25%) families of 2-5 year old children (N=179) in the New York City area. Here we contribute a CFA validation of the CEBQ in Australian, Chinese, and Indian samples, in order to provide evidence to inform considerations on the sensitivity of the factor structure to cultural differences.

In summary, the CEBQ is a widely used tool; however the sole study in which CFA has been used failed to replicate the predicted model (Sparks & Radnitz, 2012) and the cultural appropriateness of the CEBQ for non-western populations has been questioned in exploratory analyses (Cao et al., 2012). To our knowledge no validation attempts have been made within the Australian context in either Caucasian or ethnic minority samples. Yet prevalence rates of childhood overweight and obesity in Australia have more than doubled since the 1980s (Olds, Tomkinson, Ferrar, & Maher, 2009), with recent data indicating that almost a quarter of Australian children 2-8 years are overweight or obese (Department of Health and Ageing, 2008). The influence of the current 'obesogenic' environment appears to also impact (via acculturation) children from non-western immigrant families (Demory-Luce, Morales, & Nicklas, 2005; Green et al., 2003; Rovillé-Sausse, 2005), thus inclusion of ethnic minority groups in research in this space is similarly critical. In the most recent Australian census (ABS, 2011), Chinese and Indians were the third and fourth largest immigrant groups after British and New Zealanders; representing 6% and 5.6% of the 26% of Australians born overseas.

The aim of this study was to use CFA to evaluate the original factor structure and internal reliability of the CEBQ (Wardle et al., 2001) as a measure of child eating behaviour in three culturally and ethnically diverse samples of Australian mothers: (i) a community sample of mothers of 2 year old children; (ii) a sample of immigrant Indian mothers of 1-5 year old children, and (iii) a sample of immigrant Chinese mothers of 1-4 year old children. A secondary aim was to examine the association between CEBQ subscale scores and measured child weight in the NOURISH sample in order to provide a test of convergent validity.

Method

Participants

Sample 1: NOURISH trial

Sample 1 comprised 244 Australian (82% born in Australia/New Zealand; 91% living in Australia >10 years) first-time mothers who were allocated to the control group of the NOURISH randomised controlled trial (RCT) (Daniels et al., 2009) and who completed a self-administered questionnaire at the second follow up (20 months from baseline, child age 2 years). The NOURISH RCT evaluated an early feeding intervention conducted in two Australian cities (Brisbane, Queensland and Adelaide, South Australia). A consecutive sample of first-time mothers (≥18 years old) who had delivered a healthy term infant (>35 weeks, >2500g) and facility with English were approached whilst still in hospital. The protocol and details regarding selection and retention bias have been described elsewhere (Daniels et al., 2009; Daniels et al., 2012). The overall response rate was 44% and of the 698 mothers allocated at baseline (control and intervention), 67% completed the self-administered questionnaire at the second follow up.

Sample 2: Indian

Sample 2 included 203 Indian mothers living in Australia. Eligibility criteria were: mothers born in India, ≥18 years of age, at least one child 1-5 years of age, facility with English and residing in Australia for 1-8 years. Participants were recruited using convenience sampling. via online social networks, informal networks of friends and families and through 576 recruitment sources that comprised of Indian associations (n=274), media networks (n=34), worship places (n=97) and retail outlets (n=198). The questionnaire was provided in both electronic and hard-copy format. Participants completed the questionnaire (in English) with respect to their youngest child between 1-5 years of age. Estimated response rates for hard-copy questionnaires ranged from 5-17%, but could not be calculated for online questionnaires.

Sample 3: Chinese

Participants in sample 3 were 254 Chinese mothers living in Australia for no more than 10 years. All participants were born in mainland China, Hong Kong, Macau or Taiwan; regions of origin considered as representative of Chinese immigrants in past literature (Cheah, Leung, Tahseen, & Schultz, 2009). Participants were recruited via a convenience sampling technique, such as placing recruitment messages on online forums or in local Chinese Newspapers. Recruitment flyers and questionnaires were distributed by the researcher at childcare centres, playgroups, Chinese shops or Chinese language schools. Participants completed either an online or pen- and- paper questionnaire (in Chinese and English) with respect to their youngest child between 1-4 years of age. Response rates could not be estimated.

Measures

Child Eating Behaviours

The Children's Eating Behaviour Questionnaire (CEBQ; Wardle et al., 2001) is a 35 item tool that measures eight factors (subscales) scored 1(Lowest) to 5(Highest): Satiety responsiveness (5 items, e.g., *My child gets full up easily*); Slowness in eating (4 items, e.g., *My child eats slowly*); Fussiness (6 items, e.g., *My child refuses new foods at first*); Food responsiveness (5 items, e.g., *My child's always asking for food*); Enjoyment of food (4 items, e.g., *My child enjoys eating*); Desire for drinks (3 items, e.g., *My child is always asking for a drink*); Emotional Undereating (4 items, e.g., *My child eats less when s/he is upset*), and Emotional Overeating (4 items, e.g., *My child eats more when anxious*).

For sample 3, both English and Chinese versions of the CEBQ were presented side by side. A translation-back-translation procedure was performed by four bilingual postgraduate students who had a health science background and were independent of the study to ensure the accuracy of the Chinese version. For samples 2 and 3 the questionnaire was pre-tested (to check for basic understanding) with a convenience sample of 14 Indian immigrant mothers and 18 Chinese immigrant mothers, respectively. None of the mothers participating in the pre-test studies were included in the final study samples.

Demographic characteristics

Data on child gender, age (months), maternal age (years) and maternal education, and years living in Australia were collected for each sample (Table 1). Maternal BMI (kg/m^2) was calculated based on height and weight (measured by trained staff at baseline in sample 1 and self-reported in samples 2 and 3). Child weight and height were measured twice (or three times if measures differed by >.5 kg/cm) by trained staff for participants in sample 1 (NOURISH trial; Daniels et al., 2009), but were self-reported in samples 2 and 3. Measurements were converted to a weight-for-age Z-score (WAZ) using the World Health Organization (WHO, 2006) Anthro software program version 3.0.1 and macros. Due to potential reporting bias and increased measurement error associated with self-reported anthropometric data, these data were not considered comparable across samples; thus any differences or similarities across groups would be uninformative. Data are presented in Table 1 for descriptive purposes only.

Statistical Analysis

Confirmatory factor analysis using structural equation modelling (AMOS V.19) tested whether the 35-item, 8-factor CEBQ model hypothesised in the original development paper by Wardle and colleagues (2001) was a good fit to the data for each of the three samples. Model specifications included correlated factors, uncorrelated error variances, and factor variances set to 1. The path diagram for the hypothesised model is presented in Figure 1 (upper left panel). The hypothesised model was un-identified. The aim of this validation analyses was to assess the construct validity of the CEBQ in culturally and ethnically diverse samples of mothers of young children living in Australia. To this end a sequential analysis was planned as follows: (i) adequacy of fit of the CEBQ in sample 1 was to be examined first, (ii) if required modifications to improve the fit were to be explored and (iii) the adequacy of the (respecified) model to fit the data from samples 2 and 3 was to be assessed.

Model fit was assessed using the following indices: root mean-square error of approximation (RMSEA); normed chi-square (χ^2/df); and Tucker Lewis Index (TLI)/Non-normed fit index (NNFI). To determine whether or not modified models improved fit over the original model, a Comparative Fit Index (CFI) was considered. Smaller values for RMSEA (ideally $\leq$.06) and values approaching .90 for NNFI/TLI and CFI (ideally >.90) are indicative of acceptable model fit to the data (Hu & Bentler, 1999). Normed chi-square (χ^2/df) values between 1.0-2.0 or 2.0-3.0 indicate a good or an acceptable fitting model, respectively (Byrne, 2001). Residuals, item-factor loadings, item variance (invariance), and modification indices (for consideration of potential error or item-factor co-variances) were also considered when evaluating model fit. Given that a range is normally proposed for fit indices and that not all will necessarily meet the ‘ideal’ cut-off criteria, we judged the acceptability of model fit on the relative closeness of fit indices to the ideal values and whether at least one index was within the recommended range. For the purpose of comparing alternative models, $\Delta\chi^2$ was referred to for assessing significance of change in χ^2.

Samples 1 and 2 had < 0.01% missing data and ≤1.6% missing data for all items. Thus, in order to avoid deletion of cases, missing data were imputed using maximum likelihood estimation in SPSS V.19. Due to a clerical error, two items were not printed in the hard-copy questionnaire for some participants in sample 3, resulting in 27% and 51% missing values on these items in sample 3. The items were not included in the CFA for sample 3 only (*My child takes more than 30 minutes to finish a meal* [Slowness in Eating] and *My child eats less when s/he is upset* [Emotional Undereating]). After removal of these items in sample 3, there were 2.3% missing data and up to 3.5% missing data for some items in this sample, thus a more conservative method of listwise deletion was used in this instance, reducing the size of sample 3 to N=216.

Descriptive analysis, Pearson's correlations to examine bivariate relationships between CEBQ unweighted scale means and child measured WAZ (sample 1 only), and multivariable linear regressions to examine these associations adjusting for child gender and maternal BMI were conducted in SPSS V.19.

Approval for NOURISH was obtained from 11 Human Research Ethics Committees covering Queensland University of Technology, Flinders University and all the recruitment hospitals (QUT HREC 00171 Protocol 0700000752). The trial was registered with the Australian and New Zealand Clinical Trials Registry Number (ACTRN) 12608000056392. The studies that provided data for samples 2 and 3 obtained ethics approval from Queensland University of Technology Human Research Ethics Committee (Approval numbers 1000000943 and 0900001173, respectively).

Results

Characteristics of participants – NOURISH trial (sample 1), immigrant Indian (sample 2) and Chinese mothers (sample 3) – are presented in Table 1. Briefly, the majority of mothers were well-educated; however the prevalence of completing a university degree was markedly higher in the immigrant samples (95% and 78% in Indian and Chinese samples, respectively) compared to the NOURISH trial sample (64%). The Chinese mothers were on average 3 years older (mean=35, SD=4 years) than the Indian (mean=32, SD=3 years) and NOURISH trial mothers (mean=32, SD=5 years).

Approximately half of the children in each sample were girls (sample 1: 52%; sample 2: 51%; sample 3: 48%). The mean age of the children in the NOURISH trial was younger and less varied (mean=24 months, SD=1 month) compared to the children of immigrant mothers (sample 2: mean=34 months, SD=14 months and sample 3: mean=36 months, SD=14 months). Mean duration of residence in Australia was 4.3 (SD=1.9) years in sample 2 and 5.7 (SD=2.8) years in sample 3.

Validation of the 8-Factor CEBQ

Sample 1: NOURISH trial

The hypothesised model (Model 1; see Figure 1, upper left panel) showed reasonable fit in sample 1: χ^2/df=1.89 was within the most desirable range (i.e., between 1.0-2.0); values of RMSEA=.061 (PCLOSE=.002), NNFI=.88 and CFI=.90 approached ideal levels. All factor variances were significant (p<.001), all factor-item loadings were significant (p<.001), all item standardized regression weights were above .3, and all item squared multiple correlations were above .1. Modification indices showed that model fit would be significantly improved with the addition of two error co-variances between the errors for the items on the Satiety Responsiveness factor: (i) *My child gets full up easily* and *My child gets full before* *his/her meal is finished*, and (ii) *My child leaves food on his/her plate at the end of a meal* and *My child gets full before his/her meal is finished.* Given the obvious overlap in the content/theoretical basis of these two pairs of items, error co-variances were specified between the items (Model 2; Figure 1, upper right panel). The item *My child is difficult to please with meals* from the Fussiness factor showed high cross-loading on the Satiety Responsiveness factor. Arguably, a child with higher Satiety Responsiveness – measured here with items such as *My child gets full up easily* and *My child leaves food on his/her pate at the end of a meal* – may be perceived as more '*difficult to please with meals'*. This notion is consistent with the moderate correlation between these factors of *r*=.60. Based on this rationale, a covariance between the item and the factor Satiety Responsiveness was specified in Model 2 (Figure 1, upper right panel).

The re-specified model (Figure 1, upper right panel) demonstrated a significantly improved ($\Delta\chi^2(\Delta df)$=104.85(3), *p*<.001) fit compared to Model 1. Fit indices showed improvement and exceeded ideal levels: RMSEA=.048 (PCLOSE=.15); χ^2/df=1.70; NNFI=.91 and CFI=.92. Thus, Model 2 with two error co-variances and one item-factor covariance specified (Figure 1, upper right panel) was then tested in samples 2 and 3.

Sample 2: Indian

In the Indian immigrant sample, Model 2 (Figure 1, lower left panel) indicated a reasonable fit to the data: RMSEA=.059 (PCLOSE<.001) and χ^2/df=1.86 fell within the ideal range, and NNFI=.81 and CFI=.83 approached ideal values. All factor variances were significant (p<.001). However, the item *My child is difficult to please with meals* (Fussiness) had a small and non-significant item-factor loading (β=.02, *p*=.86), but a high cross-loading on Satiety Responsiveness (β=.72, *p*<.001). Another item, *My child cannot eat a meal if s/he has had a snack just before* (Satiety Responsiveness), had a small but significant item-factor loading (β=.29, *p*<.001) and a low squared multiple correlation (.082). In all other instances factor-item loadings were significant (p<.001), standardized regression weights (β) >.3, and item squared multiple correlations >.1 (Figure 1, lower left panel).

Sample 3: Chinese

Due to the necessary deletion of two items as discussed in the Methods section, Model 2 was modified accordingly before being tested in the Chinese sample (Figure 1, lower right panel). Of the three samples, model fit was the weakest in this sample: RMSEA=.076 (PCLOSE<.001), NNFI=.80 and CFI=.82 approached ideal values, and χ^2/df=2.24 was within the range for a reasonable fitting model. As was the case in samples 1 and 2, the item *My child is difficult to please with meals* appeared to have a stronger loading on the Satiety Responsiveness factor (β=.52, p<.001) than the original Fussiness factor (β=.17, p<.01). All other item-factor loadings were significant (all β >.30, p<.001), and item squared multiple correlations >.1.

Mean Scores and Internal Reliability of the CEBQ

Unweighted mean subscale scores (±SD) and internal reliability estimates are presented in Table 2 for samples 1-3. In all samples, mean values were above the scale mid-point (2.5) for 6/8 factors, however Food Responsiveness and Emotional Overeating mean scores were lower. Cronbach's α estimates ranged from .73—.91 in the NOURISH sample, .61—.88 in the Indian sample and .61—.87 in the Chinese sample. Correlations (Pearson's r) between unweighted mean subscale scores and measured child weight status (WAZ) in sample 1 were calculated to assess convergent validity (Table 2). Satiety Responsiveness (r=-.18) and Slowness in eating (r=-.21) were both negatively associated was child WAZ, ps <.01. No other correlations with WAZ were significant, rs <.10, ps >.05. Adjusting for child gender and maternal BMI did not change the interpretation of these relationships (data not shown).

Discussion

The CEBQ was designed to measure both food approach (Food Responsiveness, Emotional Overeating, Enjoyment of Food, Desire for Drinks) and food avoidance (Fussiness, Satiety Responsiveness, Slowness in Eating, Emotional Undereating) behaviours related to over- and under-eating in children (Wardle et al., 2001). In this study we evaluated the hypothesised 8-factor structure of the CEBQ in three culturally and ethnically diverse Australian samples of mothers of young children (aged 1-5 years). Results from CFA showed that the 8-factor model provided a good fit to the data in the NOURISH sample of Australian first-time mothers of two-year-old children. In both the Indian and Chinese samples, model fit indices were comparatively worse than in the NOURISH sample, but indicated reasonable fit to the data. Internal reliability of the subscales was good (Cronbach's $\alpha \geq .70$) in the majority of instances. Two exceptions were Satiety Responsiveness (sample 2: Cronbach's α =.61) and Emotional Undereating (sample 3: Cronbach's α =.61). Child measured WAZ was negatively correlated with both Satiety Responsiveness and Slowness in Eating subscales in the NOURISH sample; providing some evidence for convergent validity. Overall, this study supported the construct validity of the 8-factor CEBQ model in all three samples and provided no compelling evidence for 'limited cultural appropriateness' of the questionnaire in these populations.

In all three samples Satiety Responsiveness and Slowness in Eating factors were strongly correlated (sample 1 and 2, r=.80, sample 3, r=.77, ps<.001). This observation mirrors previous work (Wardle et al., 2001). In some past research a combined "Satiety Responsiveness/Slowness in Eating" factor has been calculated using either all or a sub-set of items from the two scales (Carnell & Wardle, 2007; Webber et al., 2009) and for the only prior validation attempt via CFA the factors were also combined (Sparks & Radnitz, 2012). However, as noted in the original development paper (Wardle et al., 2001), retaining these factors as individual constructs has theoretical merit; the two eating behaviours are considered theoretically distinct, despite high statistical relatedness. Given the high correlation between these subscales, the relationship of each to child weight status as observed in sample 1 is likely an overestimate. Thus, to use CEBQ subscales as “predictors” of child weight status in longitudinal designs one would need to take the potential multicollinearity between these factors into account by either combining the factors or using a multivariable statistical approach.

Two anomalies that emerged in the factor-factor covariance estimates are worth considering. First, the Desire for Drinks factor was positively associated with both food approach (e.g., Food Responsiveness) and avoid (e.g., Emotional Undereating, Slowness in Eating) factors (see Figure 1, upper right and lower panels). These findings are surprising given that Desire for Drinks was originally conceptualised as an indicator of obesity risk (desire to drink sweetened beverages; e.g., soft drinks) and at least in older children (7-12 years; N=406) has been associated with higher weight status (Webber et al., 2009). Australian survey data show that soft drink consumption increases with age (Clifton, Chan, Moss, Miller, & Cobiac, 2011) and that prevalence of consumption is relatively low in young children – in a study of children 12-36 months (N=374), only 9% consumed soft drink in the previous 24 hours (Chan, Magarey, & Daniels, 2010). Thus the relevance of this factor may be age dependent. It is also important to note that the Desire for Drinks items do not explicitly make reference to the types of drinks (e.g., soft drinks). Review of studies that have employed the CEBQ revealed that most either did not show an association between Desire for Drinks and child weight (convergent validity) (Cao et al., 2012; Sleddens, Kremers, & Thijs, 2008), or did not measure/report on this construct (Carnell & Wardle, 2007; Carnell & Wardle, 2008l Viana, Sinde, & Saxton, 2008). Taken together, this factor may have limited utility in terms of measuring the underlying obesity-risk behaviour of consuming too many sweetened beverages, at least in younger children.

The second anomaly appeared in sample 1: a small but significant positive correlation (r=.28, p<.001) was found between Emotional Undereating and Emotional Overeating factors. This relationship was not observed in either sample 2 or 3 (rs =.11 and .04, ps >.26). As such, the finding should be interpreted with caution, but one explanation is that it may reflect on the very narrow age range of the children in sample 1. Perhaps "emotional" eating behaviours in toddlers are less well defined and have less developmental relevance than in older children and as such may co-vary to some extent. It could also be that reliably distinguishing or identifying these emotions (worried, angry, annoyed, anxious) in 2 year olds is relatively more difficult than in older children. Planned follow up of these children from the NOURISH study at age 5 years may shed some light on this finding.

Strengths and Limitations

As noted earlier, although widely used, exploration of the factor structure of the CEBQ has predominantly been via 'data-driven' methods (e.g., PCA and other EFA methods) rather than 'theory-driven' validation techniques such as CFA. The cultural relevance of the CEBQ for non-western populations has previously been questioned (Cao et al., 2012). Here, we show that in the multicultural Australian context, the CEBQ appears to be a reliable tool for use in different ethnic/cultural populations of (predominantly) highly educated mothers from both western and non-western backgrounds.

The current study has a number of important limitations to consider. Firstly, the overall level of education of the mothers in all samples was very high (although typical for immigrants under Australia's skilled migration policy), thus generalisability of the present findings beyond predominantly well-educated populations is unknown. Secondly, there was no objective measure of child eating against which to assess the convergent validity of the constructs. Convergent validity assessed against measured child weight in the NOURISH sample showed only two (highly inter-correlated) subscales of the CEBQ to be significantly associated with child weight. Thirdly, it was not possible due to sample size to restrict samples 2 and 3 to only 2 year olds to make the three samples totally comparable. Furthermore, given that over one fifth of children in the Chinese sample were between the ages of 1-2 years, these children were included in the present analysis although the CEBQ was originally developed for children from 2 years of age (Wardle et al., 2001). Fourthly, due to the necessary deletion of two items from the model in the Chinese sample, the validation attempt via CFA in this sample could not be conducted entirely as planned. Finally, although the results of this study point to the cultural appropriateness of the questionnaire for both Australian-born and immigrant mothers of young children, the secondary data analysis nature of the study design may not be sensitive to cultural differences in interpretation of questionnaire items, nor capture an adequate range of items to conceptualise eating behaviour constructs in these cultures. However, pre-testing of the questionnaire (to check for basic understanding) with Indian and Chinese migrant mothers did not reveal any specific issues.

Future directions

Given that food approach eating behaviours appear to increase with age (Ashcroft et al., 2007), the impact on weight gain is likely best studied in longitudinal designs. The NOURISH trial will allow for examination of the continuity and stability (e.g., Ashcroft et al., 2007) of both child eating behaviours and parental child feeding practices at age 2 (present data) and at age 5 (final follow up), and enable the relationship between these behaviours and children's weight gain, dietary intake and food preferences to be examined longitudinally. These and other future analyses should ideally be conducted using structural equation modelling in favour of standard regression approaches in order to account for the modifications (covariances and cross-loading tweaks) to the CEBQ model.

Conclusion

The importance of valid and reliable measurement of behavioural constructs is critical for estimating the nature and strength of hypothesised relationships between behaviours and outcomes of interest. Valid measures are also essential for the meaningful integration of different constructs into more complex models of relationships between different behaviours (e.g., parental feeding practices and children's eating styles) and outcomes (e.g., child weight status). The present study supports the cross-cultural utility of the CEBQ as a tool for assessing the eating behaviours of young children living in Australia, and highlights the appropriateness of structural equation modelling approaches to multivariate analysis over standard regression approaches.

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Table 1. Characteristics of mothers and children in three ethnically diverse Australian samples.

Maternal and Child Characteristics	Sample 1 (N=244) NOURISH [a] mothers	Sample 2 (N=203) Indian mothers	Sample 3 (N=254) Chinese mothers
		mean ± SD or % (n)	
Maternal age (years)	32 ± 5	32 ± 3	35 ± 4 (n = 246)
Maternal education (University degree)	64 (155)	95 (191; n=202)	78 (192; n=245)
Maternal BMI [b]	26.1 ± 5.6	24.4±3.9	21.5 ± 2.9 (n=238)
Length of residency in Australia (years)	n/a	4.3 ± 1.9 (n=106)	5.7 ± 2.8 (n=248)
Child age (months)	24 ± 1	34 ± 14 (n=203)	36 ± 14 (n=246)
Child gender (girl)	52 (127)	51 (103; n=203)	48 (116; n=243)
Child weight-for-age Z-score (WAZ) [c]	0.70 ± 0.89 (n=243)	0.24 ± 1.79 (n=195)	0.25 ± 1.02 (n=230)

Different n values indicate missing data. [a] Mothers from the control group of the NOURISH randomised controlled trial (Daniels et al., 2009). [b] Maternal BMI (kg/m^2) based on height and weight measured at NOURISH baseline in sample 1 and self-reported in samples 2 and 3. [c] Weight for age Z-score (World Health Organisation, 2006) based on measured weight (sample 1) or mother-reported weight (samples 2 and 3).

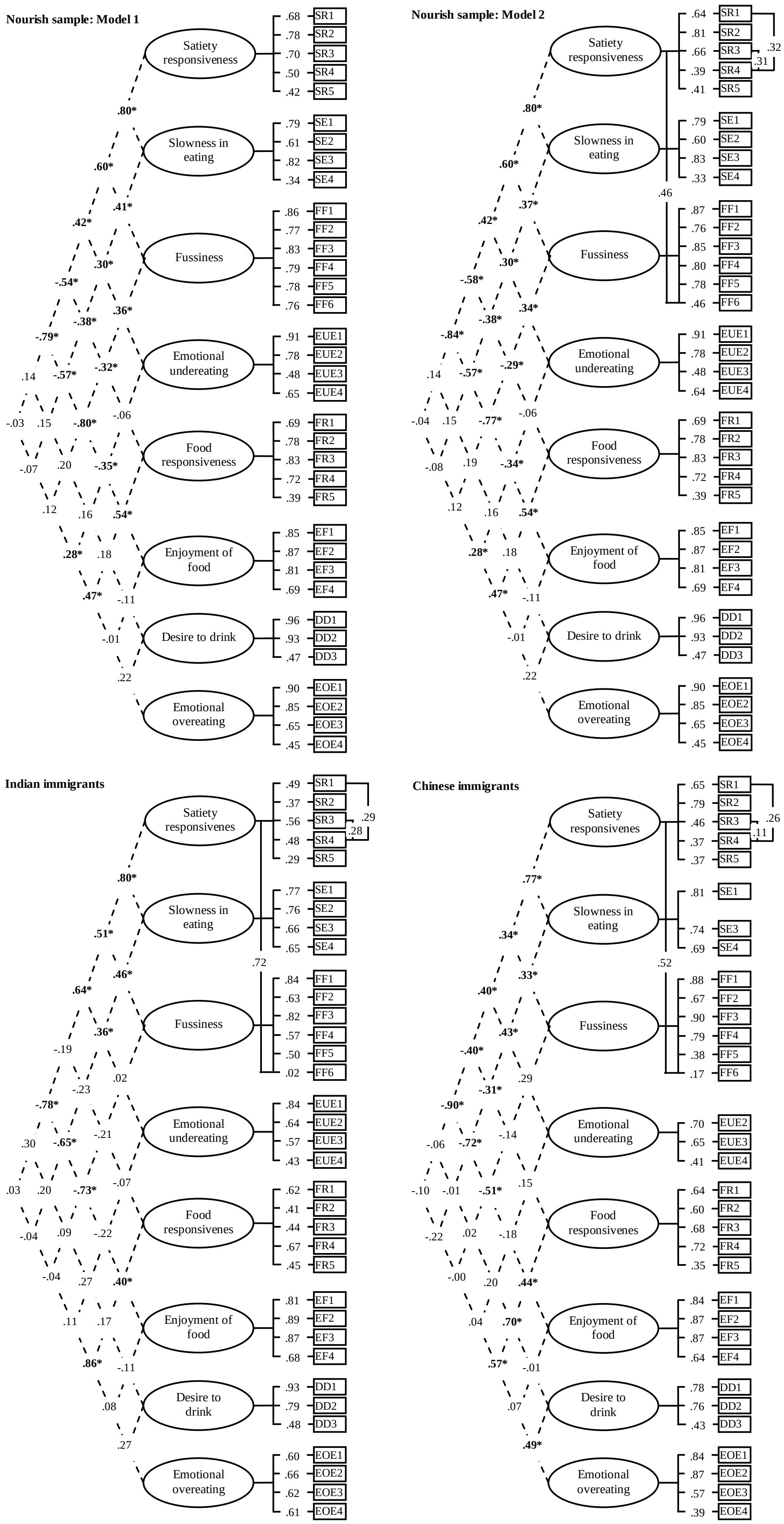
Table 2. Descriptive statistics (mean ± standard deviation) and internal consistency estimates (Cronbach's α) of the Children's Eating Behaviour Questionnaire (Wardle et al., 2001) in three groups of mothers of young children.

CEBQ subscales	Sample 1 (N=244) NOURISH [a] mothers			Sample 2 (N=203) Indian mothers		Sample 3 (N=216) Chinese mothers	
	mean ± s.d.	Cronbach's α	correlation (r) with WAZ (n=243)	mean ± s.d.	Cronbach's α	mean ± s.d.	Cronbach's α
'Food avoid constructs'							
Satiety Responsiveness (5 items; e.g., *My child gets full up easily*)	3.01 ± 0.57	.77	-.18*	3.32 ± 0.61	.61	3.05 ± 0.62	.71
Slowness in Eating (4 items, e.g., My child eats slowly)	2.93 ± 0.64	.73	-.21*	3.09 ± 0.88	.79	3.23 ± 0.84	.78
Fussiness (6 items, e.g., *My child refuses new foods at first*)	2.62 ± 0.76	.91	-.03	2.84 ± 0.74	.80	2.82 ± 0.70	.82
Emotional Undereating (4 items, e.g., *My child eats less when s/he is upset*)	2.99 ± 0.84	.79	-.03	3.05 ± 0.84	.71	3.25 ± 0.73	.61
'Food approach constructs'							
Food Responsiveness (5 items, e.g., *My child's always asking for food*)	2.26 ± 0.69	.80	.08	2.01 ± 0.64	.64	2.43 ± 0.66	.73
Enjoyment of Food (4 items, e.g., *My child enjoys eating*)	3.78 ± 0.64	.88	.10	3.36 ± 0.84	.88	3.46 ± 0.79	.87
Desire for Drinks (3 items, e.g., *My child is always asking for a drink*)	2.91 ± 0.86	.82	.08	2.57 ± 0.90	.77	2.51 ± 0.73	.70
Emotional Overeating (4 items, e.g., *My child eats more when anxious*)	1.60 ± 0.51	.75	.05	1.61 ± 0.59	.70	1.86 ± 0.56	.73

Note: For sample 3, one item excluded from Slowness in Eating subscale and one from Emotional Undereating due to missing data. [a] Mothers from the control group of the NOURISH randomised controlled trial (Daniels et al., 2009). WAZ: weight for age Z-score (World Health Organisation, 2006). * $p<.01$.

Figure 1. Path diagrams of the 8-factor Children's Eating Behaviour Questionnaire (Wardle et al., 2001) with standardised estimates fitted in sample 1 (NOURISH control group; N=244; Model 1 upper left; Model 2 upper right), sample 2 (Indian immigrants; N=203; lower left) and sample 3 (Chinese immigrants; N=216; lower right).

Figure 1.



SR1: gets full up easily

SR2: has a big appetite

SR3: leaves food on plate at the end of a meal

SR4: gets full before meal is finished

SR5: cannot eat a meal if had a snack just before

SE1: eats slowly

SE2: takes more than 30 minutes to finish a meal

SE3: finishes meal quickly

SE4: eats more and more slowly during the course of a meal

FF1: enjoys tasting new foods

FF2: enjoys a wide variety of foods

FF3: interested in tasting new foods

FF4: refuses new foods at first

FF5: dislikes a food even without tasting it

FF6: difficult to please with meals

EUE1: eats less when upset

EUE2: eats less when angry

EUE3: eats less when tired

EUE4: eats more when happy

FR1: always ask for food

FR2: always have food in mouth if given the chance

FR3: eats most of the time if given the choice

FR4: eats too much if allowed to

FR5: finds room to eat favourite food even if full up

EF1: enjoys eating

EF2: loves food

EF3: interested in food

EF4: looks forward to mealtimes

DD1: always be having a drink if given the chance

DD2: drinks continuously throughout the day if given the chance

DD3: always ask for a drink

EOE1: eats more when anxious

EOE2: eats more when annoyed

EOE3: eats more when worried

EOE4: eats more when has nothing else to do

*significantly different from zero ($p<.05$)