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Validation of the Children's Eating Behavior Questionnaire in 3 year old children of a multi-ethnic Asian population: The GUSTO cohort study

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Abstract

The Children's Eating Behaviour Questionnaire (CEBQ) was developed to measure eating behaviors related to obesity risk in children. However, this questionnaire has not been validated for use in South East Asia, where parenting practices are different from those in western countries and child obesity rates are increasing. The aim of this study was to examine the validity of the CEBQ administered to mothers of children aged 3 years in Singapore. Confirmatory factor analysis (CFA) was used to examine if the original 35-item, 8-factor model was supported in our cohort. Participants were 636 mother-child dyads (mean (SD) child age=36.7 (1.6) months), from the Growing Up in Singapore Towards healthy Outcomes (GUSTO) birth cohort in which the mothers

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Request for reprints will be available from the author.

Conflict of interest

P.D.G., K.M.G., and Y.S.C. have received reimbursement for speaking at conferences sponsored by companies selling nutritional products. These authors are part of an academic consortium that has received research funding from Abbot Nutrition, Nestec, and Danone. None of the other authors report any potential conflict of interest.

Authors Contributions

All authors were involved in all parts of the study and approved the final manuscript. The contributions are listed below. SMS, KMG, FY and YSC designed and led the GUSTO study. PLQ contributed to the statistical analysis and writing of the manuscript. CYB provided intellectual contribution to the write-up of the manuscript and advice on the statistical analysis. PLQ and MFFC were responsible for finalizing the manuscript.

were characterized in pregnancy and children were followed up to age 3 years. The CFA showed a poor model fit; RMSEA=0.072 (PCLOSE<0.001), SRMR=0.094, CFI=0.826, and TLI=0.805. Exploratory factor analysis revealed a 35 item, 7-factor structure (factor loadings 0.35): enjoyment of food, food fussiness, emotional overeating, desire to drink, emotional under eating, satiety responsiveness and slowness in eating. Cronbach's alpha estimates ranged from 0.70- 0.88 for the 7 subscales. Convergent validity tests via correlation analysis revealed that emotional under eating ($r=-0.14$), slowness in eating ($r=-0.16$) and satiety responsiveness ($r=-0.11$) were negatively correlated with BMI z-score at 3 years, while enjoyment of food ($r=0.12$) was positively correlated, $p<0.05$. In conclusion, we found a revised 7-factor structure of the CEBQ more appropriate for examining eating behavior in 3 year old children in the Singapore setting. Further replication studies in a separate cohort study are warranted before further use of these factor structures generated.

Keywords

Children's eating behavior questionnaire; confirmatory factor analysis; exploratory factor analysis

Introduction

Individual differences in appetite and eating behaviors emerge during infancy and co-evolve during childhood (Carnell & Wardle, 2007; Johnson & Birch, 1994). Specific eating behaviors have been identified as associated with the risk of obesity (Epstein, Paluch, & Coleman, 1996; Fisher & Birch, 2002). For example, stronger appetitive response to food cues (increased food responsiveness), higher eating speed, and lower response to internal cues of satiety were more common in obese compared to non-obese individuals (Carnell & Wardle, 2007).

The Child Eating Behavior Questionnaire (CEBQ), developed by Wardle *et al.*, is a widely used psychometric measure of eating behavioral traits (Goh & Jacob, 2012; Mallan, Nambiar, Magarey, & Daniels, 2014; Santos et al., 2011; Sleddens, Kremers, & Thijs, 2008; Svensson et al., 2011; Viana, Sinde, & Saxton, 2008). This 35-item parent-report questionnaire was developed using three samples of families in the UK with children aged between 2 and 9 years. It was designed to assess children's eating traits (e.g. food responsiveness, enjoyment of food) that may be related to childhood obesity (Wardle, Guthrie, Sanderson, & Rapoport, 2001).

These subscales have, however, not been consistently replicated in several populations (Cao et al., 2012; Santos et al., 2011; Sleddens et al., 2008; Svensson et al., 2011) which have adopted the exploratory factor analysis (EFA) approach. Alternatively, new subscales have emerged. (Wardle et al., 2001). For example, subscales of food responsiveness and emotional over eating clustered together in Dutch (Sleddens et al., 2008) and Swedish samples (Svensson et al., 2011) of children. A study in Chilean children revealed scales of satiety responsiveness and slowness eating clustered together (Santos et al., 2011). The only survey conducted in a Chinese population was in children aged 12-18 months, a younger age group than which the scale was originally developed for, and it revealed food responsiveness

being split into two subscales. (Cao et al., 2012). These previous studies showed how ethnic and cultural differences could determine the interpretation of the questionnaire items (Loh, Moy, Zaharan, & Mohamed, 2013; Mallan et al., 2013).

Confirmatory factor analysis (CFA) has recently been explored for testing the fit of original hypothesized factor structures to observed datasets. When applied to the CEBQ administered in American (Conway, 2003) and Australian populations (Mallan et al., 2013), the CFA showed poor replication of the hypothesized structure until further model modifications were conducted. To date, most of the validation work has been conducted in Western populations (Conway, 2003; Mallan et al., 2013; Sparks & Radnitz, 2012).

In view of the aforementioned issues, we aim to examine the validity and applicability of the original CEBQ in an Asian cohort in Singapore. Previous studies have shown that appetitive traits are age dependent (Sleddens et al., 2008; Svensson et al., 2011; Wardle et al., 2001), and that most appetitive traits become relatively stable at 3 years of age (Carnell & Wardle, 2007; Svensson et al., 2011). Based on these previous findings, we chose to focus on a fixed age group of 3 years to better capture appetitive traits at this particular age.

Methods

Participants

This study was as a cross-sectional secondary analysis with data obtained from the Growing Up in Singapore Towards healthy Outcomes (GUSTO) study, a population-based prospective mother-offspring cohort study in Singapore. Further details on the GUSTO study have been previously described [24]. Pregnant women within the age range of 18-50 years were recruited from the two major public maternity units in National University Hospital (NUH) and KK Women's and Children's Hospital (KKH). Participants had to be Singaporean citizens or permanent residents, of Chinese, Malay or Indian ethnicity with parents of homogenous ethnic background. Written informed consent was collected from all participants upon recruitment. This study was granted ethical approval by the Institutional Review Boards of the respective hospitals involved (Clinical trial registry: NCT01174875).

Of 1152 women with naturally conceived singleton pregnancy and who met eligibility criteria, only 888 (77.1%) were involved in the cohort study at the time of the CEBQ administration. The CEBQ was self-administered by the mother when her child turned 3 years. The percentages of subjects who completed the CEBQ and those who did not were 71.6% (636/888), and 28.4% (252/888) respectively (Supplementary Table 1). Listwise deletion was used in cases of missing data, thus only completed questionnaires were included in the analysis (n=636).

Measures

Maternal and child characteristics—Demographic data on maternal age, educational level, household monthly income and marital status were collected from the women using interviewer-administered questionnaires at the recruitment visit and at 15-28 weeks gestation. Information on child gender and birth order were obtained from birth records.

Child eating behavior—The CEBQ questionnaire was administered in English, which is the administrative language in Singapore. The CEBQ is a 35-item tool that measures eight factors (factors) using a five-point Likert scale (1=never, 2=rarely, 3=sometimes, 4=often, and 5=always). The 8 factors contained 3 to 6 items: Satiety Responsiveness (5 items, e.g., My child gets full up easily); Slowness in Eating (4 items, e.g., My child takes more than 30 minutes to finish a meal); Food Fussiness (6 items, e.g., My child is difficult to please with meals); Food Responsiveness (5 items, e.g., Given the choice, my child would eat most of the time); Enjoyment of Food (4 items, e.g., My child looks forward to mealtimes); Desire to Drink (3 items, e.g., If given the chance, my child would always be having a drink); Emotional Undereating (4 items, e.g., My child eats less when s/he is tired) and Emotional Overeating (4 items, e.g. My child eats more when anxious).

Anthropometric measurements—Child anthropometric measurements were taken by trained clinic staff at 3 years of age. Weight was recorded to the nearest 0.001 kilograms (kg) using SECA 334 baby weighing scales (SECA, Hamburg, Germany). Standing height at 36-months was measured using the SECA 213 stadiometer, from the top of the child's head to his or her heels to the nearest 0.1 cm. For reliability, all measurements were taken in the duplicates and averaged. Based on WHO Child Growth Standards 2006, child weight and length were converted to Body Mass Index (BMI) Z scores (BAZ) using WHO Anthro software (Version 3.2.2).

Statistical analysis—Confirmatory factor analysis (CFA) was used to test the adequacy of fit of the 35-item, 8-factor CEBQ model hypothesized in the original development paper by Wardle et al. (Wardle et al., 2001). The model fit was evaluated using several fit indices: root mean-square error of approximation (RMSEA), standardized root mean square residual (SRMR), the comparative fit index (CFI) and Tucker-Lewis index (TLI). Smaller values for RMSEA (ideally 0.06) and SRMR (0.08), while larger values for CFI and TLI (ideally >0.90) are indicative of acceptable model fit of the data (Hu, 1999). A chi-square statistic indicates the overall model fit test, where non-significance suggests the model fits the data (Hu, 1999).

In the case where the CFA model was a poor fit, an exploratory factor analysis approach (EFA) was adopted to explore the structure of the questionnaire. We used the principal component factor extraction with varimax rotation, which was applied in the original study (Wardle et al., 2001) and other similar studies (Santos et al., 2011; Sleddens et al., 2008; Svensson et al., 2011) to determine if the original 8-factor structure could be replicated in our sample. The principal component factor retains most of the original variance (Conway, 2003), while the varimax rotation allows for independent factors that are easier to interpret (Kim & Mueller, 1978). Items with reverse scales were first reverse scored, and a factor loading cutoff of 0.35 was applied (Kline, 1994; Mueller, 1978). A screeplot command with the mean option, specifying that a horizontal line be plotted at the mean of the eigenvalues was used to determine the number of factors to be retained. New variables (estimated scores) were generated for further analysis by the default regression method (Thompson scoring) which has the smallest mean squared error from the true factors and higher accuracy (Thomson, 1951).

Descriptive statistics were used to describe the demographic data. Reliability was assessed with internal consistency using Cronbach's alpha coefficient, a value of 0.7 was indicated to be an acceptable reliability coefficient. Convergent validity was assessed by running correlations between scores of the subscales generated and BMI z-score at 3 years using Pearson's correlation coefficients. All statistical analyses were performed using Stata 13.1 (StatsCorp, College Station, TX, USA).

Results

Participants of the study

Characteristics of the mothers who completed the questionnaire (n=636) are presented in Table 1. On average, mothers were 30 years old, of post-secondary or tertiary educational status, had average household incomes, a healthy pre-pregnancy BMI of 24.4 and a majority were married. The mean age of the children at the time of CEBQ administration was 36 (SD=1.6 months) months. Approximately half the children were boys (52.7%) and a higher percentage of the children were not the first child (57.7%).

In comparison to the group of mothers who did not complete the questionnaire, mothers who completed the questionnaires were more likely to be of Malay ethnicity and less likely to be of Indian ethnicity. Mothers in this group also tended to be slightly older and have a higher proportion with higher household income ($p<0.05$) (Supplementary Table 1).

Validation of the Children's Eating Behavior Questionnaire (CEBQ)

The *a priori* 8-factor model fit the data poorly according to fit statistics provided by Hu and Bentler (Hu, 1999): χ^2 (df=532)= 2268.78, $p<0.001$, RMSEA=0.072 (PCLOSE<0.001), SRMR=0.094, CFI=0.826 and TLI=0.805, indicating that the factor structure found in the original CEBQ by Wardle *et al.* (Wardle *et al.*, 2001) was not replicated in this study population. Further steps to remove item 'my child eats more when she is happy' with a low factor loading score (0.345) from the CFA, and use of modification indices were explored. However, these failed to improve the model fit. We then used exploratory factor analysis as a data driven approach to generate questionnaire subscales

Using all the 35-items, a principal-component factor analysis method with varimax rotation extracted 7 factors with eigenvalues greater than 1, closely corresponding to the original CEBQ model proposed by Wardle *et al.* (Wardle *et al.*, 2001). In total, all 35 items were retained with factor loading scores of 0.35 or greater. All the subscales contained their original items, with the exception of the enjoyment of food and emotional over eating subscales. The food responsiveness subscale was missing in the 7 factor-structure model because items from it merged with the enjoyment of food and emotional over eating subscales. Internal reliability of the factors indicated by the Cronbach's α estimates range from 0.70-0.88, indicating good internal reliability. The variance explained by the 35 items and 7 factors in the proposed model was 61.1% (Table 2).

Correlations (Pearson's r) between the subscale scores and BMI z-scores at 3 years were calculated to assess the convergent validity (Table 3). The food avoidance subscales, such as satiety responsiveness (factor 6) ($r = -0.11$), emotional under eating (factor 5) ($r = -0.14$) and

slowness in eating (factor 6), were all negatively correlated with the child's BMI z-score at 3 years, $p < 0.05$. Enjoyment of food (factor 1) was the only food approach subscale positively correlated with child BMI z-score at 3 years ($r = 0.12$, $p < 0.05$) (Table 3).

Discussion

In this study, we evaluated the hypothesized 8-factor structure of the CEBQ (Wardle et al., 2001) in an Asian cohort in Singapore and found it to be a poor fit. Exploratory factor analysis reveals a 7-factor structure which provided an appropriate and interpretable solution for our sample. This also concurs with what other populations have found (Santos et al., 2011; Sleddens et al., 2008; Svensson et al., 2011). Child BMI z-score at 3 years was negatively correlated with three food avoidance subscales, while positively correlated with one food approach subscale, providing some evidence for convergent validity. Overall, the exploratory factor analysis produced a generally applicable CEBQ factor-structure for use in this cohort of children at the age of 3 years.

In this study, the enjoyment of food subscale was a combination of items from the food approach and food avoidance subclass of the original CEBQ, namely, the enjoyment of food (4 items), food responsiveness (3 items), satiety responsiveness (1 item) and food fussiness (1 item). Firstly, it is not rare for items to load in subscales different from the original CEBQ subscales (Santos et al., 2011; Sleddens et al., 2008; Svensson et al., 2011; Viana et al., 2008). Secondly, in our Singapore population, fussy eating traits were observed to be more prevalent between ages 3-5 where parents associate picky eating with refusing food, or eating very little (Goh & Jacob, 2012). This study further affirms the observation by Goh *et al.*, because all the food fussiness items load together with good reliability, showing the subscale validity at this age. With the prevalence of food fussiness at this age, the Singaporean parents were also more concerned with getting their children to eat (Goh & Jacob, 2012). We speculate that because of this, the two items originally from the food avoidant subscales, namely "My child has a big appetite" and "My child is difficult to please with meals" (reverse-coded) were now interpreted by mothers as the child being easy to feed and therefore enjoying their food. Similarly, mothers concerned about their child not eating enough may be more likely to interpret food responsiveness items as positive behaviors and the child expressing interest in eating and enjoying food. These items include "My child is always asking for food", "Given the choice, my child would eat most of the time" and "Even if my child is full up, s/he finds room to eat his/her favorite food". This observation has not been reported in any other studies, and could be unique to this particular age group. Most studies have only administered the CEBQ to children 5 years and above (Loh et al., 2013; Santos et al., 2011; Sleddens et al., 2008; Viana et al., 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009), or to children 2 years or younger (Mallan et al., 2014; Svensson et al., 2011), but none have examined the use of the CEBQ at the specific age of 3 years when food neophobia is more prevalent (Taylor, Wernimont, Northstone, & Emmett, 2015). Furthermore, this revised subscale showed good internal reliability (Cronbach's $\alpha = 0.89$), and was positively and significantly correlated with BMI-z score at 3 years. Further studies would be required to confirm these observations and speculations.

For the food avoidant subscales, such as emotional under eating, slowness in eating and satiety responsiveness, all items were similar to the original CEBQ subscales (Wardle et al., 2001). These food avoidant subscales showed negative correlations with BMI z-score at 3 years, supporting existing evidence in the literature. Children eat less (Wardle et al., 2001), and gain less weight (Jansen et al., 2012) during negative emotional states (Wardle et al., 2001). Slowness in eating and satiety responsiveness, are hypothesized to be lower in children at risk of weight gain (Wardle et al., 2001), and have also been inversely associated with BMI in population studies in Chilean (Santos et al., 2011), Dutch (Sleddens et al., 2008), Portuguese (Viana et al., 2008) and Australian (Mallan et al., 2013) populations.

We found non-significant trends related to the negative association between the food fussiness subscale and BMI, and to the positive association between the emotional over eating subscale with BMI. These results concur with studies by Sleddens *et al.* and Vianna *et al.*, and provide further evidence that picky eaters consume fewer calories, and weigh less than non-picky eaters (Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Jacobi, Agras, Bryson, & Hammer, 2003), and that emotional over eaters tend to eat more during negative emotional states (Wardle et al., 2001). The emotional over eating subscale also had two items from the original food responsiveness subscale, “If allowed to, my child would eat too much” and “If given the chance, my child would always have food in his/her mouth. This observation concurs with previously reported studies (Sleddens et al., 2008; Svensson et al., 2011), where items from the emotional over eating subscale combined with the items from the food responsiveness subscale. Since it has been shown that eating to emotional stresses may yet to be developed in this age group (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008), it is not surprising when parents interpreted the emotional over eating items which are related to eating more or eating too much to be similar to the food responsiveness items related to overeating(eg: child is eating too much or always eating) (Sleddens et al., 2008).

Strengths and limitations

Our study shows that the original 8 -factor CEBQ was not replicated in our population. Rather, our study revealed a 7-factor structure due to the “missing” food responsiveness subscale when items from this subscale loaded with either the enjoyment of food or emotional over eating subscales. The CEBQ was also administered at a defined time point of 3 years to more accurately capture appetitive traits occurring only at this age. The current study has a number of limitations that needs to be acknowledged. Firstly, the possibility of reverse causation between the associations of appetitive traits with BMI z-score cannot be ruled out. It is possible for heavier toddlers to be viewed by their mothers as being more responsive to food, or being faster eaters. Secondly, the educational attainment of the mothers in this population was high (post-secondary and above), thus the generalizability of the present findings to less educated groups of mothers is unknown. Thirdly, this maternal self-report questionnaire can be subjective, and we were limited by the lack of objective measures of eating behavior to assess the convergent validity of some of the factors. Lastly, parents have a large influence on the child’s eating style, and factors such as maternal psychosocial factors or eating behaviors were not analyzed in this study, but could contribute to the variations in the scores of the subscale. Furthermore, the differences in the CEBQ

subscales (enjoyment of food and emotional over eating) in this study compared to the original subscale can be partly explained by the influence of cultural differences in a multi-ethnic Asian population. It is possible for cultural differences to lead to variations in interpretation of some of the questionnaire items, although more qualitative studies are required to confirm this.

Conclusion

From our validation study, we consider the 7 factor-structure model to be more relevant for use when measuring children's eating behavior at 3 years of age in multi-ethnic Asian mothers with high levels of educational attainment, and for examining important hypothesized relationships between children's eating behavior with various outcomes in this longitudinal GUSTO cohort study (e.g. weight gain and maternal feeding practices). Further replication studies need to be conducted in a separate cohort study to confirm the factor structures generated.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CEBQ	Children's Eating Behavior Questionnaire
BMIZ	BMI-for-age z-scores
CFA	Confirmatory factor analysis

EFA	Exploratory analysis
RMSEA	Root Mean Square Error of Approximation
CFI	comparative fit index

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Highlights

- The Children's Eating Behavior Questionnaire (CEBQ) has not been validated for use in South East Asia.
- Exploratory factor analysis revealed a 7 –factor subscale from the Singapore cohort
- Subscales were associated with BMI of children at 3 years of age and showed convergent validity.
- A revised 7 –factor subscale might be more relevant for use in the Singapore population

Table 1

Characteristics of mothers and children who completed the Children's Eating Behavior questionnaire (CEBQ) at 3 years of age.

Completed questionnaires (n=636)		
	N/Mean	%/SD
Maternal characteristics		
Ethnicity		
Chinese	307	48.3
Malay	208	32.7
Indian	121	19.0
Education		
None/primary/secondary	183	28.8
Post-secondary/tertiary	453	71.2
Household income		
S\$0-1999 (low)	129	20.3
S\$2000-5999 (average)	324	50.9
>S\$6000 (high)	183	28.8
Marital status		
Single/divorced	21	3.3
Married	615	96.7
Age (Years)	30.5	5.2
*Pre-pregnancy BMI (kg/m ²)	24.4	3.4
Child characteristics		
Gender		
Male	335	52.7
Female	301	47.3
Birth order		
First child	269	42.3
Not first child	367	57.7
**BMI (z-score)	0.21	1.18
***Age (months)	36.7	1.6

* Missing data from subjects was imputed with the mean pre-pregnancy BMI of 24.3 kg/m² (n=152)

** Missing data was not imputed (n=10)

*** Missing data from the subjects who completed the questionnaire but did not record the exact date when the questionnaire was completed. was imputed with the mean age of the subjects (n=121)

Table 2

Factor loadings for all items of the Children's Eating Behavior Questionnaire (CEBQ) and Cronbach's alpha scores for each factor structure.

Items ^a	Factors determined through factor analysis ^b						Original scale ^c	Cronbach's alpha
	EF	FF	EOE	DD	EUE	SE		
Factor 1; 16.5% variance								
My child loves food	0.753						EF	0.88
My child is interested in food	0.799						EF	
My child looks forward to mealtimes	0.679						EF	
My child enjoys eating	0.784						EF	
My child is always asking for food	0.676						FR	
Given the choice, my child would eat most of the time	0.500						FR	
Even if my child is full up, s/he finds room to eat his/her favorite food	0.415						FR	
My child has a big appetite	0.721						SR	
My child is difficult to please with meals	0.541						FF	
Factor 2; 9.1% variance								
My child refuses new foods at first		0.779					FF	0.83
My child enjoys tasting new foods (R)		0.798					FF	
My child enjoys a wide variety of foods (R)		0.639					FF	
My child is interested in tasting food s/he hasn't tasted before (R)		0.774					FF	
My child decides that s/he doesn't like a food, even without tasting it		0.597					FF	
Factor 3; 8.2% variance								
My child eats more when worried			0.709				EOE	0.77
My child eats more when annoyed			0.779				EOE	
My child eats more when anxious			0.833				EOE	
My child eats more when s/he has nothing else to do			0.415				EOE	
If allowed to, my child would eat too much			0.556				FR	
If given the chance, my child would always have food in his/her mouth			0.387				FR	
Factor 4; 7.6% variance								
My child is always asking for a drink				0.668			DD	0.80

Items ^a	Factors determined through factor analysis ^b							Original scale ^c	Cronbach's alpha
	EF	FF	EOE	DD	EUE	SE	SR		
If given the chance, my child would drink continuously throughout the day				0.886				DD	
If given the chance, my child would always be having a drink				0.905				DD	
Factor 5; 7.3% variance									
My child eats less when angry					0.770			EUE	0.71
My child eats less when s/he is tired					0.735			EUE	
My child eats more when she is happy					0.470			EUE	
My child eats less when upset					0.821			EUE	
Factor 6; 6.9% variance									
My child eats slowly						0.629		SE	0.70
My child takes more than 30 minutes to finish a meal						0.664		SE	
My child eats more and more slowly during the course of a meal						0.574		SE	
My child finishes his/her meal quickly						0.5460		SE	
Factor 7; 5.8% variance									
My child leaves food on his/her plate at the end of a meal							0.584	SR	0.707
My child gets full before his/her meal is finished							0.738	SR	
My child gets full up easily							0.633	SR	
My child cannot eat a meal if s/he has had a snack just before							0.360	SR	

^aItems marked with (R) have been reversed scored. There are 35 items in the table as the item with a factor loading score of 0.35 or above.

^cAppetite scale the item was originally intended to measure: EF; 'enjoyment of food'; FF; 'food fussiness'; EOE; 'Emotional Over Eating'; DD; 'desire to drink'; EUE; 'Emotional Under Eating'; SE; 'slowness in eating'; SR 'satiety responsiveness'

Table 3

Pearson correlation between CEBQ subscale scores and BMI z-score at 3years.

CEBQ subscales	Correlation (r) with BMI z-score (n=548)
Food avoidant constructs	
Food fussiness	-0.07
Emotional under eating	-0.14 *
Slowness in eating	-0.16 *
Satiety responsiveness	-0.11 *
Food approach constructs	
Enjoyment of food	0.12 *
Emotional overeating	0.07
Desire to drink	-0.01

*
p<0.05 is statistically significant