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Infant feeding in relation to eating patterns in the second year of life and weight status in the fourth year

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Abstract

Objective: To explore associations of early infant feeding with (i) eating patterns in the second year of life and (ii) weight status in the fourth year of life in a prospective cohort of children in Scotland.
Design: Growing Up in Scotland (GUS) longitudinal birth cohort study (2005–2008).
Setting: Scotland, UK.
Subjects: Children aged 9–12 months (n 5217) followed through to 45–48 months.
Results: Infant feeding was associated with eating patterns, defined by using SPSS two-step cluster analysis, in the second year of life. Children who were ever breast-fed compared with never breast-fed (adjusted OR = 1·48, 95 % CI 1·27, 1·73) were more likely to have a positive eating pattern (Cluster 2). Children who started complementary feeding at 4–5 months or 6–10 months compared with 0–3 months (adjusted OR = 1·32, 95 % CI 1·09, 1·59 or AOR = 1·50, 95 % CI 1·19, 1·89) were more likely to belong to Cluster 2. Breast-feeding was negatively associated with being overweight or obese in the fourth year of life compared with no breast-feeding (adjusted OR = 0·81, 95 % CI 0·81, 1·01). Introduction of complementary feeding at 4–5 months compared with 0–3 months was negatively associated with being overweight or obese (adjusted OR = 0·74, 95 % CI 0·57, 0·97).
Conclusions: Breast-feeding and introduction of complementary feeding after 4 months were associated with a positive eating pattern in the second year of life. Introduction of complementary feeding at 4–5 months compared with 0–3 months was negatively associated with being overweight or obese.

Keywords
Early infant feeding
Eating patterns
SPSS two-step cluster analysis

Eating patterns and behaviours in infants and young children are influenced by complex interrelated factors such as cultural beliefs[1], parental or child interactions and feeding styles[2–5], as well as the parent's or primary caregiver's education, experiences, attitudes and social and economic circumstances[6–8].

In addition to nourishing the infant, early feeding practices and diet in the pre-school years play an important role in developing fine motor skills, social skills and communicative skills and may be important in the development of energy balance regulation[9–11]. The transition from infant feeding to toddler diet is important as it marks a gradual change in nutritional habits as well as significant social and educational developments[12,13].

Most published research has focused on single behaviours such as breast-feeding[14–17] or timing of introduction to solid foods[17,18)]. There is little published data about eating patterns immediately following infancy, during the toddler years. However, there is evidence to suggest that at the individual and social level, early experiences of infant or child feeding practices and nutritional quality can play a major role in influencing eating habits and health outcomes of individuals in later life[4,5,14,16,19,20].

In Scotland, poor diet and obesity are a major public health concern[21] and many researchers have reported on the effect of early infant feeding and the risk of childhood overweight or obesity[14,16,20]. There is good evidence with plausible mechanisms for breast-feeding being protective against childhood obesity[14,16,20], however most infants in Scotland are either formula-fed or mixed-fed[22]. In addition to milk feeding, the timing of complementary feeding and diet following the infancy stage may also be important in optimising growth and development, although this is less well studied[23,24]. Two large prospective cohort studies in the UK have identified dietary patterns characterised by highly energy-dense, low-nutrient foods in 1-year-old and 3-year-old children[17,25]. This energy-dense type of pattern was shown

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to persist into later childhood[25] and in one of the studies was related to body composition at age 4 years[17].

The present paper aims to add to our understanding of the interrelationships between early feeding experiences characterised by breast-feeding, complementary feeding and patterns of diet in the first few years. This will help to identify the role of early feeding in interventions to prevent obesity and provide better understanding of the associations between early-life dietary experiences with later-life health outcomes. Although there are several methods used to aggregate infants that have similar eating patterns, the present paper uses an exploratory statistical multivariate two-step cluster analysis method, not previously used in this context, on a large and contemporary prospective study of pre-school children.

Methods

The Growing Up in Scotland (GUS) survey (http://www.ltscotland.org.uk/earlyyears/cpd/research/gus/index.asp) is a national longitudinal infant cohort study which has been collecting data annually since 2005. Each data collection period is referred to as a 'sweep'. For the purpose of addressing the research questions in the present paper, the GUS Birth Cohort data set was explored. The data set provides data on a representative random sample of Scottish infants, out of a random selection of 130 geographically clustered areas across Scotland. The Child Benefit Records held by the Department of Work and Pensions was used as the sampling frame[26]. The infants in the Birth Cohort data set were born between June 2004 and May 2005, and the first sweep of data was collected between April 2005 and May 2006. The survey data were collected using the computer-assisted personal interviewing technique. This involved a study interviewer conducting a face-to-face interview with the child's main caregiver and simultaneously entering the responses directly into a laptop computer. The variables relating to infant feeding, eating patterns, weight status and socio-economic status (SES) were available from: Sweep 1[27], collected in April 2005–May 2006 (n 5217; 9–12 months old); Sweep 2[28], collected in April 2006–May 2007 (n 4512; aged 19–24 months); and Sweep 4[29], collected in April 2008–May 2009 (n 3994; 45–48 months old). The relevant variables for the analysis were merged together to produce one SPSS (SPSS statistical software package version 17; SPSS Inc., Chicago, IL, USA) working file. The variables are described in Table 1.

Defining infant eating patterns as clusters at 19–24 months

Variables from the Food and Nutrition module of the GUS Sweep 2 (n 4512; aged 19–24 months) survey which explained infants' or young children's eating patterns were checked for completeness. Variables with >5% missing responses were excluded from the cluster analysis. The categories used to define frequency of consumption of sweets, crisps or soft drinks were re-coded to quantify consumption per week and used as continuous variables to define the clusters.

The SPSS two-step cluster analysis technique (SPSS version 17) was used to group together children with similar eating patterns, defined by variables recording variety of fruits intake, variety of vegetables intake, snacking behaviour, intake of energy-dense or low-nutrient foods, meal or snack pattern. Unweighted data from fifteen variables were entered into the two-step cluster analysis exploratory statistical procedure. These variables are listed in Fig. 1. The clusters were generated using the SPSS log-likelihood distance measure two-step cluster analysis algorithm. The algorithm used Schwarz's Bayesian information criterion to determine the number of clusters automatically. The program calculated the rank of importance for the categorical variables using Pearson's χ^2 test, while Student's t test was used for continuous variables. The resulting clusters generated were labelled by the researcher, using prior knowledge of negative and positive indicators of eating patterns identified from the WHO practical guidance on the frequency and type of food offered to infants aged 6–24 months[30]. The cluster membership solution was saved as a new variable to be used for subsequent statistical analysis.

A Forest plot diagram was generated to illustrate the OR and 95% CI for each of the selected eating pattern variables as predictors of cluster membership (see Fig. 1). The OR and 95% CI for each category in Fig. 1 were calculated using the formula: $\exp[(O-E)/(V \pm 1{\cdot}96/\sqrt{V})]$, where O = observed, E = expected and V = variance. In Fig. 1, each OR point is represented by a square whose area is proportional to the logrank variance; thus, larger squares have a greater information content and correspondingly tighter confidence intervals.

Statistical analysis

The Pearson χ^2 test was used to examine the association between infant feeding with eating patterns in the second year of life and SES. Infant feeding was described using the variables breast-feeding and age of starting complementary feeding. Breast-feeding was defined using the question 'Was the child ever breast-fed?' and age of starting complementary feeding was defined using the question 'How many months old when the child started solid food?'. SES was defined using the national Scottish Index of Multiple Deprivation (SIMD) 2006 and respondents' education based on the highest level attained (see Table 1). Binary logistic regression was used to estimate the OR, adjusted OR (AOR) and 95% CI for the univariate and multivariate (adjusted for SES) associations between eating patterns, breast-feeding and start of complementary feeding. The outcome variable used was the eating pattern cluster and the explanatory variables were breast-feeding, complementary feeding, SIMD and respondents' education (Table 2).

Table 1 List of variables used for analysis from Sweep 1, Sweep 2 and Sweep 4 of the Growing Up in Scotland (GUS) Birth Cohort data set

Variable (Sweep)	Definition	Coding
Scottish Index of Multiple Deprivation (SIMD) Quintile 2006 (Sweep 4, collected 2008–2009, age 45–48 months)	Area-based measure of deprivation. Derived from the quintiles of SIMD score variables on the Scottish Health Survey database	1 = least deprived 2 3 4 5 = most deprived
Education (Sweep 4, collected 2008–2009, age 45–48 months)	Highest educational qualification of respondent. Standard Grade or equivalent qualifications are taken at the age of 15 or 16 years old. Higher Grade or equivalent qualifications are taken at the age of 16 or 17 years old. Vocational qualifications are provided in further education colleges through apprenticeship	1 = degree or professional qualification or higher 2 = vocational qualification below degree 3 = higher grade or equivalent 4 = standard grade or equivalent 5 = other 6 = no qualification
Breast-feeding (Sweep 1, collected 2005–2006, age 9–12 months)	Was the child ever breast-fed?	1 = yes 2 = no
Age of starting complementary feeding (Sweep 1, collected 2005–2006, age 9–12 months)	How many months old when the child started solid food?	Continuous data categorised to: 1 = 0–3 months 2 = 4–5 months 3 = 6–10 months
Overweight category (includes obese children) based on BMI *Z*-scores (Sweep 4, collected 2008–2009, age 45–48 months)	Height and weight were measured by the interviewers and recorded to calculate BMI at Sweep 4. UK 1990 BMI references curves[31] were used to define the BMI *Z*-score cut-off	BMI *Z*-score cut-offs: 1 = $\geq$1·04, overweight/obese 2 = $<$1·04, not overweight/obese
Birth weight (Sweep 1, collected 2005–2006, age 9–12 months)	How much did the child weigh at birth?	Continuous variable: weight (g)
Eating patterns at 19–24 months defined using cluster analysis (Sweep 2, between 2006–2007)	15 variables which best explained infants' eating patterns. See Fig. 1 for list of variables	1 = Cluster 1 (defined as a 'more negative eating pattern') 2 = Cluster 2 (defined as 'positive eating pattern')

The univariate associations between variables that describe early nutrition (breast-feeding, age of starting complementary feeding and eating patterns in the second year of life) with weight status in the fourth year of life were assessed using Pearson's χ^2 test. Weight status was based on the UK 1990 BMI references curve[31] and the variable used to classify infants as overweight or obese was defined using the BMI *Z*-score cut-off (BMI *Z*-score $\geq$1·04 = overweight or obese and BMI *Z*-score $<$1·04 = not overweight or obese; see Table 1). Binary logistic regression was used to estimate the OR, AOR and 95 % CI for the univariate and multivariate (adjusted for SES) associations between weight status and breast-feeding, age of starting complementary feeding and eating pattern cluster. The outcome variable used was weight status at 4 years old and the explanatory variables were breast-feeding, complementary feeding and eating patterns, with birth weight, SIMD and education as potential confounders of the association (see Table 3).

Infants with missing data points within any of the models reported in Table 2 or Table 3 were excluded from the analysis.

Complex sample survey design analysis

The final Sweep 4 longitudinal survey non-response sample weight was generated using a model-based weighting technique by the GUS team to correct for sampling error and non-response bias. More detail is given in the GUS User Guide for each sweep, which can be accessed from the GUS website (http://www.growingupinscotland.org.uk/) under the 'Publications' section.

The Complex Sample module in SPSS version 17 was used to account for the longitudinal non-response sample weight and the clustering and stratification of the study's complex sample survey design. The clustering and stratification weights were used to correct for unequal sample selection. These weights were then used to create an SPSS complex sample plan file to generate the weighted descriptive and inferential statistics reported in Tables 2 and 3.

Results

Eating patterns in the second year (19–24 months) of life

A total of 4493 children (86 % of Sweep 1 sample) had complete sets of eating pattern variables and were

Category OR (95 % CI)	Cluster 1	Cluster 2	Logrank variance
(a) Variety of fruits/d (trend χ_1^2 = 585; 2*P* < 0·00001)			
None 0·12 (0·09, 0·17) 2*P* < 0·00001	134 (6·5 %)	5 (0·2 %)	33·5
One 0·18 (0·15, 0·22) 2*P* < 0·00001	408 (19·8 %)	79 (3·2 %)	107·8
Two or three 1·26 (1·12, 1·42) 2*P* = 0·0001	1166 (56·5 %)	1512 (62·2 %)	268·7
Four or more 2·42 (2·12, 2·76) 2*P* < 0·00001	354 (17·2 %)	835 (34·3 %)	217·2
(b) Variety of vegetables/d (trend χ_1^2 = 291; 2*P* < 0·00001)			
None 0·23 (0·18, 0·30) 2*P* < 0·00001	210 (10·2 %)	53 (2·2 %)	61·5
One 0·55 (0·48, 0·63) 2*P* < 0·00001	592 (28·7 %)	442 (18·2 %)	197·7
Two or three 1·68 (1·49, 1·90) 2*P* < 0·00001	1132 (54·9 %)	1634 (67·2 %)	264·1
Four or more 2·05 (1·68, 2·50) 2*P* < 0·00001	128 (6·2 %)	302 (12·4 %)	96·6
(c) Eating a variety of foods (trend χ_1^2 = 161; 2*P* < 0·00001)			
Most things 1·54 (1·36, 1·73) 2*P* < 0·00001	1084 (52·6 %)	1532 (63·0 %)	271·4
Reasonable variety 1·05 (0·92, 1·19) 2*P* > 0·1; NS	574 (27·8 %)	700 (28·8 %)	226·7
Fussy eater 0·37 (0·32, 0·45) 2*P* < 0·00001	404 (19·6 %)	199 (8·2 %)	129·7
(d) Frequency of sweets etc (trend χ_1^2 = 861; 2*P* < 0·00001)			
< once/week 3·50 (2·88, 4·25) 2*P* < 0·00001	81 (3·9 %)	371 (15·3 %)	101·0
1–6 times/week 2·71 (2·41, 3·05) 2*P* < 0·00001	721 (35·0 %)	1456 (59·9 %)	278·7
≥once/d 0·22 (0·20, 0·25) 2*P* < 0·00001	1260 (61·1 %)	604 (24·8 %)	270·9
(e) Frequency of crisps etc (trend χ_1^2 = 658; 2*P* < 0·00001)			
< once/week 3·27 (2·68, 4·00) 2*P* < 0·00001	83 (4·0 %)	348 (14·3 %)	96·8
1–6 times/week 2·30 (2·05, 2·59) 2*P* < 0·00001	719 (34·9 %)	1352 (55·6 %)	277·3
≥once/d 0·28 (0·25, 0·32) 2*P* < 0·00001	1260 (61·1 %)	731 (30·1 %)	275·4
(f) Frequency of soft drinks (trend χ_1^2 = 648; 2*P* < 0·00001)			
< once/week 4·24 (3·63, 4·96) 2*P* < 0·00001	1481 (71·8 %)	2244 (92·3 %)	158·1
1–6 times/week 0·49 (0·38, 0·63) 2*P* < 0·00001	163 (7·9 %)	97 (4·0 %)	60·8
≥once/d 0·19 (0·16, 0·23) 2*P* < 0·00001	418 (20·3 %)	90 (3·7 %)	111·9
(g) Whether snacking (trend χ_1^2 = 346; 2*P* < 0·00001)			
Something else 0·17 (0·09, 0·33) 2*P* < 0·00001	33 (1·6 %)	4 (0·2 %)	9·1
Snacks all day, no real meals 0·21 (0·14, 0·33) 2*P* < 0·00001	66 (3·2 %)	13 (0·5 %)	19·3
Snacks during day, has meals 0·48 (0·42, 0·55) 2*P* < 0·00001	1708 (82·8 %)	1687 (69·4 %)	206·1
Just has meals 2·79 (2·42, 3·22) 2*P* < 0·00001	255 (12·4 %)	727 (29·9 %)	190·6
(h) Items between meals (hetero. χ_1^2 = 2896; *P* < 0·00001)			
Crisps 0·05 (0·05, 0·06) 2*P* < 0·00001	1492 (72·4 %)	103 (4·2 %)	255·5
Sweets etc 0·12 (0·10, 0·14) 2*P* < 0·00001	890 (43·2 %)	138 (5·7 %)	196·9
Cakes/biscuits 0·39 (0·35, 0·45) 2*P* < 0·00001	924 (44·8 %)	584 (24·0 %)	248·8
Cereal 0·46 (0·38, 0·55) 2*P* < 0·00001	355 (17·2 %)	210 (8·6 %)	122·7
Bread etc 0·65 (0·58, 0·73) 2*P* < 0·00001	950 (46·1 %)	867 (35·7 %)	268·8
Savoury snack 1·00 (0·89, 1·12) 2*P* > 0·1; NS	979 (47·5 %)	1154 (47·5 %)	278·3
Other 1·48 (1·16, 1·90) 2*P* = 0·002	98 (4·8 %)	169 (7·0 %)	62·4
Fruit 4·33 (3·77, 4·97) 2*P* < 0·00001	1277 (61·9 %)	2150 (88·4 %)	201·9
Total	2062	2431	

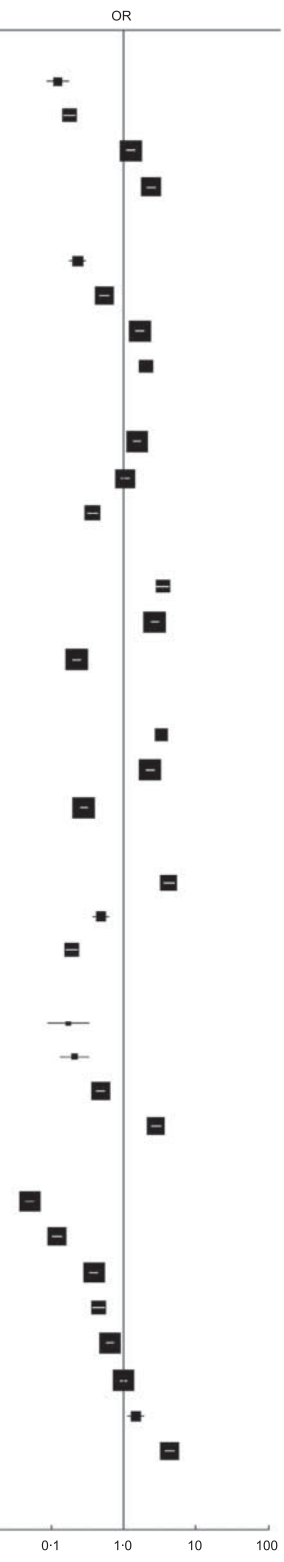

Fig. 1 OR (square symbols) and 95 % CI (horizontal lines) for various subgroups of eating patterns in the second year of life as predictors of cluster membership (Cluster 1 = more negative eating pattern; Cluster 2 = positive eating pattern); Growing Up in Scotland (GUS) Birth Cohort data set. Strong monotonic associations exist between cluster membership and eating patterns in sections (a) to (g) and are indicated by χ^2 tests for trend; section (h) also shows high heterogeneity and has been ordered by OR

Table 2 Univariate and multivariate associations of infant eating pattern cluster in the second year of life (Cluster 1 = more negative eating pattern; Cluster 2 = positive eating pattern) with breast-feeding, complementary feeding and socio-economic status variables (respondents' highest attained level of education (Educ) and Scottish Index of Multiple Deprivation (SIMD) 2006) using SPSS (version 17) Complex Sample Pearson χ^2 test and logistic regression (Cluster 1 is the reference category); Growing Up in Scotland (GUS) Birth Cohort data set

		Cluster 1, weighted		Cluster 2, weighted			Univariable for the outcome variable		Educ		Educ+SIMD	
Variable	Total (*n*)	*n*	%	*n*	%	Pearson χ^2 test	Unadjusted OR	95 % CI	Adjusted OR	95 % CI	Adjusted OR	95 % CI
Breast-feeding	3825	1793	46·9	2032	53·1	$P<0·001$; $\chi^2(1)=139·6$						
Ever breast-fed	2293	896	39·0	1397	60·9		2·20	1·93, 2·51	1·57	1·36, 1·82	1·48	1·27, 1·73
Never breast-fed	1532	897	58·6	635	41·4		1·00	Ref.	1·00	Ref.	1·00	Ref.
Age of starting complementary feeding	3766	1760	46·7	2006	53·3	$2P<0·001$; $\chi^2(2)=42·6$						
0–3 months	583	343	58·8	240	41·2		1·00	Ref.	1·00	Ref.	1·00	Ref.
4–5 months	2504	1131	45·2	1373	54·8		1·74	1·45, 2·08	1·38	1·14, 1·67	1·32	1·09, 1·59
6–10 months	679	286	42·1	393	57·9		1·96	1·56, 2·47	1·54	1·23, 1·94	1·50	1·19, 1·89
Educ	3810	1782	46·8	2028	53·2	$2P<0·001$; $\chi^2(5)=248·8$						
Degree or equivalent	1064	307	28·9	757	71·1		5·31	3·89, 7·26				
Vocational qualification below degree	1474	719	48·8	755	51·2		2·26	1·64, 3·12				
Higher grade or equivalent	283	135	47·7	148	52·3		2·36	1·66, 3·35				
Standard grade or equivalent	661	397	60·1	264	39·9		1·43	0·98, 2·08				
Other	6	4	66·7	2	33·3		0·98	0·19, 5·04				
No qualification	324	221	68·2	103	31·8		1·00	Ref.				
SIMD quintile	3798	1781	46·9	2017	53·1	$2P<0·001$; $\chi^2(4)=129·1$						
0·9449–7·7446 (least deprived)	693	223	32·2	470	67·8		2·86	2·31, 3·54				
7·7472–13·5627	729	299	41·0	430	59·0		1·96	1·56, 2·45				
13·5640–21·0436	742	340	45·8	402	54·2		1·61	1·32, 1·97				
21·0521–33·6982	705	383	54·3	322	45·7		1·14	0·91, 1·44				
33·7252–89·0941 (most deprived)	929	536	57·7	393	42.3		1·00	Ref.				

Ref., reference category.
Unweighted totals: breast-feeding, Cluster 1 = 2061 and Cluster 2 = 2431; age of starting complementary feeding, Cluster 1 = 2021 and Cluster 2 = 2401.

Table 3 Univariate and multivariate association of BMI Z-score cut-offs (not overweight/obese <1·04; overweight/obese ≥1·04) in the fourth year with eating pattern cluster in the second year of life (Cluster 1 = more negative eating pattern; Cluster 2 = positive eating pattern), breast-feeding and complementary feeding using SPSS (version 17) Complex Sample Pearson χ^2 test and logistic regression with birth weight (BW) and socio-economic status variables (respondents' highest attained level of education (Educ) and Scottish Index of Multiple Deprivation (SIMD) 2006) as potential confounders for the multivariate analysis (not overweight is the reference category); Growing Up in Scotland (GUS) Birth Cohort data set

		Not overweight/obese is the reference category for the outcome variable		Frequency of cases overweight/obese			Univariable		BW+Educ+SIMD	
Variable	Total (*n*)	*n*	%	*n*	%	Pearson χ^2 test	Unadjusted OR	95 % CI	Adjusted OR	95 % CI
Eating pattern in second year of life	3501	3075	87·8	426	12·2	$P = 0·598$; $\chi^2(1) = 0·3$				
Cluster 1	1632	1428	87·5	204	12·5		1·06	0·85, 1·33	0·96	0·76, 1·21
Cluster 2	1869	1647	88·1	222	11·9		1·00	Ref.	1·00	Ref.
Breast-feeding	3515	3089	87·9	426	12·1	$P = 0·004$; $\chi^2(1) = 9·4$				
Ever breast-fed	2144	1913	89·2	231	10·8		0·73	0·59, 0·90	0·81	0·64, 1·01
Never breast-fed	1371	1176	85·8	195	14·2		1·00	Ref.	1·00	Ref.
Age of starting complementary feeding	3462	3040	87·8	422	12·2	$2P = 0·009$; $\chi^2(2) = 11·4$				
0–3 months	522	436	83·5	86	16·5		1·00	Ref.	1·00	Ref.
4–5 months	2319	2050	88·4	269	11·6		0·66	0·51, 0·86	0·74	0·57, 0·97
6–10 months	619	553	89·3	66	10·7		0·60	0·40, 0·90	0·72	0·48, 1·09

Ref., reference category.
Unweighted totals: eating pattern in second year of life, not overweight/obese = 3186 and overweight/obese = 424; breast-feeding, not overweight/obese = 3244 and overweight/obese = 431; age of starting complementary feeding, not overweight/obese = 3193 and overweight/obese = 426.

included in the two-step cluster analysis. Two homogeneous clusters were identified, with each child belonging to one of the clusters. Figure 1 illustrates the relative contributions of the variables, together with the OR and 95 % CI, as predictors of cluster membership. It can clearly be seen how membership of 'Cluster 1' (*n* 2062; 46 % of sample) is associated with more negative eating patterns than membership of 'Cluster 2' (*n* 2431; 54 % of sample), notably in the lower variety of fruit/vegetable intake daily, the higher frequencies of sweets, crisps and soft drinks and the prevalence of snacking behaviour. Therefore children in Cluster 1 were defined as having a 'more negative eating pattern'. Cluster 2 was characterised by children who consumed a high variety of fruit daily, a high variety of vegetables daily and fruit between meals, and had a higher prevalence of eating just a meal with no snacking; therefore this group was defined as having a 'positive eating pattern'.

Infant feeding and eating patterns in the second year of life

Within the whole birth cohort 60 % of the infants were breast-fed, 69 % of infants were breast-fed in Cluster 2 compared with 50 % in Cluster 1.

Breast-feeding was significantly associated with Cluster 2. This relationship between breast-feeding and positive eating pattern in the second year of life was attenuated but remained significant after adjusting for SES, i.e. respondents' education and SIMD quintile (AOR = 1·48, 95 % CI 1·27, 1·73), Table 2.

The prevalence of infants starting complementary feeding at 0–3 months, 4–5 months and 6–10 months was respectively 20 %, 64 % and 16 % in Cluster 1 and 12 %, 69 % and 20 % in Cluster 2. The age of starting complementary feeding was significantly associated with positive eating pattern in the second year. The adjusted odds for a positive eating pattern in children who started complementary feeding at 4–5 months and 6–10 months was AOR = 1·32 (95 % CI 1·09, 1·59) and AOR = 1·50 (95 % CI 1·19, 1·89), respectively (Table 2).

Infant or child feeding and weight status in the fourth year of life

Any breast-feeding was negatively associated with overweight or obesity in the fourth year of life. Infants who were breast-fed were less likely to be overweight or obese (OR = 0·73, 95 % CI 0·59, 0·90). This association was attenuated after adjusting for birth weight and SES (AOR = 0·81, 95 % CI 0·64, 1·01), Table 3. Introduction of complementary feeding at 4–5 months compared with 0–3 months had a negative association with overweight or obesity in the fourth year of life (AOR = 0·74, 95 % CI 0·57, 0·97), Table 3. No significant relationship was observed between eating patterns in the second year of life and being overweight or obese in the fourth year, Table 3.

Socio-economic status and eating patterns

There was a strong association between eating patterns and respondents' education. Thirty-seven per cent of caregivers whose children were allocated to the positive cluster (Cluster 2) had a degree or equivalent compared with 17 % in the more negative cluster (Cluster 1). Where the main caregivers reported their highest education level to be a degree or equivalent, the odds for belonging to the positive cluster was OR = 5·31 (95 % CI 3·89, 7·26) compared with those with no qualification.

Likewise, 23 % of respondents in Cluster 2 were in the least deprived SIMD quintile while 13 % of respondents in Cluster 1 were in the least deprived SIMD quintile. The odds for belonging to Cluster 2 in the least deprived SIMD quintile was OR = 2·86 (95 % CI 2·31, 3·54) compared with the most deprived.

Discussion

The present study explored the relationship of early infant feeding (breast-feeding and age of starting complementary feeding) with eating patterns in the second year and weight status in the fourth year of life using a Scottish longitudinal birth cohort. The SPSS two-step cluster analysis technique was used to identify clusters of infants with similar eating patterns in their second year. The application of this technique to identify eating pattern clusters is advantageous, because it allows us to investigate how eating patterns in the second year of life may be influenced by infant feeding decisions and the potential influence they may have on the causal pathway of childhood overweight and obesity. We are not aware of any studies published to date that have used the SPSS two-step cluster analysis technique in this particular age group, to cluster infants according to eating pattern.

In the current study two clusters of infants were identified. Infants in Cluster 2 were predominantly leaning towards a 'positive eating pattern' as defined by a high variety of fruits daily, a high variety of vegetables daily, fruit between meals and higher prevalence of eating just a meal with no snacking. It is well recognised that a key component of healthy eating, in children going through the infancy to toddler diet transition phase, is the variety of healthy food choices available for snacks and meals[32]. Also food choices early in life provide an important foundation for diet and nutritional health later in life[33].

Breast-feeding

Infants who were breast-fed were more than twice as likely to be in Cluster 2 in their second year compared with those who had never been breast-fed. Although this relationship was attenuated it remained significant after adjusting for SES. However residual confounding from unmeasured social influences cannot be ruled out particularly when the attenuating affect is so strong. One recent study, supporting our finding, found suggestive evidence that breast-feeding during infancy was positively associated (OR = 1·26, 95 % CI 1·02, 1·55) with a healthy dietary pattern in Australian children aged 2–8 years[34]. A study in Scottish children aged 39–42 months published in 2002 found that the prevalence of obesity was significantly lower in breast-fed children and the association persisted after adjustment for SES, birth weight and gender[15]. The relationship between breast-feeding and overweight or obesity found in the present study was in the direction expected and as reported elsewhere[14,35–37], however significance was borderline after adjusting for education and SES. Previous studies that have found evidence of a significantly lower prevalence of overweight or obesity due to breast-feeding suggest it is important to measure the dose and duration of breast-feeding[9,14,35–38].

Age of starting complementary feeding

Infants who started complementary feeding at the age of 6–10 months or 4–5 months were respectively 50 % and 32 % more likely to be in Cluster 2 compared with children who started complementary feeding very early, at 0–3 months. We are unaware of any published papers to date that have investigated the association between eating pattern and age of starting complementary feeding. Those who started complementary feeding after 4 months, compared with 0–3 months, were less likely to be overweight or obese in their fourth year of life. There is observational evidence from other studies to support this finding, demonstrating that early complementary feeding is significantly associated with increased risk of overweight or obesity at age 3 years[39–41].

The ideal age to start introducing complementary food is around 6 months as recommended by the Department of Health. In Scotland, it was found that 60 % of the mothers started complementary feeding by 4 months[22]. This is consistent with the GUS data presented in the current paper, which revealed that 66 % and 18 % of infants started complementary feeding between 4–5 months and 6–10 months, respectively. The 2005 UK infant feeding survey found that 31 % of mothers started complementary feeding between 4 and 5 months and only 2 % of mothers started complementary feeding after 6 months[22], which is much lower than observed in the GUS data.

Socio-economic status

In the current study we used the respondents' education and the national SIMD 2006 index to define SES and assess its impact on infant feeding and eating patterns in the second year of life. It is well recognised that in the UK, mothers who breast-feed tend to be older and hold higher levels of educational qualification[22]. Although there is a fairly substantial body of evidence that has explored the association of eating patterns with SES[8,34,42–45] and education[8,34,42,45,46], there is less information immediately following infancy. It has been reported that children of younger mothers with lower levels of education were more likely to consume a diet based on convenience foods and foods high in fat, whereas a 'healthy' diet was positively associated with increased levels of maternal education[8,25]. A similar finding was observed in the present study. Eating patterns in the second year were strongly related to the main caregivers' level of education, with a larger proportion of older and more educated mothers belonging to Cluster 2, suggesting that education continues to be an important determinant of eating patterns beyond infancy.

The association observed between SIMD quintiles and eating patterns in the second year in our study are consistent with previously published data that have demonstrated associations with social inequalities in early diet[8]. The effect sizes were less for SIMD when compared with respondents' education, suggesting that although significant, SIMD was not such a strong determinant of eating patterns as education. It is not clear from research to date why education is so strongly linked to eating patterns. Perhaps caregivers of infants with higher education have stronger intentions to follow recommended guidelines for their infants. They may also have better access to and understanding of health promotion campaigns. Therefore an individual- or family-level based measure of SES, such as education, is likely to provide a better reflection of infant feeding[6,8]. However at the same time there is a need to acknowledge that in self-reported questionnaires as used here for the GUS survey, respondent bias can be a potential limitation to the findings due to better educated subjects reporting more favourable dietary behaviour in their children, in a manner consistent with societal expectations[47]. Nevertheless, from a public health point of view, a measure of area-level SES such as SIMD can provide relative understanding of how social deprivation within an area can impact infant eating patterns.

Study strengths and limitations

The main strength is that the GUS study is a large, contemporary, prospective birth cohort study of a nationally representative sample (n 5217) of infants from the Scottish population. The attrition rate in the study analysis over time can be partly explained by those lost to follow-up in the study and partly by those with missing measurement data. The GUS User Guide for each sweep provides detailed analysis of the respondents' and non-respondents' characteristics[27–29]. In Sweep 1 the response rate was 63 % as a percentage of all eligible infants identified for participation in the study. In Sweep 2 and Sweep 4 the response rates were 87 % and 77 %, respectively, as a percentage of all Sweep 1 cases. To correct for non-response bias and unequal sample selection, the longitudinal non-response sample weight and the clustering and stratification weights have been used in the analysis reported here.

The infant feeding data were collected retrospectively in Sweep 1 when the infants were 9–12 months of age and therefore are dependent on the respondents' accurate recall. The validity and reliability of maternal recall for the timing of infant feeding data have been reported and should be considered in future research design[48]. The breast-feeding data were based on a question 'Was the child ever breast-fed?' and as such does not give information on the measure of exclusiveness or duration of breast-feeding. This is a limitation of the present study, as a number of researchers have reported that duration and the amount of breast milk are important in the protective effect of breast-feeding[20,36,49]. The mixing together of infants who hardly breast-fed with those breast-fed exclusively for months in the 'ever breast-fed' group could be the main reason why a strong protective effect of breast-feeding with weight status in the fourth year of life is not observed in the study reported here. Due to this concern, when the new GUS cohort started in January 2011, the breast-feeding question was improved to provide a precise measure.

The measure of BMI was used to define overweight or obese infants in the fourth year of life. This provides a well-accepted proxy estimate of obesity in population samples of this kind[50]. However it is not a direct measure of adiposity and therefore children who have BMI within the normal range but have a high proportion of body fat may not be identified as overweight or obese. Since there were roughly equal proportions of data missing from infants belonging to Cluster 1 and Cluster 2, it is likely that a direct measure of adiposity may have increased the sensitivity of detecting a significant association in the multivariate model looking at the relationship between eating pattern and weight status.

The dietary data collected in Sweep 2 when the children were 19–24 months old, to define the eating pattern clusters, were not a record of the whole diet but asked about consumption of key foods (e.g. fruits, vegetables and snack foods) and so it is important to note that the clusters are generated from a limited list of foods. The majority of nutrition-focused studies that have used clustering methods to determine dietary patterns seem to prefer the *k*-means[42,44,51] or hierarchical Ward's[45,46,52] cluster algorithms or principal component factor analysis[8,34,43] rather than the SPSS two-step cluster analysis to derive dietary patterns from FFQ. The main advantage of the SPSS two-step log-likelihood cluster analysis algorithm is that it can process both categorical and continuous variables and it assigns a child to one eating pattern group.

Conclusions

Infant feeding and eating patterns in very young children beyond the first year of life are likely to influence later eating habits and therefore may have an impact on later-life health outcomes, as they can leave an imprint on metabolic functions and behaviour. Results from the present study suggest infant feeding practice may be indicative of the type of diet taken in the toddler years. The introduction of complementary feeding at 4–5 months compared with 0–3 months was negatively associated with being overweight or obese. There are a number of factors influencing childhood obesity including maternal dietary intake during gestation and lactation[53,54] and easy availability of a variety of healthy snacks and meal choices for pre-school children and their caregivers. Therefore it is sensible to consider the overall picture of early nutrition, i.e. breast-feeding, complementary feeding and eating patterns beyond the first year, when designing early interventions to improve nutrition and prevent obesity.

The results from the present study support the hypothesis that a positive start to nutrition during infancy, as defined by breast-feeding and timely complementary feeding, is more likely to track to a positive eating pattern in the second year.

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