Public Health Nutrition: 12(7), 957–966 doi:10.1017/S1368980008003364

Dietary patterns among a national sample of British children aged $1\frac{1}{2} - 4\frac{1}{2}$ years

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Submitted 18 June 2007: Accepted 24 June 2008: First published online 12 January 2009

Abstract

Objective: Using a nationally representative sample, to identify groups among British children aged $1\frac{1}{2} - 4\frac{1}{2}$ years who report similar patterns of diet.
Design: Nationally representative dietary survey, using 4 d weighed dietary records, of girls and boys aged $1\frac{1}{2} - 4\frac{1}{2}$ years living in private households in Great Britain in 1992–1993. Cluster analysis was used to aggregate individuals into diet groups.
Setting: Great Britain.
Participants: Eight hundred and forty-eight boys and 827 girls.
Results: Three clusters were identified for girls and three for boys. Among boys the most prevalent cluster was 'Healthy Diet' (52·3 %), the second was 'Convenience Diet' (38·3 %) and the third was 'Traditional Diet' (9·3 %). Among girls, the most prevalent dietary cluster was 'Healthy Diet' (58·7 %), followed by a 'Convenience Diet' (36·6 %) and 'Traditional Diet' (4·3 %). There were important differences in nutrient profile, sociodemographic and behavioural characteristics between clusters.
Conclusions: Cluster analysis identified three groups among both girls and boys which differed not only in terms of reported dietary intake, but also with respect to nutrient intake, social and behavioural characteristics. The groups identified could provide a useful basis for the development, monitoring and targeting of public health nutrition policy for pre-school children in the UK. Further research is needed on the consequences for chronic disease in the future for these children.

Keywords
Diet
Cluster analysis
Nutrients
Food groups
Socio-economic variables

Empirical dietary surveys frequently examine the food intake of a population in terms of nutrient intake. This approach provides valuable information on nutrient adequacy and excess, and allows testing of a priori hypotheses on the association between nutrients and morbidity. However, the approach does not allow the complexities of dietary intake of individuals, or groups of individuals, to be considered in terms of their overall dietary pattern.

In recent years there has been increasing interest in the identification of dietary patterns as consumed by populations. It has been suggested that such analyses could shed light on the complex relationship between diet and chronic disease[1–3]. From a public health perspective, identification of groups within a population which have similar patterns of diet would be of value to policy makers for translating national dietary goals into practical dietary recommendations for the public, for monitoring population trends towards nutritionally 'healthier' diets, for identification and surveillance of those at nutritional risk, and for tailoring and targeting public health nutritional interventions. It is also this aspect that is most amenable to change by intervention[4–9].

Previous approaches to analysis of dietary patterns have utilised frequency of food use to develop food variety scores or a qualitative food use profile of a population[2,10,11]. More recently, multivariate statistical techniques have been used to examine the combination of foods consumed by populations, relating these to either population characteristics or morbidity. Several studies have used factor analysis to classify dietary patterns in adults according to the frequency of reported food consumption[2,12] or reported food intake[13–15]. However, the factors identified by this technique do not refer to identifiable groups of individuals within a population, and hence do not give an indication of the prevalence of a particular type of diet. On the other hand, cluster analysis aims to identify relatively homogeneous groups within the population based upon selected attributes (dietary variables). The technique has not been widely used to analyse dietary data.

The National Diet and Nutrition Survey (NDNS) of children aged $1\frac{1}{2} - 4\frac{1}{2}$ years provided detailed information

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on the food intake of a national sample of children living in Britain, together with important socio-economic and lifestyle characteristics. The present paper reports an analysis of the NDNS of children aged $1\frac{1}{2} - 4\frac{1}{2}$ years in which we used the multivariate statistical technique of cluster analysis to identify groups within this population who reported similar patterns of diet. The food types that characterise the groups, together with the nutrient intakes, sociodemographic and lifestyle characteristics of the groups, are presented herein. To our knowledge cluster analysis has previously not been used to characterise children's diets in the UK.

Methods

The database used was the Dietary and Nutritional Survey of British children aged $1\frac{1}{2}$ to $4\frac{1}{2}$ years. Briefly, fieldwork was carried out between July 1992 and June 1993, on behalf of the UK Government (Department of Health and the Ministry of Agriculture, Fisheries and Food), by the Social Survey Division of the Office of Population Censuses and Surveys and the Micronutrient Status Group of the Medical Research Council (MRC).

The sample was recruited using a multistage random probability design, with postal sectors as the first stage. The Postage Address File (PAF) was used as a sampling frame. All postal sectors in Wales, England and mainland Scotland were stratified according to region and 1991 census data on social class. One hundred postal sectors were selected as first-stage units, with the chance of selection being proportional to size. One eligible child was randomly selected from each household, making the sample of 2101 children.

The survey design included face-to-face interviews with the child's mother/carer, to provide information on sociodemographic characteristics of the child's household including age, sex, social class, income, benefits, geographical area of residence, cigarette smoking and household composition.

A structured interview carried out by trained fieldworkers was completed for 1859 children (88 % of the identified sample) and was considered to be representative of the population in terms of sociodemographic characteristics according to the 1992 General Household Survey[16].

Ethical approval was obtained from the National Health Service Local Research Ethics Committee for each location and from the MRC Nutrition Unit's Ethical Committee.

Carers/parents of the child were issued with calibrated food weighing scales and asked to keep a weighed record of all food consumed by the child during a period of four consecutive days (including Saturday and Sundays) for 1675 children. The information was checked during subsequent visits by the interviewer. The response rate for the 4 d intake was 80 %. The present analysis uses only the sample that kept the 4 d weighed intake. One thousand six hundred and seventy-five individuals completed the food intake.

The weighed intake method has the advantage of being the most precise one available for accurately recording amounts of food consumed. The method does not have the disadvantages of inaccuracies attributable to errors in recall and errors involved in estimating portion size are also minimised. However, validation studies of the weighed intake method in adults that have used either doubly labelled water to assess to energy expenditure or urinary N as a marker for dietary N have shown that under-reporting bias is present[17,18].

Analyses were conducted for boys and girls separately. Nineteen food/drink groups were used in the analysis (food groups are detailed in the Appendix) Continuous food and beverage group values (all estimated in g/week or ml/week) were standardised by converting to the standard normal deviate. The clustering technique used was a hierarchical agglomerative (or stepwise) technique available in the SPSS for Windows software. Ward's method was used, based on squared Euclidean distances[19]. In Monte Carlo studies, Ward's method has been found to be the most robust clustering method using a similarity matrix based upon squared Euclidean distances[20,21]. The matrix of distances based upon squared Euclidean distance was computed followed by stepwise fusion of cases. The clustering coefficient was then used to indicate the stage on the agglomeration schedule where large changes between fusions were evident as compared with immediately preceding stages[19].

As possible instability of the results could be one of the limitations of a cluster analysis, we tested the stability of the cluster solution. Two methods were used: (i) discriminant analysis to test the degree of association between group membership assigned by cluster analysis using nineteen food/beverage groups; and (ii) by randomly splitting the data into two, clustering separately in each subset and comparing cluster membership in each split sample.

Statistical comparisons were made across the clusters in terms of reported food group consumption, intakes of macronutrients and micronutrients, selected socioeconomic, demographic and behavioural variables. Parametric one-way ANOVA was used to test for between-group differences in frequency distribution of food groups and nutrients. All food groups were either logged or squared to make the distribution normal. The χ^2 test was used for categorical variables. Statistical analyses were performed using SPSS version 12 (SPSS Inc., Chicago, IL, USA) and STATA version 7 (Stata Corporation, College Station, TX, USA) statistical software packages.

Tables present median food/beverage intakes for boys and girls separately. Cluster median food/beverage intakes below 50 % of the male and female median intake were considered 'low'. Cluster median intakes between 50 and 99 % and 100 and 149 % were considered respectively 'moderately low' and 'moderately high', and intakes above 150 % of the male and female median intake were considered 'high'.

Results

Identification of clusters

In order to test the stability of the solution obtained, a discriminant analysis was undertaken to test the degree of association between group membership assigned by cluster analysis using nineteen food/beverage group variables. The level of agreement between group membership identified by cluster analysis and predicted group membership using discriminant analysis was 87 % among boys and 86 % among girls. We also examined a split sample to test whether the results were different in each split sample. The results show that the split samples were the same identifying three large clusters. These results indicate relatively good overall agreement between actual and predicted group membership using cluster and discriminant analysis, and using the split samples.

Boys' dietary clusters

Table 1 shows the food group intake by the three clusters for boys.

The 'Traditional Diet' (BC1; *n* 79; 9·3 %) had moderately high (100–150 % of the median intake) intake of white refined cereals, cakes/puddings, egg dishes, bacon/ham, beef/veal/lamb/pork, poultry, meat products, sugar/confectionery and soft drinks. This diet was also moderately low (50–100 % of the median intake) in pasta/rice, wholegrain cereals, high-fat and low-fat dairy products, fat spreads, fish/shellfish, vegetables/salad, chips/potatoes, fruit/nuts and fruit juices.

The 'Healthy Diet' (BC2; *n* 444; 52·3 %) was moderately high in wholegrain cereals, low-fat dairy products, egg dishes, fat spreads, poultry, vegetables/salad, fruit/nuts and fruit juices. This diet was moderately low in pasta/rice, white refined cereals, cakes/puddings, high-fat dairy products, bacon/ham, beef/veal/lamb/pork, prepared meat products, fish/shellfish, chips/potatoes and sugar/confectionery, and low (<50 % of the median) in soft drinks.

The 'Convenience Diet' (BC3; *n* 325; 38·3 %) was moderately high in white refined cereals, cakes/puddings, high-fat dairy products, egg dishes, fat spreads, bacon/ham, beef/veal/lamb/pork and sugar/confectionery, and high (>150 % of the median intake) for prepared meat products, chips/potatoes and soft drinks. This diet was moderately low in pasta/rice, wholegrain cereals, low-fat dairy products, poultry, fish/shellfish, vegetables/salad, fruit/nuts and fruit juices.

Girls' dietary clusters

Table 1 shows intake of food groups by the three clusters for girls.

The 'Traditional Diet' (GC1; *n* 36; 4.3 %) was moderately high in pasta/rice, wholegrain cereals, cakes/puddings, egg dishes, fat spreads, bacon/ham, beef/veal/lamb/pork, poultry, prepared meat products, fish/shellfish, chips/potatoes and sugar/confectionery, and high in soft drinks. This diet was moderately low in white refined cereals, high-fat dairy products, low-fat dairy products, vegetables/salad and fruit/nuts, and low in fat spreads and fruit juices.

The 'Healthy Diet' (GC2; *n* 487; 58·7 %) was moderately high in wholegrain cereals, low-fat dairy products, egg dishes, poultry, fish/shellfish, vegetables/salad, fruit/nuts and fruit juices and was moderately low in pasta/rice, white refined cereals, cakes/puddings, high-fat dairy products, fat spreads, bacon/ham, beef/veal/lamb/pork, prepared meat products, chips/potatoes, sugar/confectionery and soft drinks.

The 'Convenience Diet' (GC3; *n* 304; 36·6 %) was moderately high in pasta/rice, white refined cereals, cakes/puddings, fat spreads, bacon/ham and sugar/confectionery, and high in prepared meat products, chips/potatoes and soft drinks. This diet was moderately low in wholegrain cereals, high-fat dairy and low-fat diary products, egg dishes, beef/veal/lamb/pork, poultry, fish/shellfish, vegetables/salad, fruit/nuts and fruit juices.

Macronutrient density

Table 2 shows energy and macronutrients as a percentage of energy for boys and girls.

Among boys the 'Traditional Diet' had the highest carbohydrate, sugar, total fat, SFA and MUFA as a percentage of energy compared with the 'Healthy Diet', which had the lowest percentage of energy as carbohydrate, sugar, total fat, SFA and MUFA, and energy, but the highest percentage of energy as protein. The 'Convenience Diet' was mid way between the 'Traditional Diet' and the 'Healthy Diet', but with high energy values. There were no significant differences for *n*-3, *n*-6 and total PUFA.

Among girls, the 'Healthy Diet' had the highest percentage of energy as protein, and the lowest percentage of energy as carbohydrate, sugar, total fat and SFA, whereas the 'Traditional Diet' had the highest percentage of energy as carbohydrate, sugar, total fat, SFA and MUFA, and the lowest energy. The 'Convenience Diet' was between the 'Traditional Diet' and the 'Healthy Diet' according to the values of macronutrient densities, whereas its energy was the highest among the diet clusters. There were no significant differences between the clusters for *n*-3, *n*-6 and total PUFA.

Micronutrient density

Table 3 shows the micronutrient density of the three clusters for boys and girls.

Among boys, the 'Traditional Diet' had the lowest density for all vitamins and minerals apart from vitamin B_6 and vitamin B_{12}, which were the same as in the

Table 1 Median dietary intake (g/week or ml/week) for the three clusters, and the relative level*, for boys and girls aged $1\frac{1}{2}-4\frac{1}{2}$ years, Great Britain, 1992–1993

	Boys (*n* 848)							Girls (*n* 827)						
		BC1 Traditional (*n* 79)		BC2 Healthy (*n* 444)		BC3 Convenience (*n* 325)			GC1 Traditional (*n* 36)		GC2 Healthy (*n* 487)		GC3 Convenience (*n* 304)	
Food group	Population median	Intake	Level	Intake	Level	Intake	Level	Population median	Intake	Level	Intake	Level	Intake	Level
Rice, pasta	1919	1900	ML	2045	ML	1745	ML	2130	2882	MH	2029	ML	2222	MH
White bread, refined cereals	3094	3116	MH	2880	ML	3382	MH	2868	2775	ML	2781	ML	3017	MH
Brown bread, wholegrain cereals	1309	1072	ML	1510	MH	1092	ML	1103	1158	MH	1129	MH	1053	ML
Biscuits, cakes, pastries	3811	4250	MH	3587	Ml	4009	MH	3394	3693	MH	3181	ML	3700	MH
High-fat diary	2630	2451	ML	2653	ML	2641	MH	2794	2983	ML	2787	ML	2781	ML
Low-fat dairy	4000	2060	ML	4628	MH	3613	ML	4408	3815	ML	5187	MH	3230	ML
Egg dishes	513	637	MH	541	MH	445	MH	651	1097	MH	698	MH	522	ML
Fat spreads	425	403	ML	396	MH	469	MH	415	418	L	392	ML	451	MH
Bacon/ham	885	901	MH	817	ML	975	MH	802	808	MH	782	ML	832	MH
Beef/veal/lamb/pork	1147	1318	MH	1192	ML	1045	MH	1112	1498	MH	1100	ML	1087	ML
Poultry	669	774	MH	698	MH	604	ML	668	876	MH	684	MH	617	ML
Prepared meats	1679	1707	MH	1548	ML	2670	H	1495	1910	MH	1337	ML	2890	H
Fish/shellfish	697	654	ML	692	ML	617	ML	680	801	MH	682	MH	663	ML
Vegetables/salad	2685	2360	ML	2709	MH	2275	ML	2758	2738	ML	3167	MH	2742	ML
Chips/potato products	3963	3679	ML	3702	ML	6050	H	3884	4557	MH	3798	ML	7210	H
Fruit/nuts	3504	3490	ML	3634	MH	3492	ML	3548	3438	ML	3922	MH	3281	ML
Sugar/confectionery	1788	2454	MH	1499	ML	2021	MH	1672	2167	MH	1523	ML	1852	MH
Fruit juices	2385	1499	ML	3220	MH	1460	ML	2787	919	L	3580	MH	1737	ML
Soft drinks	28 013	37 101	MH	12 982	L	75 107	H	24 513	84 737	H	11 962	ML	37 488	H

*L, low (<50 % of median intake); ML, moderately low (50–100 % of median intake); MH, moderately high (100–150 % of median intake); H, high (>150 % of median intake).

Table 2 Mean energy intake and macronutrient density (percentage of energy or g/1000 kcal) in the sample population by sex and dietary cluster: boys and girls aged $1\frac{1}{2} - 4\frac{1}{2}$ years, Great Britain, 1992–1993

	Boys (*n* 848)								Girls (*n* 827)							
		BC1 Traditional (*n* 79)		BC2 Healthy (*n* 444)		BC3 Convenience (*n* 325)				GC1 Traditional (*n* 36)		GC2 Healthy (*n* 487)		GC3 Convenience (*n* 304)		
Nutrient	Population mean	Mean	SE	Mean	SE	Mean	SE	*P*	Population mean	Mean	SE	Mean	SE	Mean	SE	*P*
Energy (MJ)	4·9	5·1	1·03	4·8	4·08	5·3	3·65	0·001	4·6	4·5	3·77	4·7	3·59	5·3	1·86	0·001
Protein	12·8	10·9	0·02	13·6	0·01	12·2	0·01	0·001	13·1	11·7	0·03	13·7	0·11	12·2	0·01	0·001
Carbohydrate	51·4	56·7	0·07	49·6	0·02	52·5	0·03	0·001	50·8	56·2	0·01	49·2	0·02	52·7	0·03	0·001
Sugar	28·6	35·6	0·01	26·6	0·02	29·7	0·03	0·001	28·5	35·7	0·01	26·9	0·02	30·4	0·03	0·001
Total fat	35·7	36·7	0·02	32·2	0·02	35·1	0·06	0·001	36·0	37·0	0·09	31·9	0·02	35·9	0·02	0·001
SFA	16·1	16·8	0·01	14·1	0·03	15·6	0·01	0·001	16·1	16·8	0·04	13·5	0·01	15·3	0·01	0·001
MUFA	11·6	11·2	0·08	10·2	0·02	11·0	0·01	0·001	11·2	10·4	0·40	11·3	0·08	10·9	0·10	0·001
n-3 PUFA	0·6	0·5	0·03	0·7	0·02	0·6	0·01	0·035	0·6	0·6	0·07	0·7	0·01	0·6	0·01	0·103
n-6 PUFA	3·8	3·7	0·01	3·8	0·06	3·8	0·07	0·512	3·9	3·8	0·20	4·0	0·80	3·9	0·06	0·670
Total PUFA	4·5	4·3	0·01	4·6	0·73	4·5	0·08	0·265	4·6	4·5	0·22	4·6	0·08	4·6	0·73	0·838

'Convenience Diet', and carotene, which was lower in the 'Healthy Diet'.

Among girls, the 'Traditional Diet' had the lowest density for all vitamins and minerals apart from Cu and vitamin D, which were the same as in the 'Convenience Diet', whereas pantothenic acid and biotin were lower in the 'Convenience Diet'.

Social and economic profile

Table 4 shows social and economic characteristics for boys' and girls' families and by cluster.

Among boys, those consuming the 'Traditional Diet' included the highest proportion of manual workers and the highest proportion of families receiving benefits compared with the 'Convenience Diet' and the 'Healthy Diet'. There was no significant difference between household income, region or mother's education by the diet clusters. Among those consuming the 'Traditional Diet' there was a high proportion of light smokers and heavy smokers and the lowest proportion of non-smokers compared with the other diet groups. Among those consuming the 'Traditional Diet', there was a lower proportion of parents who lived in a house/bungalow and the highest proportion of parents living in a flat compared with other diet groups. In the 'Healthy Diet' group, a greater proportion of children were not feeling well during the diet survey, compared with the 'Traditional Diet' and the 'Convenience Diet'.

Among girls there was no significant difference in social class, household income, region, mother's smoking, mother's education or type of accommodation by diet group. The percentage of parents receiving benefits was lower in the 'Traditional Diet' compared with the 'Healthy Diet' and 'Convenience Diet'. The proportion of children not feeling well during the diet survey was lower in the 'Healthy Diet' than in the 'Traditional Diet' and 'Convenience Diet' groups.

Discussion

In the present paper we report the results of an investigation that used cluster analysis to identify groups of children aged $1\frac{1}{2} - 4\frac{1}{2}$ years with similar patterns of diet within the UK population. Compared with a more traditional approach of a priori classification of individuals, e.g. by social class, followed by ANOVA, cluster analysis adopts a more dynamic approach to exploring patterns of food intake by grouping participants with comparable combinations of food types.

We characterised the sample using nineteen food groups and then used cluster analysis to identify similar eating patterns. Three clusters were identified in the sample of boys and three clusters in the sample of girls characterising dietary patterns we labelled the 'Healthy Diet', the 'Convenience Diet' and the 'Traditional Diet'. Some 52·3 % of boys and 58·7 % of girls consumed the 'Healthy Diet'; 38·3 %

Table 3 Mean micronutrient density (percentage of energy or mg/100 kcal, μg/1000 kcal) of the sample population by sex and dietary cluster: boys and girls aged $1\frac{1}{2} - 4\frac{1}{2}$ years, Great Britain, 1992–1993

	Boys (*n* 848)								Girls (*n* 827)							
		BC1 Traditional (*n* 79)		BC2 Healthy (*n* 444)		BC3 Convenience (*n* 325)				GC1 Traditional (*n* 36)		GC2 Healthy (*n* 487)		GC3 Convenience (*n* 304)		
Nutrient	Population mean	Mean	SE	Mean	SE	Mean	SE	*P*	Population mean	Mean	SE	Mean	SE	Mean	SE	*P*
K	1322·3	1162·0	29·80	1396·4	13·02	1259·9	13·88	0·001	1342·9	1203·5	34·05	1413·6	13·42	1246·3	15·28	0·001
Ca	561·1	416·8	14·90	626·3	9·39	507·1	9·73	0·001	565·9	427·3	25·21	621·6	9·38	493·1	9·14	0·001
Mg	120·7	106·3	2·65	127·4	1·15	115·1	1·24	0·001	120·5	108·7	3·45	125·7	1·10	113·5	1·31	0·001
P	651·3	524·9	13·11	704·6	6·80	609·2	7·46	0·001	657·7	548·2	19·52	700·8	7·06	601·7	7·28	0·001
Fe	4·9	4·4	0·13	5·1	0·09	4·6	0·07	0·001	2·3	1·8	0·31	2·5	0·14	2·2	0·10	0·638
Cu	0·4	0·3	0·01	0·4	0·00	0·4	0·00	0·001	4·9	4·8	0·31	4·9	0·10	4·8	0·14	0·989
Zn	3·8	3·2	0·09	4·1	0·04	3·6	0·05	0·001	3·9	4·8	0·02	4·1	0·01	3·6	0·01	0·001
I	104·0	72·9	3·13	116·4	2·78	94·5	2·43	0·001	107·1	81·8	6·04	120·2	2·81	89·2	2·58	0·001
Retinol	387·8	253·9	31·59	443·6	58·67	343·6	28·87	0·152	371·9	267·3	34·70	415·8	29·62	314·0	17·35	0·017
Carotene	780·4	796·8	67·09	772·5	31·78	787·3	35·87	0·928	55·5	729·4	27·80	1104·6	8·91	756·0	29·26	0·001
Vitamin D	1·5	1·1	0·13	1·6	0·09	1·4	0·09	0·023	1·7	1·5	0·24	1·8	0·10	1·6	0·10	0·208
Thiamin	0·7	0·6	0·02	0·7	0·01	0·6	0·01	0·001	0·7	0·6	0·33	0·7	0·01	0·6	0·01	0·001
Riboflavin	1·0	0·7	0·02	1·1	0·01	0·9	0·93	0·001	1·0	0·8	0·048	1·1	0·01	0·9	0·02	0·001
Niacin	14·2	13·5	0·48	14·5	0·14	13·8	0·18	0·002	14·6	14·0	0·95	15·7	0·16	14·8	0·18	0·001
Vitamin C	43·5	41·4	5·39	60·3	1·58	42·4	1·74	0·001	48·2	47·3	7·67	64·8	1·89	47·7	1·68	0·027
Vitamin E	3·7	3·6	0·12	3·8	0·07	3·7	0·84	0·490	3·9	3·8	0·31	3·9	0·07	3·9	0·08	0·955
Vitamin B_6	1·0	1·0	0·06	1·1	0·01	1·0	0·01	0·001	1·1	1·0	0·11	1·1	0·31	1·4	0·34	0·001
Vitamin B_{12}	2·4	2·2	0·18	2·6	0·1	2·2	0·05	0·001	2·5	2·2	0·31	2·7	1·31	2·6	1·42	0·001
Folate	115·0	105·7	3·85	120·3	1·8	110·0	1·93	0·001	118·3	108·0	6·19	123·6	1·78	111·0	1·87	0·001
Pantothenic acid	2·3	2·0	0·06	2·5	0·03	2·2	0·03	0·001	2·4	2·3	0·18	2·6	0·03	2·2	0·03	0·001
Biotin	15·0	12·0	0·42	16·5	0·3	13·6	0·23	0·001	15·2	14·4	1·10	16·5	0·24	13·42	0·26	0·001

Table 4 Socio-economic and behavioural variables by sex and by dietary cluster: boys and girls aged 1½ – 4½ years, Great Britain, 1992–1993

	Boys (*n* 848)							Girls (*n* 827)						
	BC1 Traditional (*n* 79)		BC2 Healthy (*n* 444)		BC3 Convenience (*n* 325)			GC1 Traditional (*n* 36)		GC2 Healthy (*n* 487)		GC3 Convenience (*n* 304)		
Social variables	*n*	%	*n*	%	*n*	%	*P*	*n*	%	*n*	%	*n*	%	*P*
Social class of household head														
Manual	42	53	226	51	149	40	0·003	17	47	243	49	150	49	0·740
Non-manual	37	46	214	49	195	60		19	53	247	51	156	51	
Parents receiving benefits														
Yes	31	40	146	33	106	33		10	28	168	35	106	35	
No	47	60	298	67	219	67	0·024	26	72	319	65	198	65	0·017
Household income														
<£10 000	30	38	153	35	113	35		10	28	169	35	109	36	
>£10 000	49	62	291	65	212	65	0·831	26	72	318	65	195	64	0·627
Region														
Scotland	9	11	31	7	24	7		4	11	40	8	22	7	
Northern England	23	29	118	27	95	29		9	25	125	26	96	32	
Central, South-West and Wales	21	27	168	38	120	37		10	28	179	37	97	32	
London and South-East	26	33	127	29	86	26	0·465	13	36	143	29	89	29	0·487
Mother's smoking status														
Non-smoker	40	50	298	67	220	67		28	78	318	65	203	67	
Light smoker	27	27	102	23	69	22		7	19	116	24	78	26	
Heavy smoker	12	12	40	10	36	11	0·082	1	3	52	11	21	7	0·168
Mother's education														
Degree or equivalent	14	18	89	20	51	16		7	19	80	16	53	18	
A levels	6	8	36	8	32	10		5	14	51	10	41	14	
O levels	22	28	147	33	122	37	0·115	11	31	175	36	87	29	0·693
CSE or equivalent	16	20	64	14	42	13		6	17	78	16	42	14	
None	20	26	109	25	78	24		7	19	101	21	78	26	
Type of accommodation														
House, bungalow	61	80	374	84	276	85		31	86	404	83	276	85	
Flat in block	15	20	59	13	44	14	<0·0001	3	8	69	14	44	14	0·523
Part house, room	0		11	3	5	1		2	6	14	3	5	1	
Child feeling unwell during diet survey														
No	73	92	396	89	306	94	<0·05	34	94	430	88	287	94	0·011
Yes	6	8	48	11	19	6		2	6	57	12	17	6	

of boys and 36·6% of girls consumed the 'Convenience Diet'; and 9·3% of boys and 4·3% of girls consumed the 'Traditional Diet'.

Among boys, those consuming the 'Traditional Diet' included the highest percentage of manual workers and parents receiving benefits, and the highest percentage of mothers who smoked compared with the 'Convenience Diet' and 'Healthy Diet' groups. There was a lower proportion of parents living in a house or bungalow compared with the other diet groups. There was no significant difference in income or region by diet group. Among girls, a higher proportion of parents received benefits in the 'Traditional Diet' group compared with the other diet groups, but no other differences in social/economic variables. The 'Traditional Diet' had the lowest micronutrient density for most of the vitamins and minerals, for both boys and girls, compared with the 'Healthy Diet' and the 'Convenience Diet'.

In previous research, a priori classification by social class and gender showed that among girls there was no significance difference for food groups, but for boys vegetables/salad, fruit/nuts, egg dishes and bacon/ham were significantly different by social class(22). In the present study, differences in mean levels by clusters were larger and combinations of undesirable/desirable dietary and other factors were observed. For example, the 'Traditional Diet' included high fat and low micronutrient densities, and the group had a high prevalence of maternal smokers. On the other hand, the 'Healthy Diet' group had a low mean fat intake, higher micronutrient densities and fewer maternal smokers.

Other studies have shown that childhood diet may influence the development of chronic diseases in adult life. The Bogalusa Heart Study has found that coronary atherosclerosis and essential hypertension can begin in childhood, and both are risk factors for CVD(23,24). Other studies have shown that childhood fruit and vegetable consumption may have a long-term protective effect on cancer risk in adulthood(25). In the present study children in the 'Convenience Diet' and 'Traditional Diet' groups were not eating enough fruit and vegetables according to recommendations. Findings like this underline the importance of the UK Government's national school fruit scheme which entitles 4–6-year-old children a piece of fruit each school day(26,27).

It is well established from studies in adults that smoking status is associated with dietary quality(28–33). Smokers have been reported to have diets lower in fibre and antioxidants and higher in fats. They consume less fruit and vegetables and wholemeal bread and more meat products, chips and soft drinks. Passive smoking has also has also been shown to be associated with dietary quality[34,35]. Passive smokers who live with smokers have food and nutrient intakes that are intermediate between those of smokers and non-smokers[36,37]. As many children eat family foods, it is likely that their diet will be affected to some extent by the smoking habits of their parents.

Four studies have investigated the effects of parental smoking on the diet quality of their children. Johnson *et al.*[36] described dietary intakes among children in low-income families in the USA according to the smoking status of their parents; Crawley and White[37] analysed the diets of British teenagers by smoking status; and Burke *et al.*[38] investigated the health behaviours in 10–12-year-olds in Australia. All of these studies suggested that the children of smokers consumed a diet that conformed less closely to current recommendations on healthy eating than did the children of non-smokers. Rogers *et al.*[39] have shown that dietary differences between children of smokers and non-smokers are in line with those observed between the diets of adult smokers and non-smokers. In the present study, boys eating a ‘Traditional Diet’ were more likely to have mothers who smoked and to be receiving benefits, although the patterns was not reproduced in girls.

Other studies among adults have shown that more health-conscious behaviour is associated with higher social class[40]. In the present study, children from higher social classes had the ‘Healthy Diet’ with the benefits of higher micronutrient density and healthy macronutrient density. Their parents were less likely to be on benefits and there were fewer maternal smokers.

In conclusion, our research has identified three diet groups in both boys and girls aged $1\frac{1}{2} - 4\frac{1}{2}$ years in the UK population that differed not only in reported dietary intake, but also with respect to their micronutrient and macronutrient density, social status and economic profile. Cluster analysis has been used to group foods or nutrients for the adult population[3,41–45], but we know of no other studies where cluster analysis has been used to identify food patterns in young children in Great Britain. Our results should be relevant to the development, monitoring and targeting of public health nutrition policy in the UK. In particular, they could be used to develop a tailored health promotion programme based on the diet clusters, by positively reinforcing the healthy diet and targeting the convenience and the traditional diet for significant improvements. Further research is needed on the consequences for chronic disease in the future for these children.

Acknowledgements

Both the authors have read and approved the paper for publication, and both were involved in the conception, writing and revising of the paper. J.A.P. did the analysis. There are no financial or other relationships that lead to competing interests. This paper has not been published elsewhere in part or in full or been submitted elsewhere.

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Appendix

Food groups

1. Pasta/rice and other miscellaneous cereals.
2. White bread and refined breakfast cereals such as cornflakes, Rice Krispies, Sugar Puffs, Honey Smacks, etc.
3. Brown and granary bread and wholegrain cereals such as All Bran, Shredded Wheat, Weetabix, Cheerios, etc.
4. Biscuits, cakes, pastries and puddings such as buns, cakes, pastries, fruit pies, doughnuts, jam tarts, scones, ice cream, instant whip, fruit crumble, custard puddings, cream desserts, jelly, fools, sponge puddings, milk puddings.
5. High-fat dairy such as whole milk, cream, cheese, whole-milk yoghurts, fromage frais.
6. Low-fat dairy such as semi-skimmed milk, skimmed milk, low-fat yoghurts, low-fat yoghurt drinks, low-fat fromage frais.
7. Eggs and egg dishes such as boiled, scrambled, omelettes, soufflé, quiche, scotch eggs, etc.
8. Fat spreads such as butter, polyunsaturated margarines, other margarines and spreads.

9. Bacon and ham such as bacon joints, rashers, gammon joints/steaks, ham.
10. Beef, veal, lamb and pork: beef and veal dishes such as beef and veal joints, steaks, minced beef, stewing steak, beef stews and casseroles, meat balls, lasagne, chilli con carne, curry, bolognaise sauce; lamb and lamb dishes such as lamb joints, chops, curries, Irish stews, lamb casseroles and stews; pork and pork dishes such as joints, chops, belly rashers, pork stews/casseroles, sweet and sour pork, etc.
11. Poultry such as coated chicken, chicken and turkey drumsticks, chicken pieces, nuggets, fingers, burgers, roast chicken or turkey, barbecued/curries/stews/casseroles, chicken/turkey roll.
12. Prepared meats including burgers, kebabs, sausages, meat pies and pastries, pork pies, veal and ham pies, sausage rolls, other meat products such as game pies, faggots, black pudding, meat paste, canned meats, salami, meat loaf, etc.
13. Fish/shellfish including white fish in batter or breadcrumbs, fish fingers, fish cakes, fish paste, fish in sauces, fish pie, kedgeree, oily fish including herrings, kippers, mackerel, sprats, salmon, tuna and sardines, and shellfish.
14. Vegetables and salad including salad vegetables such as lettuce, tomatoes, cucumber, coleslaw and prepared salads; vegetables including beans/pulses, cooked vegetables, vegetable casseroles/stews, curries, cauliflower cheese.
15. Chips and potato products including fried potatoes and chips potato waffles, hash browns, roast, sautéed and croquettes, other potatoes including boiled, mashed, jacket and instant potato, crisps, puffs, rings, Twiglets.
16. Fruit and nuts including fruit raw, cooked, canned, fruit pie fillings; nuts including almonds, hazelnuts, mixed nuts, peanuts, peanut butter, Bombay mix and seeds.
17. Sugar and confectionery including sugar and preserves including white and brown sugar, black molasses, treacle, syrup, jams, marmalade, glace cherries, mixed peel, marzipan; confectionery includes boiled sweets, gums, pastilles, fudge, chews, mint, rock, liquorice, toffee, popcorn, chocolate bars, filled bars, assortments.
18. Fruit juices including single fruit juice, mixed fruit juice, canned, bottles, cartons, still, carbonated, freshly squeezed.
19. Soft drinks including carbonated and low-calorie versions, fruit squashes, cordials, fruit drinks, syrups.