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Mealtime energy intake and feeding behaviour in children who fail to thrive: A population based case-control study

Abbreviated title: Mealtime energy intake and feeding behaviour in children who fail to thrive

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Abstract

Background: The essential link between energy needs and energy intake is feeding behaviour, yet few studies have directly observed feeding behaviour in children who have failed to thrive. A cohort of 961 term infants was screened to identify children with first year weight gain below the 5th centile in order to examine their feeding behaviour and food intake.

Methods: A nested case-control study was used with direct observation at 13-21 months over two lunchtime meals, one consisting of finger foods and the other of 'spoon foods'. Thirty children who failed to thrive and 57 controls were studied. The video-tapes were coded for feeding behaviour using a behavioural coding inventory which distinguishes between children feeding themselves and responding to being fed by their mother. The main outcome measures were counts of five feeding actions (*give, accept, feedself, refuse, reject)* and measures of energy intake, the weight of food eaten and meal duration.

Results: There were systematic differences in feeding behaviour between meal types, with mothers feeding their child more often at meals comprising spoon foods and children feeding themselves more often at meals comprising finger foods. By weight, more food was consumed at the spoon food meals, but energy intake was no higher, showing that the children compensated for the differing energy yields of the foods. Children who failed to thrive took in less energy than controls, and were less likely to sit in a highchair throughout the meal, but there were no clear differences in other aspects of feeding behaviour.

Conclusions: Food type is an important variable when studying childhood feeding behaviour. Children who fail to thrive take in less energy than controls of the same age, despite there being no major differences in mealtime feeding behaviour.

Keywords: Failure to thrive, thrive index, feeding, eating behaviour, parent-child interaction, energy intake, weaning.

Introduction

Slow weight gain in infancy, if it is sustained, is often termed 'failure to thrive' (FTT). The underlying mechanism is thought usually to be inadequate energy intake, and a number of studies have shown that infants who fail to thrive have low energy intakes (Pugliese, Weyman-Daum, Moses & Lifshitz, 1987; Pollitt & Eichler, 1976; Drewett, Kasese-Hara & Wright, 2002) and that they grow better if fed more (Whitten, Pettitt & Fischhoff, 1969; Wright, Callum, Birks & Jarvis, 1998).

Why children who fail to thrive have low energy intakes is less clear. The essential link between energy needs and energy intake is feeding behaviour, and feeding difficulties are more commonly reported by the mothers of children who fail to thrive than those of controls (e.g. Pollitt et al., 1976; Kotelchuck & Newberger, 1983; Wilensky et al., 1996). Examining the objective basis for these reports requires observational methods and these have been used in only a limited number of studies, which have generally found a higher prevalence of feeding problems, including food refusal (Singer, Song, Hill & Jaffe, 1990; Pollitt et al., 1976; Drewett et al. 2002). Ramsey, Gisel & Boutry (1993) have suggested that long meal durations provide a clinically valuable indicator of feeding problems, but Mathisen, Skuse, Wolke and Reilly (1989) found meal durations were significantly shorter in children who failed to thrive than in controls, and Heptinstall et al. (1987) found no difference.

There are two general methodological problems in this area. Typically infants with weights falling below the fifth or third centile have been studied. This criterion is unsatisfactory because it confounds poor postnatal weight gain (which may be related to feeding problems) with poor prenatal weight gain (which cannot be). More appropriate criteria based specifically on postnatal weight gain are now available (Wright, Waterston, Matthews & Aynsley-Green, 1994; Drewett, Corbett & Wright, 1999). Secondly, research has tended to rely on referred samples of children who failed to thrive, which introduce important types of

selection bias (Batchelor, 1999; Batchelor & Kerslake, 1990; Boddy, 1997). Only one study has observed feeding behaviour in a non-referred sample (Heptinstall et al., 1987).

In this study we screened a population-based cohort for failure to thrive using a measure of post-natal weight gain, in order to examine their feeding behaviour and energy intakes using previously validated observational methods.

Method

Sampling frame and growth screening

The Millennium Baby Study recruited 1029 infants shortly after birth, comprising 82% of all infants born to Gateshead residents within 34 'recruiting' weeks between 1st June 1999 and 31st May 2000. At recruitment baseline information was collected, including birth weight and socio-economic status. Routine baby clinic weights were then obtained via parental questionnaires, and infants were weighed at a health check at 12-13 months. Of the 1029 infants, 961 were born at 37 weeks gestation or later. A birth weight and at least one weight between 9 and 13 months were available for 817 (85%) of these.

Weights were transformed to standard deviation scores (SDS) using the UK 1990 growth reference (Freeman et al., 1995; revised Preece, Freeman & Cole, 1996). Weight gain was assessed using the thrive index methodology (Wright et al., 1994; Wright, Avery, Epstein, Birks & Croft, 1998). A thrive index is a Z score for change in weight, adjusted for the child's initial weight. The score that identifies the slowest growing 5% at different ages has been established (Wright et al., 1998; Drewett et al., 1999) and was used to identify cases as failing to thrive. For this study the initial weight used was the average of the birthweight SDS and any weight SD scores available between 4-8 weeks, to reduce the influence of possible erroneous individual weights. The later weight used was the latest available weight collected at 9-13 months. Controls were identified from a 10% random sample of the remainder of the cohort, provided their thrive index after 9 months was above the 10th percentile.

Home visits

Participants were studied for two lunchtime meals at 13-21 months (mean 15.7, SD 1.4) in their own homes, generally on consecutive days. One was a finger food and one a spoon food meal, and the order was randomly counterbalanced. Commercially produced foods of known energy content were provided, selected by the mother from two lists. One comprised finger foods (e.g. fish fingers, chips and fruit), and the other spoon foods (e.g. mashed potato, spaghetti bolognese and yoghurt) which the mother then prepared and gave the meal as usual, and provided any drinks. Video-recording began when the food was placed in front of the child and continued until the food was removed, or the meal was clearly over. Mothers were encouraged to use a highchair to facilitate the recording process. All food offered and left over was weighed using an electronic balance, accurate to 1g (Salter, model 4001). The child was weighed naked using electronic scales (SECA) accurate to 20g. Of the home visits, 170 were conducted by the first author (KNP), and 20 by an experienced associated research worker (ASD). Throughout data collection and coding, neither knew whether the child was a case or a control.

Analysis

Feeding behaviour was coded using an established behavioural coding inventory (Young & Drewett 1998; Parkinson & Drewett 2001), which describes both self- and parental-feeding (Table 1). *Give* codes for parental behaviour, and *accept* and *refuse* for responses to it. *Feedself* codes for the child's self-feeding behaviour and *reject* codes for spitting out food. Feeding and drinking are distinguished using codes for substance type. Each meal was coded in real time using all-occurrence sampling with a purpose-written program (Marsh, 1988). The inter-observer reliabilities of the behavioural codes have been established in previous studies in children 12 to 24 months old, and are generally > .8 (Parkinson & Drewett, 2001; Drewett et al , 2002). Meal duration was defined as the time from the first coded feeding act

to the last. Counts have a lower bound of zero and are usually skewed, so non-parametric methods were generally used in the analysis of these behavioural variables. Parametric methods were used to analyse the other variables. *Table 1 here*

Results

Fifty-five children out of the 817 met the criteria for FTT. These 55 cases and 80 controls were approached, and 38 (69%) cases and 58 (72%) controls were studied. Eight cases and one control were excluded as the weight recorded at the home visit showed that they no longer fulfilled the criteria for participation. It is unclear whether this was due to errors in the screening data from which they were identified, or whether they had recovered by the time of observation. The analyses, then, were based on 30 cases and 57 controls, and all fulfilled the inclusion criteria at the time of observation. Two controls were observed for one meal only (one for the finger meal, the other for the spoon meal) so 172 meals were analysed.

The children were usually fed by their mother (159 meals) although some were fed by another family member (13 meals). The birth weight for the two groups was similar, while, as expected, the weight and thrive index at the time of observation was significantly different, (Table 2). Although the cases and controls were not matched on any variable, their families did not differ in any social and economic circumstances that were recorded except that children who failed to thrive were more likely to be second or later born, a finding also reported by Drewett et al. (1999). In almost all families this means, of course, that the mother was caring for more than one child at the time. *Table 2 here*

Table 3 shows feeding behaviour and food intake by meal type. *Table 3 here.* There were substantial differences between the meal types. In both cases and controls the child was more likely to be fed by the mother at spoon meals and a greater weight of food was eaten. Energy intake, however, did not differ significantly across the meal types. As regards feeding behaviour variables, minor differences in the feeding behaviour variables between cases and

controls did not reach statistical significance for either the finger or spoon meals (Table 4) and this was unaffected by controlling for birth order using regression methods. The normally distributed variables *energy intake*, *weight of food eaten* and *meal duration* (Table 5a) were considered simultaneously in a multivariate analysis of variance (Table 5b). As regards *weight of food eaten* and meal *duration* there was a significant difference between the meal types, but no significant difference between the groups (or meal type by group interaction). As regards *energy intake*, there was no significant difference between the meal types but cases took in significantly less energy than controls. Again there was no interaction. Fluids were consumed in 108 of the 172 meals, generally water or juice (105 meals). It was not possible to determine the energy taken in drinks, which were provided by the mother, but the cases drank less (median 1.75 sips) than the controls (3.50 sips), a difference of marginal statistical significance (Z=-1.94, p=.052).

Table 4 and Table 5a + Table 5a here

All but one family had a high chair, but controls were significantly more likely than cases to remain in it for the entire meal: 60% cases and 82% controls for the finger meal ($\chi^2 = 5.03$, p=.025), and 63% cases and 83% controls for the spoon meal ($\chi^2 = 6.64$, p=.031).

Discussion

Analyses of feeding behaviour in the whole sample showed major systematic differences according to the type of food being eaten, which justified our imposition of two distinct meal types in the study. At this age handling finger foods is relatively easy; handling spoons is not (Connolly & Dalgleish, 1989). The mothers of both groups fed the child more often at spoon meals which were significantly shorter than finger meals, even though 59% more food by weight was eaten. There was, however, no significant difference in energy intake between meals; this is probably due to the young child's capacity to regulate energy intake successfully, a capacity which has previously been documented experimentally in a number of

other situations (Fomon, Thomas, Anderson & Nelson, 1975; Birch, Johnson, Andressen, Peters & Schulte, 1991; Birch & Deysher, 1986).

To examine case-control differences, we took meal type into account, using the two way analysis of variance summarised in Table 5b. Although no statistically significant differences were found in any measured aspect of feeding behaviour, cases did have a significantly lower energy intake than the controls, supporting the findings of Pollitt et al. (1976) and Drewett et al. (2002). Although the difference was small, if it was as big at other meals the children who failed to thrive would consume about 10% less energy than controls overall. It is, of course, a common assumption that children who fail to thrive have a low food intake, but it is still important that the difference can be demonstrated reliably in a controlled study, since this allows further investigation of the subtler question which concerns the origin of the difference.

We encouraged the use of a high chair, but cases were significantly less likely to stay in it for the whole meal. This replicates the finding of Mathisen et al. (1989) and may suggest a lower interest in feeding in children who fail to thrive, though obviously other explanations are possible. This was the only clear behavioural difference found. Other differences in feeding behaviour have been found in two previous observational studies (Pollitt et al., 1976; Drewett et al., 2002), but these were of referred cases, and many biases can be introduced by the referral process. Batchelor and Kerslake (1990) found that children whose failure to thrive is *detected* have three times as many feeding problems as those in whom it is not detected, so groups of referred cases may have a higher probability of feeding problems. There was also no difference in meal duration, which is in keeping with the only previous study of a non-referred sample (Heptinstall et al., 1987). However, there must be some behavioural difference to account for the difference in energy intake seen. The bite size, which we could not measure directly, may have been different.

This investigation of feeding behaviour in children who fail to thrive had three strengths. It was a population based study, and thus avoided referral bias; it was larger than any previous study of feeding behaviour in children with this condition; and it used direct observation of feeding during meals, rather than relying on parental report, in a controlled but naturalistic setting. The screening threshold used to identify failure to thrive was consistent with current clinical practice, corresponding to a mean fall through 2½ inter-centile spaces, but it is, of course, possible that more striking differences might be found in a study of more severely affected children.

In summary, children who failed to thrive had significantly lower energy intake in test meals, but did not differ significantly from controls in any major way in feeding behaviour, though they were more likely to leave high chairs during the meal. Feeding behaviour did differ markedly with the type of food offered at the meal, confirming the importance of controlling for the type of food in clinical studies of this kind. Energy intake was unaffected by the type of food offered, showing again how successfully energy intake is regulated by young children.

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Table 1

Parent	*Give*	Parent brings food/spoon/bottle/cup to child's mouth to place in mouth
Child	*Accept*	Child accepts food/drink from parent's spoon/hand/bottle/cup directly into mouth
	Refuse	Child refuses to open mouth or closes mouth as food/spoon/bottle/cup approaches and before it is fully in mouth and/or turns head away, arches back, pushes spoon away, covers mouth
	Feedself	Child grasps food/spoon/bottle/cup and brings it towards mouth without assistance (assumes child is successful in getting some food into mouth)
	Reject	Child spits out food/drink after *accept* or *feedself*

Table 2

	Cases (n = 30)	Controls (n = 57)
Birth weight in z scores	0.13 (1.02)	-0.23 (1.06)
13-21 month weight z scores*	-1.78 (0.65)	0.25 (0.95)
13-21 month thrive index**	-1.78 (.35)	0.37 (.89)
Child's age (at first meal, in months)	15.8 (1.60)	15.4 (1.19)
Males	47% (14)	54% (31)
First born***	30% (9)	53% (30)
Mother's age	30.9 (6.5)	30.7 (6.1)
Family		
Caucasian	100% (30)	100% (30)
Has wage earner	77% (23)	79% (45)
Home owner	77% (23)	65% (37)
Car owner or has use of car	74% (22)	74% (42)

The figures show the mean (SD) or percentage (n). Ages are given in decimal years. The differences between the groups were examined using *t*- or Mann-Whitney *U*-tests, or χ^2 tests as appropriate. Except for those reflecting the child's growth, only one comparison was statistically significant (comparing the proportion first born). * $t = 8.4$, $p<.001$; ** $t = 12.75$, $p<.001$; *** $\chi^2 = 4.07$, $p=.044$.

Table 3

	All Children				
Behavioural variables	Median	Q1 to Q3		Spearman's ρ	Wilcoxon W
Give					
Finger	3.0	0.0 to 12.0		.22	7.1
Spoon	36.5	15.8 to 49.3		p=.047	p<.0005
Accept					
Finger	1.0	0.0 to 7.0		.15	7.0
Spoon	24.0	8.0 to 39.3		NS	p<.0005
Refuse					
Finger	1.0	0.0 to 5.3		.29	5.8
Spoon	8.0	3.0 to 13.3		p=.008	p<.0005
Feedself					
Finger	47.5	28.8 to 65.8		.25	5.2
Spoon	17.0	2.0 to 40.8		p=.022	p<.0005
Reject					
Finger	4.0	2.0 to 9.3		.08	6.5
Spoon	1.0	0.0 to 2.0		NS	p<.0005
Other variables	Median	Mean	SD	Pearson's *r*	t
Energy intake (kJ)					
Finger	568	686	406	.44	0.5
Spoon	687	702	286	p<.0005	NS
Weight of food eaten (g)					
Finger	86	99	53	.35	8.7
Spoon	163	168	73	p=.001	p<.0005
Duration (mins)					
Finger	21.5	22.0	7.3	.19	8.4
Spoon	14.1	14.5	5.2	NS	p<.0005

NS : not significant (p≥0.05). Q1: first quartile; Q3: third quartile.

Table 4

	Cases		Controls	
Behavioural variables	Median	Q1 to Q3	Median	Q1 to Q3
Give				
Finger meal	2.5	0.0 to 8.8	3.0	0.0 to 12.0
Spoon meal	31.5	15.8 to 49.8	38.5	14.5 to 49.3
Accept				
Finger meal	0.5	0.0 to 7.0	1.0	0.0 to 7.0
Spoon meal	19.5	8.5 to 43.0	25.0	8.0 to 35.0
Refuse				
Finger meal	0.0	0.0 to 4.5	2.0	0.0 to 5.8
Spoon meal	7.0	3.8 to 13.3	8.0	3.0 to 13.8
Feedself				
Finger meal	47.5	21.3 to 65.8	47.5	29.3 to 67.3
Spoon meal	14.5	1.8 to 38.0	19.5	2.3 to 42.3
Reject				
Finger meal	3.5	2.0 to 6.5	5.0	2.0 to 10.0
Spoon meal	1.0	0.0 to 4.0	1.0	0.0 to 2.0

Using the Mann-Whitney U test, p was >.05, NS, for all ten comparisons. Q1: first quartile; Q3: third quartile.

Table 5a

	Cases Mean (SD)	Controls Mean (SD)
Energy intake (kJ)		
Finger meal	593 (283)	737 (453)
Spoon meal	632 (292)	740 (278)
Weight of food eaten (g)		
Finger meal	89 (47)	105 (56)
Spoon meal	165 (82)	169 (68)
Duration (mins)		
Finger meal	21.9 (7.9)	22.1 (7.1)
Spoon meal	13.4 (4.7)	15.1 (5.4)

Table 5b

Analysis of variance	$F_{(1,83)}$	p
Energy intake (kJ)		
Between group (Case-control)	4.16	<.05
Between meal type (Finger-spoon)	0.30	NS
Interaction	0.14	NS
Weight of food eaten(g)		
Between group (Case-control)	1.02	NS
Between meal type (Finger-spoon)	71.99	<.001
Interaction	0.42	NS
Duration (mins)		
Between group (Case-control)	0.72	NS
Between meal type (Finger-spoon)	68.69	<.001
Interaction	0.83	NS

NS : not significant ($p \geq 0.05$). Degrees of freedom are 1, 83 in each case.

Table legends

Table 1

Behavioural codes used in the analyses.

Table 2

Characteristics of case and control children studied.

Table 3

Descriptive statistics, correlation coefficients and associated statistics across the two meals for feeding behaviour variables, energy intake, weight of food eaten and meal duration (n = 84 to 86). The Spearman ρ statistics show the correlation between the meals; the Wilcoxon W statistics show whether the difference in the medians is statistically significant.

Table 4

Case-control differences in feeding behaviour for finger food meals and spoon food meals (n = 30 cases, 56 controls). The figures shown are the quartiles for counts for each behavioural variable.

Table 5a

Descriptive statistics for energy intake, food intake and meal duration for finger food meals and spoon food meals (n = 30 cases, 56 controls).

Table 5b

Comparison of energy intake, weight of food eaten and meal duration across meal type and group. Results from a 2 by 2 factorial multivariate analysis of variance, each with 1,83 degrees of freedom.