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Eating Behaviour and Weight in Children

L Webber¹, C Hill¹, J Saxton¹, CHM Van Jaarsveld¹, and J Wardle¹

¹Department of Epidemiology and Public Health, University College London, London, UK

Abstract

Objective: To test the hypothesis that quantitative variation in eating behaviour traits shows a graded association with weight in children.

Design: Cross-sectional design in a community setting.

Subjects: Data were from 406 families participating in the Physical Exercise and Appetite in Children Study (PEACHES) or the Twins Early Development Study (TEDS). Children were aged 7 to 9 years (PEACHES) and 9 to 12 years old (TEDS).

Measurements: Weights and heights were measured by researchers. BMI SD-scores were used to categorise participants into healthy-weight, overweight and obese groups, with an additional division of the healthy-weight group into higher- and lower-healthy-weight at the 50th centile. Eating behaviour traits were assessed with the Child Eating Behaviour Questionnaire (CEBQ), completed by the parent on behalf of their child. Linear trend analyses compared CEBQ sub-scale scores across the five weight groups.

Results: Satiety Responsiveness/Slowness in Eating and Food Fussiness showed a graded negative association with weight, while Food Responsiveness, Enjoyment of Food, Emotional Overeating and Desire to Drink were positively associated. All effects were maintained after controlling for age, sex, ethnicity, parental education and sample. There was no systematic association with weight for Emotional Undereating.

Conclusion: These results support the idea that approach-related and avoidance-related appetitive traits are systematically (and oppositely) related to adiposity, and not exclusively associated with obesity. Early assessment of these traits could be used as indicators of susceptibility to weight gain.

Keywords

BMI; appetite; satiety; hunger; adiposity

Introduction

Research into the behavioural correlates of obesity has identified a variety of eating behaviour traits in obese children and adults (1-3). In the paediatric literature, behavioural studies have shown that obese children have lower responsiveness to internal satiety signals (4-6), eat faster during the course of a meal (7-9) and are more sensitive to external food cues (10) than healthy-weight children. Heightened desire to consume may go beyond food to include palatable drinks, with intake of high-energy drinks being associated with weight gain (11). Food fussiness (or pickiness) has also been linked with weight, with picky girls

having lower BMI and lower rates of overweight (12;13), although this finding has not always been replicated (14-16).

Ingestive responses to stress or distress have also been proposed as significant influences on food intake. The idea originated in the 'psychosomatic theory' of obesity, which proposed that eating in response to emotional distress rather than hunger was one cause of excessive weight gain (17), while more recent analyses suggest that stress can deregulate eating through effects on the reward system (18). In practice, empirical studies analysing associations between food intake, weight and stress have not produced entirely consistent results (19;20). However, one recent study in young adults found that those who had either gained or lost weight reported more stress than those whose weights were stable (21), suggesting that individuals may vary in the extent to which they experience hyperphagic or hypophagic responses to emotional distress.

It has recently been argued that appetitive traits are not only pathogenic for obesity *per se*, but vary quantitatively across the entire weight distribution and could determine risk of positive energy balance (1;2). This is consistent with evidence that the same genetic influences determine variation in weight within the healthy range as determine the extremes of obesity (22). Positive responses to food – enjoyment, responsiveness to palatability and rapid consumption – are hypothesised to promote food intake, while sensitivity to internal cues of satiety or fussiness about food are likely to reduce intake. In environments with multiple opportunities to eat highly palatable, energy-dense foods, these appetitive traits will moderate the risk of weight gain.

One recent study used the Child Eating Behaviour Questionnaire (CEBQ) (23) to index a number of positive and negative appetitive traits, and compared obese/overweight and healthy-weight children, as well as a small sample of underweight children (24). Consistent with previous work, obese/overweight children showed higher responsiveness to food cues, more emotional eating, lower satiety responsiveness and less fussiness than healthy-weight children. In addition, the underweight group differed from the healthy-weight group, with lower responsiveness to food cues, lower emotional eating, higher satiety responsiveness and greater fussiness. These results supported the idea of a graded association between appetite and weight, rather than an aberrant eating style that is specific to clinically overweight populations, although the authors noted that the small sample size for the underweight group, and the different recruitment methods for overweight/obese and healthy-weight/underweight children, limited the confidence with which conclusions could be drawn. However, a very similar association was reported in a recent community-based study, although this study assessed only two aspects of appetite, Satiety Responsiveness and Enjoyment of Food (1).

In the present study we examined associations with weight for the seven appetitive traits included in the CEBQ scale in a large, community-based, sample of 7 to 12-year-old children. To examine the patterning of associations between appetite and weight in more detail, we not only compared obese, overweight, healthy-weight and underweight groups, but also subdivided the healthy-weight group into higher-healthy-weight and lower-healthy-weight at the 50th centile. We predicted that CEBQ sub-scales indicating 'food approach' (Enjoyment of Food, Food Responsiveness, Emotional Overeating, Desire to Drink) would show a positive association with weight, while Satiety Responsiveness/Slowness in Eating, Food Fussiness and Emotional Under-eating would be highest in the thinnest children and show a negative association with weight.

Method

Participants

The data for these analyses came from two community-based samples. One sample consisted of 7 to 9-year-old children and their parents recruited through five schools around London as part of the Physical Exercise and Appetite in CHildren (PEACHES) study (Sample 1). This is a longitudinal study examining associations between eating behaviour, physical activity and adiposity during childhood, and the data reported here come from the first year of the study. Out of a total of 531 families invited to take part, 400 parents (206 parents of boys and 194 parents of girls), replied to the invitation giving consent to their child's participation. Parents were sent a questionnaire containing the CEBQ and socio-demographic questions (including education level and ethnicity), of which 268 were returned, a response rate of 67%.

The second sample was from a sub-sample of 214 families from the Twins Early Development Study (TEDS) – a cohort study beginning when the twins were 4 years-old (25), enrolled in a longitudinal study of eating behaviour and weight. Of these, 100 families had overweight or obese parents and 114 had normal-weight parents. Families were matched on social class. 173 (81%) families participated in the 2006 follow-up. The data here come from one child per family selected at random from the follow-up when the children were aged 9 to 12 years. Children were weighed and measured and parents were asked to complete the CEBQ and questions relating to their socio-economic status (including education level and ethnicity) during a study home visit.

Psychometric measures

The CEBQ is 35-item validated instrument designed to assess a range of eating behaviours in children (23). It has good internal consistency, test-retest reliability, and stability over time (23;26) and has been shown to be related to food intake in behavioural tests (27). It includes four sub-scales that measure food approach behaviours (Enjoyment of Food, Food Responsiveness, Emotional Overeating, Desire to Drink) and four that index more avoidant-type responses (Satiety Responsiveness/Slowness in Eating, Emotional Under-eating, Food Fussiness). Because Satiety Responsiveness and Slowness in Eating have been found to load onto the same factor (23) they were combined to form a single sub-scale. Response options for all sub-scales were from 'never' to 'always' on a 1-5 likert scale.

Anthropometrics

In both samples, a stadiometer (Leicester height measure, Seca, Birmingham, UK) was used to measure children's height to the nearest millimetre. Children were weighed to the nearest tenth of a kilogram using Tanita TBF-300MA Body Composition Analyser in sample 1 and a digital Tanita scale in sample 2 (Tanita Corporation, Tokyo, Japan). In both samples, waist circumference was measured using standard instructions (28).

BMI was calculated from children's weight and height and the Imsgrowth macro (<http://homepage.mac.com/tjcole>) was used to transform BMI into age and sex appropriate BMI SD-scores from British 1990 reference data (29). BMI SD-scores were categorised according to recommended groupings for underweight (thinness grade 1, 2, 3; (30)) and IOTF (International Obesity Taskforce) categories for healthy-weight, overweight and obese (31). The healthy-weight group was subdivided into lower-healthy-weight (< 50th centile) and higher-healthy-weight (>50th centile but not meeting criteria for overweight) for comparison of eating behaviours across the weight spectrum.

Statistical analysis

Relationships between possible covariates (ethnicity, education, age, sex) and BMI SD-score were assessed using Pearson's correlations and t-tests where appropriate. Mean scores for each CEBQ sub-scale were calculated if at least 70% of the items (or 67% in the case of the 3-item 'Desire to Drink' sub-scale) were completed, in line with recommendations for dealing with missing data when calculating sub-scale scores (32). Cases with any missing sub-scales were excluded.

To establish that it was appropriate to combine data from the two samples, we tested the sample-by-CEBQ interactions for each sub-scale adjusting for age, sex, ethnicity and parent education in regression analyses on BMI SD-score. When significant, we inspected regression coefficients, confidence intervals and mean scores to check the direction and pattern of the association between CEBQ sub-scale scores and BMI SD in each of the two samples separately. Samples were combined if the patterning of these figures were comparable. For each sub-scale, trend analysis was performed across the five weight groups in order to examine whether adiposity showed a graded association with eating behaviours. When the weighted linear term was significant, each sub-scale was entered into separate regression models, adjusted for age, sex, ethnicity, parent education and sample to determine the proportion of variance explained in BMI SD-score. All analyses were carried out using SPSS v14.0 (SPSS Inc., Chicago, IL).

Statement of Ethics

Full ethical approval was gained from University College London Committee on the Ethics of Non-NHS Human Research. All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed in both studies.

Results

Sample characteristics

Complete data were available for 406 children (Sample 1: n=239; Sample 2: n=167) and they are described in Table 1. In Sample 1, 49% were girls (n=117). Based on IOTF cut-offs, 13.0% of the children were overweight and 3.3% were obese which is low compared with population data for the UK (Health Survey for England, 2006; available from the UK Data Archive: www.data-archive.ac.uk). BMI SD-scores were significantly higher in boys (0.28 ± 1.28) than girls (-0.12 ± 1.27) ($t(238)=2.41$, $p=.016$). There was high ethnic diversity compared with UK population data, with 46% of participating children classified as non-white (Office of National Statistics, 2005, available at: www.ons.gov.uk/). Parent education level was similar to the UK average (National Statistics, 2005: www.dcsf.gov.uk/).

In Sample 2, 60.5% were girls. Based on IOTF cut-offs, 18.6% were overweight and 7.2% were obese, which is again slightly lower than UK population data (HSE, 2006). Differences in BMI SD-scores between boys (0.55 ± 1.2) and girls (0.40 ± 1.2) were not significant. The majority of children were white (92.9%), which is comparable to UK population data (ONS, 2005). Parent education level was slightly lower than the national average (National Statistics, 2005).

There were higher proportions of non-white ($\chi^2=68.7$, $p<.0001$) and male participants ($\chi^2=4.8$, $p=.028$) and the parents had more years of education ($\chi^2=8.7$, $p=.003$) in Sample 1 than Sample 2. Children in sample 2 were significantly older ($t=-49.5$, $p<.0001$) and had higher BMI SD-scores ($t=-3.0$, $p=.003$) than sample 1.

In the combined sample, less educated parents had children with higher BMI SD-scores ($t(629)=3.25$, $p=.001$), and older children had higher BMI SD-scores than younger children ($r=.12$, $p=.001$). There was no difference in adiposity (BMI SD-score) between white and non-white children ($t(409)=-1.05$, $p=.29$) or between boys and girls ($t(735)=.13$, $p=.90$).

CEBQ sub-scales

Sub-scales were normally distributed (skewness and kurtosis between 1 and -1) and had good internal consistency, with Cronbach's alphas over .74.

There was a significant interaction between study sample and Enjoyment of Food for BMI SD-score in the adjusted model ($F(1,398)=5.17$, $p=.02$). Enjoyment of Food significantly predicted weight in Sample 2 ($B(SE)=-.50(.13)$, $p<.0001$) but not in Sample 1 ($B(SE)=.11(.11)$, $p=.32$), although B values were positive in both samples. A significant interaction with sample was also seen for Food Responsiveness ($F(1,398)=7.68$, $p=.006$): effects were significant in both samples, but the association between Food Responsiveness and weight was stronger in Sample 2 ($B(SE)=.65(.11)$, $p<.0001$) than in Sample 1 ($B(SE)=.23(.10)$, $p=.02$). Inspection of the mean scores by weight group for both of these sub-scales showed that patterns were comparable, with means increasing across weight groups in both samples. No other interactions were significant, so it was deemed appropriate to combine the samples for further analyses.

A significant sex-by-subscale interaction was seen for Food Fussiness ($F(1,398)=10.13$, $p=.002$), where the effect was significant in girls ($B(SE)=-.27(.10)$, $p=.008$) but not in boys ($B(SE)=-.11(.10)$, $p=.27$). Food fussiness was therefore stratified by sex for further analyses. All other sex-by-subscale interactions were not significant.

Linear Trend Analysis

CEBQ sub-scale scores are shown by IOTF category in Table 2. There were significant positive linear trends by weight group for Food Responsiveness ($p<.001$), Emotional Overeating ($p<.001$), Enjoyment of Food ($p<.001$) and Desire to Drink ($p=.037$) (Box 1), and significant negative linear trends for Satiety Responsiveness/Slowness in Eating ($p<.001$) and Food Fussiness in girls ($p=.02$) and boys ($p=.05$). The linear trend was not significant for Emotional Undereating (Box 2).

Regression analysis

Table 3 presents a summary of the regression analyses. The baseline model was significant ($p=.001$) and explained 4.9% of the variance in BMI SD-score. All sub-scales significantly predicted BMI SD-score, explaining 1.0% to 6.3% of additional variance. For every unit increase in Food Responsiveness, Enjoyment of Food, Emotional Overeating and Desire to Drink, BMI SD increased by 0.39 ($p<.0001$), 0.25 ($p=.003$), 0.41 ($p<.0001$) and 0.16 ($p=.04$) respectively. Every unit increase in Satiety Responsiveness/Slowness in Eating corresponded to a 0.49 decrease in BMI SD-score ($p<.0001$). Every unit increase in Food Fussiness corresponded to a 0.27 decrease in girls' BMI SD-score but was not significantly associated with adiposity in boys. Analyses with waist SD-score showed similar results and they are not presented here.

DISCUSSION

An appetitive profile characterised by more responsiveness to and enjoyment of food, more emotional eating, lower responsiveness to internal satiety cues, and lower fussiness, was quantitatively associated with weight in a large sample of 7 to 12-year-old, ethnically-

diverse, British children. Similar results were obtained using BMI SD-scores and waist SD-scores as outcomes and all effects were independent of age, ethnicity and parental education.

These findings are consistent with earlier research demonstrating that obese children tend to eat more rapidly (7;8), are less sensitive to satiety cues (4;5), and are more responsive to food cues (10) than healthy-weight children. They are also comparable to results recently reported by Viana and colleagues in 3 to 13-year-old Portuguese children, although theirs was a clinical sample with a very small underweight group and they did not subdivide the healthy-weight group (24). They found that the lean children had the lowest positive responses to food and highest avoidant responses, and we found the same results in this study. These results might equally be construed as showing that certain traits are protective from contemporary obesogenic environments as that the opposite traits are risk factors, lending support to the behavioural susceptibility theory of obesity (27).

Our results add to debate regarding the association between fussy eating and BMI (14-16;33). They suggest that, at least in childhood, fussiness could be protective against overeating by reducing the effective choices for a child because of a greater number of dislikes. Alternatively, fussiness may reflect the reverse of enjoyment, so that if eating *per se* is not as well liked, then desire to eat may not be enough to overcome fussiness.

As far as we are aware, this is the first study to report an association between wish to drink and adiposity, at least in an environment where many of the available drinks are high in energy. The literature in this area is limited and the mechanism by which desire to drink might be related to weight needs more investigation. At one level, it could simply be an expression of wanting something in the mouth; if such an individual is offered caloric drinks, energy intake would be a side-effect, and energy intake from drinks is notoriously non-compensated (34). Alternatively, it could be a specific liking for higher calorie drinks. One study found that higher-risk children (based on maternal pre-pregnancy weight) consumed more fruit juice and less milk at 3 and 4 years, and more sweetened-drinks at 6 years, than lower-risk children, suggesting that caloric drink consumption is a behavioural phenotype for obesity risk (35). Extension of the Desire to Drink subscale to include specific types of drink is necessary to explore these ideas. Another possibility is that increased thirst is associated with weight as a consequence of snack intake; salt - often present in savoury snacks - increases thirst, and recent research describes an association between salt and total fluid and sweet-drink consumption in 4 to 18-year-olds (36). Assessing associations between thirst and food and drink intake is an interesting line of further study.

Our finding that heavier children show higher emotional eating supports the hypothesis that a hyperphagic response to stress and distress increases the risk of weight gain (37). Intake in emotional states tends to favour sweet or fatty foods, which would augment the impact of energy intake (38;39). Emotional undereating was not related to BMI SD-score in this study, and has only been weakly related to BMI in previous work (24). However, we observed higher emotional undereating in both the heaviest and lightest groups, and further research is needed to determine whether this is a true effect, but it does at least indicate that emotional overeating and undereating are not opposites.

Associations between food responsiveness and enjoyment of food and weight group were stronger in sample 2 (from families with twins). Age differences did not explain the effect, because it persisted after controlling for age. It is possible that these effects are due to residual cultural differences as our sample size did not allow full adjustment of the variety of ethnic groups in sample 1. However, because there was no significant sample interaction with the other eating behaviours, it is possible that the findings are due to sampling error.

Future research will be needed to identify environmental factors that might moderate the associations between eating behaviour and weight outcomes.

Although limited to English speakers, this study is strengthened by having an ethnically diverse, community-based sample. Including waist circumference as an alternative measure of adiposity - and finding the same results as with BMI SD score - was also valuable in light of evidence that abdominal fatness is associated with negative health outcomes in children (40-42). These features permit generalisability of results to the wider UK population. The study also has limitations. The cross-sectional design means it is not possible to ascertain whether the eating behaviours we assessed were consequences or determinants of adiposity. However, this issue has been most troublesome in studies comparing clinical samples of obese children with healthy-weight groups, because appetitive differences in the obese might reasonably be thought to be a consequence of the worry, dieting, family arguments, school teasing, etc, which obese children receive. The fact that eating behaviours show significant stability (26), and that very thin children were shown to have lower appetites than thinner healthy-weight children, who in turn had lower appetites than fatter healthy-weight children makes it less likely that changes in eating behaviour are a psychosocial consequence of higher weight. Children in sample 1 will be followed up and so it will be possible to assess whether developmental changes during early adolescence (e.g. pubertal growth) influence appetite.

Another limitation is that the sample was relatively lean in comparison with UK population data, which we assume to be due to self-selection out of the study of families with heavier children. In sample 1, it is more likely that heavier children opt-out because measurement takes place at school, whereas in sample 2, measurements took place at home. This may explain weight differences between the samples. However a smaller variation in weight compared to the general population means associations with eating behaviours are more likely to be underestimated than overestimated.

The evidence that CEBQ scores are markers of risk of weight gain makes it important to understand the determinants of these behaviours. Recent work points to a genetic basis (43; 44) with one study demonstrating that genetic influences on weight are partially mediated by satiety (45). As obesity has a strong heritable component, eating behaviours may be one mechanism by which familial risk is transmitted. As a result, food environments in which high energy foods (and drinks) are easily accessible will allow at-risk eating behaviours to manifest. Genetically sensitive, longitudinal designs are necessary to understand the respective influence of genes and environment on the expression of eating behaviours and subsequent weight gain.

Because weight tracks into adulthood, early intervention to prevent expression of 'at risk' eating behaviours could be fundamental in curbing further increases in obesity. This study makes it possible to identify healthy-weight individuals who are at risk of weight gain by virtue of their eating behaviour profiles. The challenge then is to discover whether appetitive traits can be modified in ways that reduce obesity risk. Knowing that eating behaviours are quantitatively distributed, it may also be possible to learn more about the behavioural profile that protects children from weight gain and constitutes a 'lean phenotype'. This could be used as a point of departure from which to develop interventions to modify risky eating behaviours, as well as offering insights into tackling the obesogenic environment.

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Box 1.

Figures a-d. Mean 'food approach' sub-scale scores by weight group

Figure a) Food Responsiveness

Figure b) Enjoyment of Food

Figure c) Desire to Drink

Figure d) Emotional Overeating

Box 2.

Figures e-f. Mean 'food avoidant' sub-scale scores by weight group

Figure e) Food Fussiness

Figure f) Satiety Responsiveness/Slowness in Eating

Table 1

Sample characteristics

	Overall sample (n=406)	Sample 1 (PEACHES) (n=239)	Sample 2 (TEDS) (n=167)
Age in years, mean (SD)	9.5 (1.6)	8.3 (.63)	11.2 (.55)
% girls (n)	53.7 (218)	49 (117)	60.5 (101)
% boys (n)	46.3 (188)	51 (122)	39.5 (66)
BMI SD-score, mean (SD)	.24 (1.3)	.09 (1.3)	.46 (1.2)
% underweight	10.3	13.4	6.0
% healthy weight	69.5	70.2	68.2
<i>of whom % lower healthy weight</i>	<i>33.3</i>	<i>35.1</i>	<i>30.5</i>
<i>of whom % higher healthy weight</i>	<i>36.2</i>	<i>35.1</i>	<i>37.7</i>
% overweight	15.3	13.0	18.6
% obese	4.9	3.3	7.2
Waist SD-score, mean (SD)	.94 (1.1)	.90 (1.0)	.98 (1.2)
Ethnicity			
% white	70.0	54.0	92.9
% non-white	30.0	46.0	7.1
Parental education			
% GCSEs/equivalent or below	56.9	50.7	65.9
% A levels/equivalent or above	43.1	49.3	34.1

Table 2
Unadjusted mean (SD) CEBQ scale score by international obesity taskforce category (IOTF).

	Underweight (n=42)	Lower healthy weight (n=135)	Higher healthy weight (n=147)	Overweight (n=62)	Obese (n=20)	Linear Trend (P value)
Food Responsiveness	2.15(.62)	2.29(.74)	2.43(.84)	2.84(.89)	3.13(1.06)	<.0001
Emotional Overeating	1.71(.64)	1.79(.62)	1.93(.69)	2.16(.74)	2.66(.94)	<.0001
Enjoyment of Food	3.58(.13)	3.93(.07)	3.84(.07)	3.93(.10)	4.43(.17)	<.0001
Desire to Drink	2.40(.10)	2.50(.91)	2.56(.95)	2.75(.98)	2.73(.84)	.037
Satiety Responsiveness/Slowness in Eating	3.06(.62)	2.80(.64)	2.64(.65)	2.55(.61)	2.29(.35)	<.0001
Emotional Undereating	2.88(.80)	2.69(.78)	2.70(.73)	2.78(.71)	2.90(.50)	.837
Food Fussiness	2.82(.16)	2.78(.09)	2.62(.10)	2.49(.16)	2.09(.24)	.023
	3.02(.19)	2.81(.11)	2.86(.11)	2.86(.16)	2.24(.27)	.045

Table 3

Linear regression analyses for CEBQ sub-scales on BMI SD-scores

CEBQ sub-scale (n=406)	Unstandardised coefficients B (SE B)	<i>l</i> Change in R ²	p value
Food Responsiveness	.39(.07)	.063	<.0001
Enjoyment of Food	.25(.08)	.020	.003
Emotional Overeating	.41(.09)	.053	<.0001
Desire to Drink	.16(.07)	.010	.037
Satiety Responsiveness/ Slowness in Eating	-.49(.10)	.056	<.0001
Food Fussiness			
Girls	-.27(.10)	.031	.008
Boys	-.11(.10)	.007	.265

l relative to basic model including covariates only. Variables standardised β coefficients: sex -.13 (p=.01), ethnicity -.02 (p=.71), study .03 (p=.80), age .13 (p=.32), and parent education -.11 (p=.03).