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Title

Eating behaviour and weight status at two years of age: data from the Cork BASELINE Birth Cohort Study.

Running Title

Eating behaviour and weight status in preschool-age children

Authors and Institutional Addresses

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Conflict of Interest

The authors declare no conflict of interest.

Author's contributions

E.K.M. carried out data collection, database construction and data analysis. M.K. designed the study and E.K.M. and M.K. drafted the manuscript. M.K. had responsibility for the final content. C.ní C. carried out data collection. D.M. is the Principal Investigator (PI) of the Cork BASELINE Birth Cohort Study and J.O'B.H., L.C.K. and M.K. are co-PIs and specialist leads. L.C.K. is the PI of the SCOPE Ireland pregnancy cohort study. All authors reviewed and approved the final submission.

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Abstract

Background/Objectives: To conduct an analysis of associations between eating behaviours and weight status in two-year old children.

Subjects/Methods: Data were collected prospectively in the maternal-infant dyad Cork BASELINE Birth Cohort Study. The weight status of children aged two years (n = 1189) was assigned using the International Obesity Task Force BMI cut-offs using measured heights and weights. Eating behaviours were assessed using the Children's Eating Behaviour Questionnaire (CEBQ).

Results: 80% of children were of normal weight, 14% were overweight or obese and 6% were underweight. From the CEBQ, food approach behaviours including Enjoyment of Food (OR 1.90, 95% CI 1.46-2.48) and Food Responsiveness (OR 1.73, 95% CI 1.47-2.03) were associated with overweight/obesity (all P<0.001). The food avoidant behaviours of Satiety Responsiveness (OR 2.03, 95% CI 1.38-2.98) and Slowness in Eating (OR 1.44, 95% CI 1.01-2.04) were associated with underweight at two years (all P<0.05).

Conclusions: Eating behaviours are associated with weight status as early as two years of age.

Keywords

Birth cohort, childhood obesity, childhood underweight, children's eating behaviour.

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Introduction

Individual differences in eating styles and behaviours have been hypothesised to contribute to weight problems in children.[1] The worldwide prevalence of overweight and obesity in preschool-age children was estimated to be 43 million in 2010, an increase from 4.2% in 1990 to 6.7% in 2010.[2] In Ireland, 27% of two-year olds are overweight or obese according to the National Pre-School Nutrition Survey (NPNS).[3] Overweight and obesity in childhood can track into adulthood resulting in detrimental effects on health including increased risk of cardiovascular disease, certain cancers and type 2 diabetes.[4] Similarly, underweight in early childhood can have long term implications for health including suboptimal growth, delays in cognitive development and nutrient deficiencies.[5] The prevalence of underweight in preschool-age children is 1.6% in developed countries.[6] Worries surrounding weight status during childhood and potential lifelong health risks have prompted an interest in investigating all factors that can contribute to weight problems, including the role of eating behaviours.

Eating behaviours vary amongst individuals ranging from picky eating to overeating or binge eating. Variations in child eating behaviours can be measured either using behavioural tests or psychometric measures. Behavioural tests are objective measures of eating behaviours but they only capture behaviour on one occasion and usually in a laboratory setting.[7] Psychometric measures, such as the Children's Eating Behaviour Questionnaire (CEBQ), are an alternative that are useful for large studies of young children as they can be completed by parents if children are too young to do so themselves.

Associations between eating behaviours and weight status during childhood have been explored in some detail. Research has mainly focused on older children and using the CEBQ, many studies have observed a positive association between the food approach eating behaviours of Enjoyment of Food and Food Responsiveness and weight status and an inverse association between weight status and the food avoidant behaviours of Satiety Responsiveness and Food Fussiness.[8-11] The only study on eating behaviours (as assessed by the CEBQ) in children younger than three years of age found no association between CEBQ scores and weight status, but these are limited data in a subset of a relatively small sample.[12]

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Current evidence on the role of eating behaviours in healthy weight maintenance in young children is limited and somewhat conflicted and the data are frequently from cross-sectional observational studies, with inadequate adjustment for potential ante- and postnatal confounders for weight status. The main objective of the current study was to explore associations between eating behaviours and weight status in two-year old children from a large prospective birth cohort study, with appropriate consideration of early life events.

Materials and Methods

Participants

The data for this study were collected from participants of the Cork BASELINE (Babies after SCOPE: Evaluating the Longitudinal Impact using Neurological and Nutritional Endpoints) Birth Cohort Study, a prospective birth cohort established in 2008 to investigate links between early nutrition and perinatal outcomes and physical and mental growth and development during childhood. It was approved by the Clinical Research Ethics Committee of the Cork teaching hospitals, ref ECM 5(9) 01/07/2008 and is registered at the National Institutes of Health Clinical Trials Registry (http://www.clinicaltrials.gov), ID: NCT01498965. The Cork BASELINE Birth Cohort Study is following infants born in the SCOPE (Screening for Pregnancy Endpoints) Ireland pregnancy study. SCOPE is an international multicentre study aimed at investigating early indicators of pregnancy complications,[13] registered at the Australian, New Zealand Clinical Trials Registry (http://www.anzctr.org.au), ID: ACTRN12607000551493.

Informed consent to the Cork BASELINE Birth Cohort Study was provided by 2183 parents, of which the majority (73%) were recruited through SCOPE Ireland, with the rest recruited at birth through the postnatal wards of the Cork University Maternity Hospital (recruitment concluded November 2011). Overall, 2137 infants were registered for postnatal follow-ups and infants were followed prospectively over the first two years of life, beginning at day 2 and at 2, 6, 12 and 24 months. Detailed information on early life environment, diet, lifestyle, health, growth and development of study participants were gathered by interviewer-led questionnaires and clinical assessments and then entered at the time of appointment into an internet-based, secure database developed by Medical Science Online

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(MedSciNet), Sweden, compliant with the US Food and Drug Administration and the Health Insurance Portability Accountability Act. A complete methodology of the Cork BASELINE Birth Cohort Study has been provided by O'Donovan *et al.*[14]

Eating behaviour assessment

Eating behaviours were assessed using the CEBQ at the study's 24 month assessment. The CEBQ developed by Wardle and colleagues is a 35-item parent administered questionnaire designed to assess eating style and behaviour in children.[1] It is a validated psychometric tool that displays good internal consistency and test-retest reliability.[15] It comprises four subscales that measure food approach eating behaviours (Enjoyment of Food, Emotional Overeating, Desire to Drink, Food Responsiveness) and four subscales that measure food avoidant behaviours (Satiety Responsiveness, Slowness in Eating, Food Fussiness, Emotional Under-eating). Enjoyment of Food and Food Responsiveness represent a heightened interest in food and responsiveness to environmental food cues. Satiety Responsiveness represents an increased sensitivity to internal satiety cues and a closer monitoring of energy intake based on these internal cues. The subscales of Slowness in Eating and Food Fussiness reflect a lack of interest and enjoyment of foods, while Emotional Overeating and Emotional Under-eating reflect a child's eating response to both positive and negative emotional stimuli. The Desire to Drink subscale measures a child's desire to drink fluids. Sample statements from the CEBQ include "My child looks forward to mealtimes (Enjoyment of Food)", "My child eats slowly (Slowness in Eating)", "My child decides that s/he doesn't like a food, even without tasting it (Food Fussiness)". Reponses to the CEBQ were scored using a five-point Likert scale (1 = never, 5 = always) and reverse scoring was applied, where appropriate.

Anthropometric measures

Children's heights and weights were measured at their 24 month assessment using standard operating procedures by trained researchers in the study's dedicated research facility. Standing height was measured using a wall mounted stadiometer (seca 206, Birmingham, United Kingdom) to the nearest 0.1cm and weight was measured to the nearest 0.1kg using digital scales (seca 384). The child's body

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mass index (BMI, kg/m^2) was calculated using recorded heights and weights. The weight status of children were assigned using the International Obesity Task Force (IOTF) BMI cut-offs for thinness, overweight and obesity in children aged 2-18 years.[16,17] These sex- and age-specific cut-offs were developed based on international data and correspond to adult BMI ranges. For this analysis, children were assigned into three weight categories: underweight, normal weight and overweight/obese.

Statistical analysis

Statistical analysis of the data was conducted using SPSS© for Windows™ Version 20.0 (SPSS, Inc., IBM, Chicago, IL, USA). The distributions of all variables were tested with Kolmogorov-Smirnov tests and descriptive statistics were reported as median and interquartile range (IQR) and percentages, where appropriate. As it was not possible to statistically normalise the CEBQ subscale scores, differences in socio-demographic characteristics and CEBQ subscale scores between weight categories were explored using non-parametric tests (Mann-Whitney U and Kruskal-Wallis test).

Univariate logistic regression analysis was used to model the associations of maternal and child characteristics including eating behaviours (as measured by the eight CEBQ subscales) with the risk of being underweight or overweight/obese at two years (separate models for each dependent variable). Associations were expressed as odds ratios (OR) and 95% confidence intervals (95% CI). Separate multivariate models were fitted for each eating behaviour subscale due to the colinearity between behaviours and models included covariates identified as significant at the 10% ($P < 0.1$) level in the univariate analysis. For the underweight model, these included gender, birth weight, maternal education status and BMI at 15 weeks gestation. For the overweight/obese model, these included gender, birth weight, maternal education status, race and smoking status at 15 weeks gestation. Associations were considered statistically significant in the model if $P < 0.05$.

Results

A total of 1537 children attended their 24 month assessment with the study, pre-term infants ($n = 54$) and children with incomplete anthropometric or eating behaviour data ($n = 294$) were excluded providing a sample size of 1189. The median [IQR] age at the 24 month assessment was 2.1 [2.1, 2.2]

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123 years (Table 1). Of mothers, 99% were Caucasian and 88% had attended third level education. There
124 were no significant differences in socio-demographic characteristics of participants between the weight
125 categories (all $P > 0.05$). However, significant differences in weight, height and BMI at 24 months and
126 birth weight did exist, with the lowest values for all observed in the underweight category (all $P < 0.05$).

127 Using the IOTF BMI cut-offs, participants were divided into three weight categories (Table 1). Of
128 participants, 6% were underweight with a median [IQR] weight, height and BMI of 11.1 [10.4, 11.7]
129 kg, 0.87 [0.85, 0.89] m and 14.6 [14.3, 14.8] kg/m^2. The majority of participants (80%) were normal
130 weight with a median [IQR] weight, height and BMI of 12.9 [12.1, 13.6] kg, 0.88 [0.86, 0.90] m and
131 16.6 [16.0, 17.2] kg/m^2. Those classified as overweight or obese (14%) had a median [IQR] weight,
132 height and BMI of 15.0 [14.0, 15.9] kg, 0.89 [0.87, 0.91] m and 18.8 [18.5, 19.4] kg/m^2 respectively.

133 Results from the multivariate logistic regression were consistent with findings demonstrated by the
134 descriptive analysis (Table 2). High scores in Enjoyment of Food and Food Responsiveness were
135 associated with an increased risk of overweight and obesity, while the food avoidant behaviours of
136 Satiety Responsiveness, Slowness in Eating and Food Fussiness were negatively associated with the
137 risk of overweight/obesity (all $P < 0.01$) (Table 3). Both Satiety Responsiveness and Slowness in Eating
138 were positively associated with the risk of underweight at two years, while the approach behaviours of
139 Enjoyment of Food and Food Responsiveness were negatively associated with the risk of underweight
140 (Table 3) (all $P < 0.05$). Emotional Overeating, Emotional Under-eating or Desire to Drink were not
141 associated with either underweight or overweight/obesity at two years (all $P > 0.05$).

142 **Discussion**

143 The current study is the first to explore associations between eating behaviours and weight status among
144 two-year olds from a large prospective birth cohort study, with appropriate adjustment for potential
145 early life confounders.

146 From the CEBQ, food approach behaviours were positively associated with the risk of being overweight
147 or obese, while negatively associated with the risk of being underweight at two years. Increasing scores
148 in food avoidant behaviours were associated with a decreased risk of overweight/obesity and an

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increased risk of being underweight at two years. These findings are consistent with previous studies in older children.[9,10,18] While they are in contrast with the only other study to explore eating behaviours using the CEBQ in children younger than three years of age, which observed no association, although that study was limited by a small sample size (n = 174) and included a wide age range of children (1-6 years), which would have challenged data interpretation.[12]

There were no significant associations between the CEBQ subscales of Emotional Under-eating, Emotional Overeating and Desire to Drink and weight status. Previous findings surrounding emotional eating behaviours have been mixed, although our results are similar to those reported in older children.[8, 10, 11] However, a positive association between the Emotional Overeating subscale and weight status has been observed in some studies.[11, 18] Emotional overeating has been described as an abnormal response in young children as it is proposed that younger children maintain the more natural reaction to emotional/stressful situations which is a reduction in appetite.[19] Therefore, emotional under-eating is a more common response to emotional distress in young children.[1] In the current study, the lack of association may be due to the children being too young to display any abherrent eating behaviours or patterns in response to emotional stimuli.

Weight status in the current study was assigned using the IOTF BMI cut-offs for children aged 2-18 years [16,17] to allow for comparison with previous studies carried out on this topic. The prevalence of overweight/ obesity, at 14%, was slightly lower than that reported by the National Preschool Nutrition Survey (NPNS) of Ireland at 17%.[3] We also observed a slightly higher prevalence of underweight (6%) than the NPNS, at 4%. The IOTF BMI cut-offs have previously been described as conservative in their estimation of overweight and obesity [20] and can overestimate the prevalence of underweight.[21]

This study, from a large prospective birth cohort, is the first of its kind to explore associations between eating behaviours and weight status in two-year old children. The prospective design, detailed assessments and use of validated protocols in the Cork BASELINE Birth Cohort Study enabled us to explore associations between eating behaviours and weight status, while accounting for early life exposures that may influence weight status at two years of age. A potential limitation of this study is

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that both eating behaviours and weight status at two years were measured concurrently, therefore this analysis is cross-sectional in design, although it is important to note that maternal and early life data were used in the analysis, thereby enabling deeper interpretation of the data than would be possible with a cross-sectional survey. This cohort is being followed prospectively, and eating behaviours are being assessed at five years, which will enable a unique longitudinal analysis of eating behaviours and their impact on weight status at that time.

Conclusions

Eating behaviours are independently associated with weight status in children aged two years from a large prospective birth cohort in Ireland. We will investigate whether these associations persist or develop over time. An exploration of the genesis of unhealthy eating behaviours in young children is warranted.

Acknowledgements

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Conflict of interest

The authors declare no conflict of interest.

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Table 1. Demographic and anthropometric characteristics of study participants from the Cork BASELINE Birth Cohort Study (n = 1189)

	% or Median [IQR]
Maternal	
Caucasian	99
Country of birth - Ireland	86
Attended 3rd level education	88
Smoker at 15 weeks gestation	11
BMI at 15 weeks gestation >30kg/m^2 *	10
Age at delivery (years)	32.0 [29.0, 34.0]
Child	
Gender - Male	50
Birth weight (kg)	3.6 [3.2, 3.9]
Gestational Age (weeks)	40.2 [39.4, 41.0]
Infant Feeding	
Any breastfeeding at hospital discharge	73
Any breastfeeding at two months	30
Age first given solids (weeks)	20.0 [17.0, 22.0]
Anthropometry (24 month assessment)	
Weight (kg)	13.0 [12.1, 13.9]
Height (m)	0.89 [0.85, 0.90]
BMI (kg/m^2)	16.7 [15.9, 17.5]
IOTF classification - underweight	6
IOTF classification - normal weight	80
IOTF classification - overweight/obese	14

* Data available for participants of SCOPE study only (n = 896)

IQR: interquartile range; BMI: body mass index; IOTF: International Obesity Task Force BMI cut-offs used to assign participants into three categories of weight status.

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253 **Table 2.** Median [IQR] CEBQ subscale scores across three weight categories of two-year olds (n =
254 1189)

	Underweight *n* = 77	**Normal Weight** *n* = 947	**Overweight/Obese** *n* = 165	**P-value***
	Median [IQR]	Median [IQR]	Median [IQR]	
Food Approach Grouped	2.3 [2.0, 2.6][a]	2.5 [2.1, 2.8][b]	2.7 [2.4, 3.0][c]	<0.001
Enjoyment of Food	3.8 [3.0, 4.1][a]	4.0 [3.5, 4.5][b]	4.3 [3.8, 4.8][c]	<0.001
Food Responsiveness	1.0 [1.0, 2.0][a]	1.1 [1.0, 2.0][b]	2.0 [1.0, 3.0][c]	<0.001
Emotional Overeating	1.5 [1.0, 1.8]	1.5 [1.0, 1.8]	1.5 [1.0, 2.0]	0.153
Desire to Drink	2.7 [1.8, 3.5]	2.7 [2.0, 3.3]	2.7 [2.3, 3.7]	0.128
Food Avoidant Grouped	3.0 [2.5, 3.3][a]	2.8 [2.4, 3.1][b]	2.6 [2.3, 2.9][c]	<0.001
Satiety Responsiveness	3.0 [2.7, 3.7][a]	2.7 [2.3, 3.0][b]	2.3 [2.0, 3.0][c]	<0.001
Slowness in Eating	3.0 [2.7, 3.7][a]	2.7 [2.3, 3.3][b]	2.6 [2.3, 3.0][c]	<0.001
Food Fussiness	2.7 [2.2, 3.4][a]	2.5 [2.0, 3.0][b]	2.3 [1.8, 2.9][c]	<0.001
Emotional Under-eating	2.8 [2.0, 3.8]	3.0 [2.3, 3.5]	3.0 [2.3, 3.5]	0.812

255 * Significant differences between groups explored by Mann-Whitney U test and Kruskal-Wallis test.

256 [a,b,c] Different superscript letters denote significant differences between groups (P< 0.05).

257 IQR: interquartile range; CEBQ: Children's Eating Behaviour Questionnaire.

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Table 3. Multivariate analysis of CEBQ subscales as potential risk factors for overweight/obesity and underweight at two years (n = 1189)

	Overweight/obesity [1]		**Underweight [2]**	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Food Approach Behaviours				
Enjoyment of Food	1.90 (1.46, 2.48)	<0.001	0.63 (0.45, 0.89)	0.008
Food Responsiveness	1.73 (1.47, 2.03)	<0.001	0.49 (0.32, 0.75)	<0.001
Emotional Overeating	1.30 (0.94, 1.80)	0.112	0.77 (0.47, 1.25)	0.290
Desire to Drink	1.11 (0.94, 1.31)	0.225	0.93 (0.73, 1.17)	0.523
Food Avoidant Behaviours				
Satiety Responsiveness	0.56 (0.43, 0.73)	<0.001	2.03 (1.38, 2.98)	<0.001
Slowness in Eating	0.57 (0.45, 0.73)	<0.001	1.44 (1.01, 2.04)	0.042
Food Fussiness	0.70 (0.56, 0.88)	0.002	1.15 (0.83, 1.58)	0.411
Emotional Under-eating	0.97 (0.81, 1.16)	0.724	0.96 (0.75, 1.23)	0.731

[1] Model adjusted for gender, birth weight, maternal education status, race and smoking status at 15 weeks gestation. Not overweight/obese used as the reference.

[2] Model adjusted for gender, birth weight, maternal education status and body mass index at 15 weeks gestation. Not underweight used as the reference.

OR: odds ratio; CI: confidence interval; CEBQ: Children's Eating Behaviour Questionnaire.

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