The contribution of breakfast to the diets of a sample of 136 primary-schoolchildren in Edinburgh

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The contribution of breakfast to mean daily energy and nutrient intakes was investigated in a sample of 7–8-year-old children recruited by letter from five Scottish schools. After eighteen families dropped out of the study and three dietary records were discarded, the final sample numbered 136 (51%). Dietary data were collected using the 7 d weighed inventory, while a questionnaire was used to classify children into manual or non-manual social class groups. Mean daily energy intakes were close to estimated average requirements (Department of Health, 1991), while intakes of most micronutrients were in excess of reference nutrient intakes (RNI; Department of Health, 1991). The most popular breakfast consumed by the children was one including a ready-to-eat breakfast cereal (RTEBC). Differences in macronutrient content were seen between breakfasts of boys and girls, while manual-social-class children ate breakfasts which were lower in energy, NSP and certain micronutrients than those of non-manual-class children. Breakfast contributed 14% of energy and 9–36% of micronutrient intakes to the overall diets. Breakfasts including RTEBC contributed significantly more energy and nutrients than other types of breakfast. Children who ate RTEBC nearly every day had overall diets which had a higher nutrient density and were lower in fat than those of children who ate RTEBC less frequently or not at all. Intakes of most micronutrients were above the RNI in both these groups, with the exception of folate, Fe and vitamin A, which were below the RNI for those consuming RTEBC infrequently. However, the type of breakfast eaten did not appear to influence energy and nutrient intakes at other meals during the day. Nevertheless, it was concluded that breakfast, particularly one containing RTEBC, had a strong influence on the daily energy and nutrient intakes of 7–8-year-old children, particularly by reducing the proportion of energy from fat.

Nutrient intake: Breakfast: Schoolchildren

It has been suggested that breakfast makes an important contribution to the nutrient intake of children (Morgan *et al.* 1986; Meyers *et al.* 1989; Albertson & Tobelmann, 1993). Reports on breakfast consumption indicate that children under 12 years old and adults over 65 years eat breakfast on a more regular basis than other age groups and that breakfast omission is most frequent in young adults (Gardner Merchant, 1991). Food choices at breakfast have changed over the last decade and ready-to-eat breakfast cereals (RTEBC), for example Frosties or Weetabix, have been cited as children's most popular choice of breakfast (Gardner Merchant, 1991).

There is conflicting evidence on whether breakfast consumption is linked to social class. Chao & Vanderkooy (1989) reported that breakfast omission was more common in economically disadvantaged urban children and children from rural sectors than more advantaged urban children, while Walker *et al.* (1982) found breakfast omission to be independent of social class.

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Reports on the contribution of breakfast to children's energy and nutrient intakes vary. Livingstone (1991) suggested that breakfast supplied 6% of energy intake in 5–9-year-olds, while the figure was put at 20% for 8-year-olds by Magarey *et al.* (1987) and 16% for 10–15-year-olds by Spyckerelle *et al.* (1992). Albertson & Tobelmann (1993), in a study of 7–12-year-olds, found that breakfasts including a RTEBC contained less fat and more vitamins and minerals than other types of breakfast. Moreover, children who regularly consumed RTEBC had overall diets which were lower in fat than those of children consuming RTEBC less frequently or not at all. Higher micronutrient intakes and lower fat intakes were also found in teenagers who consumed RTEBC by Crawley (1993) and by Sommerville & O'Reagan (1993). There is little information on the contribution of breakfast to dietary fibre intake. Magarey *et al.* (1987) suggested that breakfast supplied 24% of dietary fibre in 8-year-olds while Hackett *et al.* (1986) reported that, in their study, breakfast cereals contributed only 10%. Crawley (1993) reported that teenagers consuming a high-fibre breakfast cereal had greater mean daily NSP intakes.

There are few up-to-date studies on the role of breakfast in Scottish primary-schoolchildren, a population group who are described by the Scottish Office (1993) as having 'an inappropriate diet' and 'unhealthy eating patterns'. The present paper will provide new data on the breakfast habits of 7–8-year-olds and will consider the role of breakfast as a health-education tool.

SUBJECTS AND METHODS

Ethical approval for the study was granted by the Research Evaluation Committee of Lothian Region's Education Department in June 1989. Five schools, situated in and around Edinburgh, Scotland, were selected at random by the Committee. Three schools contained a mix of social classes, while two schools were from an area of multiple deprivation.

Caucasian children in Primary 3 (i.e. aged 7 or 8 years) were selected as the target population since there is little information on the 5–9 years age group. A letter requesting participation in the study was sent to parents of 269 Primary-3 children during 1991 and the 157 families agreeing to participate were followed up with a visit. Following instruction by one of the authors (CHSR), parents were asked to weigh and record all food and drinks consumed by their child for a period of seven, usually consecutive, days using Salter electronic scales weighing up to 2 kg in 2 g increments. Wastage was also weighed and recorded enabling actual intake to be calculated. If illness occurred, the study was suspended until a normal eating pattern was re-established. In order to reduce error, families were visited 48 h into the weighed inventory and at the end of the 7 d period. At both these visits, dietary records were checked and errors in recording corrected. During the first of these visits, a structured questionnaire, aimed at assessing the social class and educational level of the parents, was completed. The data collection period ran from February 1991 to March 1992, although records were not collected during school holidays. School meals were weighed and recorded by a trained research assistant and the consumption of school milk was noted. Items eaten away from home or school were recorded in a notebook, usually by an adult but sometimes by the child, and these notebooks were checked daily for clarity.

Of the 157 who initially agreed to participate, eleven subsequently changed their minds (reasons included an illness in the family, a new job, the birth of a baby or being unable to cope with the weighing of the child's food), seven failed to complete the study period and three dietary records were discarded due to incomplete data, leaving a sample size of 136 (51%) which included sixty-four boys and seventy-one girls. Records of 6 d duration were accepted if one weekend day was included, although this only applied to three records.

Table 1. *Anthropometric measurements on children participating and not participating in the dietary survey*

Measurement	Participants (*n* 136)		Non-participants (*n* 121)	
	Mean	SD	Mean	SD
Height (m)	1·248	0·054	1·242	0·052
Weight (kg)	25·0	4·2	25·5	4·1
BMI (kg/m^2)	16·0	2·0	15·8	1·8
Skinfold thicknesses				
Triceps (mm)	12	4·9	11	3·8
Biceps (mm)	7	4·3	7	3·5
Subscapula (mm)	8	5·4	8	4·3
Suprailiac (mm)	9	5·5	9	4·9
Height velocity (mm/year)*	55	14	52	12
Weight velocity (kg/year)*	3·4	1·9	3·2	1·6

* For height and weight velocity measurements: *n* 130 for participants and *n* 106 for non-participants because some children were not available on the second measurement occasion.

Height, weight and skinfold thickness were measured in 98% (*n* 257) of the 269 Primary-3 children attending the five schools. Parents who did not undertake the 7 d weighed intake were notified by letter that the measurements were to be taken and given the opportunity to refuse to allow their child to participate, although only one parent did this. Five other children were not measured as they were absent from school on the days that the measurements were taken. After approximately 12 months the measurements were repeated, this time obtaining a sample of 90% (*n* 240). The twenty-nine children not measured at the follow-up included thirteen absentees, one child whose parent did not give consent to take part (same child as on first occasion) and fifteen children who had moved to other schools. Of the children who provided dietary records, 136 (100%) were measured on the first occasion, while 130 (94·8%) were measured at follow-up. Height was measured to the nearest 1 mm, using a Child Growth Foundation stadiometer, by placing the child (with shoes removed) under the arm of the stadiometer facing the researcher with feet together, arms by the side and heels touching the wall. The child was then gently stretched upwards by being held under the mastoids and asked to inhale and exhale while the head was positioned with the external auditory meatus and the outer canthus of the eye in the same horizontal plane. The measurement was taken after the arm of the stadiometer was brought down gently onto the child's head. Weight was measured to the nearest 0·5 kg using Soehnle spring-balance scales. Growth rate was expressed in terms of mm gained per year for height (height velocity) and kg/year for weight (weight velocity), taking into account the actual number of days between the two measurements. Skinfold thicknesses at the tricep, bicep, subscapula and suprailiac sites were measured to the nearest 1 mm, following a period of training, using Harpenden skinfold callipers which were calibrated by the manufacturer before being used in the study. The technique used was that described by Tanner & Whitehouse (1975). Anthropometric data for those children providing dietary records and those who did not participate are shown in Table 1.

The sample was believed to be representative of the Edinburgh population for three reasons; there were no significance differences in age, height, weight, BMI, weight velocity, height velocity or skinfold thickness between children who participated in the study and those who did not (Table 1); the percentage completion rate for the study at each of the five schools was similar; and the social class profile of the sample, using the Registrar

Table 2. *Recruitment profile by school*

(Values are numbers of subjects, with percentages in parentheses)

Details of recruitment	Schools					Total
	1	2	3	4	5	
Children in Primary 3	66	49	81	27	46	269
+ve replies to letter (%)	35 (53)	27 (55)	32 (40)	10 (37)	7 (17)	111 (42)
−ve replies to letter (%)	12 (18)	7 (14)	14 (18)	4 (15)	11 (26)	48 (18)
Gained by follow-up	4	5	15	4	18	46
Lost after agreeing	3	4	4	0	0	11
Undertook 7DWI (%)	36 (55)	28 (57)	43 (53)	14 (52)	25 (53)	146 (54)
Successful completion (%)	34 (54)	27 (55)	39 (49)	13 (48)	23 (55)	136 (51)
Time span (weeks)	7	6	10	4	8	35
No. boys completing (%)	16 (47)	15 (64)	16 (44)	5 (50)	13 (54)	65 (49)
No. girls completing (%)	18 (56)	12 (57)	23 (51)	8 (47)	10 (45)	71 (52)

7DWI, 7 d weighed intake.

General's classification (Office of Population Censuses and Surveys, 1990), was similar to that found in the Caucasian population of Edinburgh. Children were classed as non-manual if the social class of the main breadwinner (usually the father but in some cases the mother, e.g. in the case of the single parents or unemployed fathers) was I, II or IIIa (*n* 64, 47 %) and as manual if their social class was IIIb, IV or V (*n* 64, 47 %). Eight (6 %) children could not be classified in this manner as their mothers were single and did not have a current or previous occupation. The recruitment profile for each school is shown in Table 2.

Dietary data were analysed using the nutritional package COMP-EAT 4 (Nutrition Systems Ltd., London) which enabled breakfast, defined as a solid item of food taken before attending school or before 11.00 hours at weekends, to be analysed separately from other meals. Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) for Windows (SPSS Inc., Chicago, IL, USA) and non-parametric statistics were used where nutrient intake did not follow a normal distribution. The two-tailed Student's *t* test or the Mann–Whitney *U* test was used to investigate statistical differences between two groups. Multiple regression analysis was performed when more than one variable was believed to have influenced nutrient intakes. This was done by identifying one particular nutrient as the dependent variable and including all influencing variables, such as sex, social class or breakfast type, as the independent variables. A 2×2 χ^2 test was used to investigate whether or not sex and social class were related to breakfast consumption.

RESULTS

Mean energy intakes were normally distributed and close to estimated average requirements (Department of Health, 1991), while mean intakes of most micronutrients were far in excess of reference nutrient intakes (RNI). It was believed that the incidence of under-reporting, a major error of dietary assessment methods, was low in this study since reported energy intakes were close to predicted energy expenditure calculated according to the equation of Livingstone *et al.* (1992).

Breakfast was consumed five to seven times per week by the majority (94 %) of children in the study and no child missed breakfast more than five times per week. When children

Table 3. *Types of breakfast most frequently taken by a sample of 136 primary-schoolchildren in Edinburgh*

Type of breakfast	*n*	%
Breakfast cereal	105	77·2
Bread/toast only	20	14·7
Cooked only	2	1·5
Other type*	9	6·6
Total	136	100·0

* Included confectionery, soup and milky drinks with or without bread.

were classified by the type of breakfast most frequently taken during the week, it was found that the most popular choice was a breakfast including RTEBC. Details of the other types of breakfast eaten can be seen in Table 3.

RTEBC were consumed six or seven times per week by sixty-four (47%) of the children, four to five times per week by forty-one (30%) of the children and zero to three times per week by thirty-one (23%) of the children. There were no significant differences between the breakfast choice or frequency of RTEBC consumption between boys and girls. Slightly more non-manual-social-class children than manual-social-class children ate RTEBC six or seven times per week ($P < 0{\cdot}05$; χ^2).

Energy and nutrient intakes at breakfast

Differences in energy and nutrient intakes at breakfast were examined for boys and girls and for children from different social classes. A few significant differences between boys and girls were found in the amounts of energy and nutrients consumed at breakfast (Table 4), these being energy ($P < 0{\cdot}01$), protein ($P < 0{\cdot}05$), fat ($P < 0{\cdot}01$), carbohydrate ($P < 0{\cdot}05$) and starch ($P < 0{\cdot}01$). The differences appeared to be due to the amount of food eaten at breakfast rather than the actual composition since, when nutrient density was calculated, the breakfast intake differences seen between boys and girls became non-significant.

When social class was considered, children from non-manual families (*n* 64) were found to have higher intakes at breakfast of energy ($P < 0{\cdot}05$), carbohydrate ($P < 0{\cdot}05$), total sugar ($P < 0{\cdot}005$), NSP ($P < 0{\cdot}05$), riboflavin ($P < 0{\cdot}05$), vitamin C ($P < 0{\cdot}05$), nicotinic acid equivalent ($P < 0{\cdot}05$) and Ca ($P < 0{\cdot}05$) than children from manual families (*n* 64). However, as with the differences between the sexes, there were no significant differences in nutrient density suggesting that the nutrient differences may have been related to the amounts of food eaten. There were no associations between breakfast composition and other social variables collected using the questionnaire, such as parental marital status, father's educational level, number of siblings and birth order. However, the age at which the child's mother left full-time education did have a significant association with dietary intake at breakfast. Children whose mothers left full-time education at or after 17 years of age (*n* 43) had higher intakes of energy ($P < 0{\cdot}01$), protein ($P < 0{\cdot}005$), carbohydrate ($P < 0{\cdot}001$), total sugar ($P < 0{\cdot}0005$), NSP ($P < 0{\cdot}001$), thiamin ($P < 0{\cdot}01$), riboflavin ($P < 0{\cdot}005$), vitamin B_6 ($P < 0{\cdot}05$), folate ($P < 0{\cdot}05$), nicotinic acid equivalent ($P < 0{\cdot}01$), vitamin C ($P < 0{\cdot}0005$), Ca ($P < 0{\cdot}005$) and Fe ($P < 0{\cdot}05$) at breakfast than children whose mothers left full-time education before 17 years of age (*n* 93). Percentage energy from carbohydrate was higher ($P < 0{\cdot}005$) in the breakfasts of the former group (65% *v.* 60% in children of early school leavers) and percentage energy from fat higher ($P < 0{\cdot}01$) in the breakfasts of the latter group (28% *v.* 22% in children of late school leavers). However,

Table 4. *Mean energy and nutrient intakes at breakfast in a sample of 136 primary-schoolchildren in Edinburgh*

(Mean values and standard deviations)

Variable	Boys (*n* 65)		Girls (*n* 71)		
	Mean	SD	Mean	SD	$P <$
Energy from fat (%)	26·8	8·94	25·0	9·53	NS
Energy from protein (%)	12·8	2·73	12·4	2·93	NS
Energy from carbohydrate (%)	60·6	9·40	62·5	10·4	NS
Energy from starch (%)	33·5	8·44	32·1	8·47	NS
Energy from sugars (%)	27·1	9·38	30·2	11·5	NS
Energy (MJ)	1·17	0·41	0·99	0·37	0·001
Protein (g)	9·12	3·57	7·57	3·44	0·005
Vitamin A (μg)	83·2	58·0	73·0	37·1	NS
Thiamin (mg)	0·34	0·18	0·30	0·14	NS
Riboflavin (mg)	0·60	0·34	0·56	0·28	NS
Vitamin B_6 (mg)	0·47	0·35	0·43	0·27	NS
Vitamin B_{12} (μg)	0·94	0·50	0·86	0·44	NS
Nicotinic acid equivalent (mg)	6·34	3·11	5·53	2·52	NS
Folate (μg)	62·5	42·0	58·0	34·4	NS
Vitamin C (mg)	5·12	6·96	6·62	9·10	NS
Vitamin D (μg)	0·70	0·48	0·65	0·38	NS
Calcium (mg)	190	86·3	170	86·6	NS
Iron (mg)	3·02	2·94	2·30	1·78	NS
Fat (g)	8·56	4·29	6·68	3·85	0·01
Total carbohydrate (g)	45·8	16·7	39·0	14·6	0·05
Total starch (g)	25·1	10·8	20·2	9·20	0·01
Total sugar (g)	20·4	9·49	18·4	7·78	NS
NSP (g)	1·55	1·43	1·26	1·12	NS

only differences in NSP and vitamin C content remained after the results were expressed as nutrient density, although this does not diminish the fact that intakes of fat at breakfast were lower in children of more-educated women.

The association between the weekly frequency of RTEBC consumption and intakes of energy and nutrients at the breakfast meal was examined and is shown in Table 5. Children eating a breakfast including RTEBC six or seven times per week (high-RTEBC group) were compared with children eating this type of breakfast four to five times per week (moderate-RTEBC group) and zero to three times per week (low-RTEBC group). There was a trend towards significantly lower intakes of energy, carbohydrate, starch, total sugar, NSP, thiamin, riboflavin, vitamin B_6, vitamin B_{12}, folate, nicotinic acid equivalent, vitamin D, Ca and Fe as the frequency of RTEBC consumption decreased. The highest intakes were seen in the high-RTEBC group. Percentage energy from carbohydrate and percentage energy from total sugars were higher in the high-RTEBC breakfast group, while percentage energy from fat was higher in the low-RTEBC group.

Percentage contribution of breakfast to daily energy and nutrient intakes

The contribution of breakfast was calculated by expressing energy and nutrient intakes at breakfast as a percentage of mean daily energy and nutrient intakes. Table 6 presents the results for boys and girls. Breakfast contributed 14% of energy, 10% of fat, 16% of protein, 18% of carbohydrate, 16% of total sugar, 21% of starch and 16% of NSP. There were no significant differences in the contribution of breakfast to overall diet in boys and

Table 5. *Energy and nutrient intakes at breakfast by weekly frequency of ready-to-eat breakfast cereal (RTEBC) consumption in a sample of 136 primary-schoolchildren in Edinburgh*

(Mean values and standard deviations)

Variable	High RTEBC 6–7 times (*n* 64)		Moderate RTEBC 4–5 times (*n* 41)		Low RTEBC 0–3 times (*n* 31)		
	Mean	SD	Mean	SD	Mean	SD	$P <$*
Energy from fat (%)	22·2	7·59	25·4	6·46	34·1	10·5	0·0001
Energy from protein (%)	13·0	2·31	12·8	2·73	11·6	3·67	NS
Energy from carbohydrate (%)	65·0	8·28	62·0	7·71	54·1	11·8	0·0001
Energy from starch (%)	33·7	7·91	33·0	8·62	30·4	9·14	NS
Energy from sugars (%)	31·1	8·32	29·1	9·40	23·4	14·2	0·005
Energy (MJ)	1·20	0·39	0·98	0·41	0·95	0·35	0·005
Protein (g)	9·35	3·62	7·80	3·38	6·82	3·16	0·005
Vitamin A (μg)	83·3	58·0	71·3	36·4	74·3	39·2	NS
Thiamin (mg)	0·41	0·14	0·29	0·14	0·17	0·08	0·0001
Riboflavin (mg)	0·77	0·27	0·53	0·22	0·26	0·17	0·0001
Vitamin B_6 (mg)	0·59	0·32	0·41	0·24	0·18	0·14	0·0001
Vitamin B_{12} (μg)	1·13	0·43	0·86	0·38	0·48	0·33	0·0001
Nicotinic acid equivalent (mg)	7·42	5·43	5·43	2·33	3·46	1·60	0·0001
Folate (μg)	78·7	38·3	55·4	30·9	27·9	18·8	0·0001
Vitamin C (mg)	6·58	7·67	5·51	8·45	5·03	8·85	NS
Vitamin D (μg)	0·78	0·49	0·65	0·39	0·47	0·26	0·005
Calcium (mg)	215	85·4	164	76·3	125	68·4	0·0001
Iron (mg)	3·45	3·06	2·20	1·22	1·57	1·42	0·001
Fat (g)	7·35	4·28	7·08	3·82	8·74	4·27	NS
Total carbohydrate (g)	49·1	15·0	39·3	14·7	32·1	12·9	0·0001
Total starch (g)	25·7	10·2	20·9	10·2	18·3	8·41	0·005
Total sugar (g)	23·1	7·78	18·1	7·82	13·3	7·71	0·0001
NSP (g)	1·84	1·48	1·17	1·09	0·80	0·59	0·001

* ANOVA; significant at $P < 0·05$.

girls. The tendency of these children to select relatively low-fibre breakfast cereals may have accounted for the lower than anticipated contribution of breakfast to total NSP intake. The contribution of breakfast to daily micronutrient intakes was greater than the contribution to macronutrient intakes. One exception was vitamin C of which breakfast supplied only 9%. Breakfast contributed approximately one-third of the intakes of 'B' vitamins and vitamin D and approximately one-quarter of the intakes of nicotinic acid equivalent, Ca and Fe. The large contribution to overall intake for a number of the micronutrients, notably Fe, folate, nicotinic acid equivalent, thiamin and riboflavin, was most probably due to micronutrient fortification of RTEBC.

In order to investigate whether the frequency of RTEBC consumption influenced the percentage contribution of breakfast to the overall diet, daily energy and nutrient intakes were compared for the three breakfast groups defined previously. High-RTEBC breakfasts made a significantly greater contribution to overall diet (roughly one-quarter to one-third) than breakfasts which included RTEBC less often (approximately one-fifth). The differences were highly significant for the micronutrients used in fortification mentioned previously (most $P < 0·0001$; ANOVA). High-RTEBC breakfasts also contributed significantly more Ca ($P < 0·0005$) to the overall diet, presumably since RTEBC are routinely eaten with milk.

Table 6. *Percentage contribution of breakfast to mean daily energy and nutrient intakes in a sample of 136 primary-schoolchildren in Edinburgh*

(Mean values and standard deviations)

	Boys (*n* 65)		Girls (*n* 71)		All (*n* 136)	
Variable	Mean	SD	Mean	SD	Mean	SD
Energy	15·0	4·90	13·9	5·02	14·4	4·98
Protein	16·8	6·04	15·1	5·96	15·9	6·04
Vitamin A	17·6	10·4	15·2	8·45	16·4	9·46
Thiamin	30·8	11·0	28·8	12·9	29·7	12·0
Riboflavin	35·0	13·4	36·2	15·1	35·7	14·3
Vitamin B_6	30·2	14·8	30·7	17·7	30·5	16·3
Vitamin B_{12}	27·6	12·8	27·1	13·5	27·4	13·1
Nicotinic acid equivalent	25·6	9·14	24·6	11·2	25·1	10·2
Folate	34·0	14·8	33·2	16·8	33·6	15·8
Vitamin C	8·7	10·0	9·6	8·82	9·2	9·35
Vitamin D	36·1	17·3	32·2	17·6	34·1	17·5
Calcium	22·9	8·9	21·2	8·34	22·0	8·64
Iron	27·1	11·6	25·5	12·6	26·5	12·1
Fat	11·0	5·04	9·18	4·98	10·0	5·08
Total carbohydrate	18·2	5·71	17·3	6·20	17·7	5·97
Total starch	22·0	7·07	20·0	8·53	21·0	7·90
Total sugar	16·1	6·61	16·0	6·56	16·1	6·56
NSP	17·3	10·9	14·6	9·78	15·9	10·4

Association between the frequency of RTEBC consumption and mean daily energy and nutrient intakes

It has been shown that breakfast, particularly one frequently including RTEBC, makes an important contribution to daily micronutrient intakes in 7–8-year-old children. However, it is not known whether the type of breakfast eaten can affect the overall diet or energy and nutrient intakes from other meals during the day. These points were investigated by comparing mean daily energy and nutrient intakes in the three breakfast groups defined previously. The results and statistical significances are shown in Table 7.

The overall diets of children in the high-RTEBC-breakfast group were higher in total carbohydrates, total sugars, NSP and certain micronutrients (thiamin, riboflavin, vitamin B_6, vitamin B_{12}, vitamin D, folate, nicotinic acid equivalent, and Fe) compared with those of children who ate RTEBC-containing breakfasts less often. More importantly, percentage energy from carbohydrate was significantly higher and percentage energy from fat lower in the diets of the high-RTEBC-breakfast group. Differences in micronutrient intakes were still seen when energy and nutrient intakes in the two breakfast groups were expressed as a percentage of RNI (Table 8). Children in the high- and medium-RTEBC breakfast groups met RNI for all micronutrients, while mean daily intakes of folate and Fe in the low-RTEBC breakfast group were below RNI.

The consumption of RTEBC breakfasts may be solely related to these results or it could be that children in the high-RTEBC-breakfast group had different intakes throughout the rest of the day compared with children in the other breakfast groups. Alternatively, there may have been a social class influence since more children from social classes I and II ate RTEBC-containing breakfasts. The latter point was investigated using multiple regression analysis which separated the association between breakfast and overall nutrient intake from the association between social class and overall nutrient intake by examining the

Table 7. *Mean daily energy and nutrient intakes by weekly frequency of ready-to-eat breakfast cereal (RTEBC) consumption in a sample of 136 primary-schoolchildren in Edinburgh*

(Mean values and standard deviations)

	High RTEBC 6–7 times (*n* 64)		Moderate RTEBC 4–5 times (*n* 41)		Low RTEBC 0–3 times (*n* 31)		
Variable	Mean	SD	Mean	SD	Mean	SD	$P <$*
Energy from fat (%)	36·0	3·82	38·6	3·16	39·5	4·14	0·0001
Energy from protein (%)	12·0	1·55	11·8	1·84	11·6	2·34	NS
Energy from carbohydrate (%)	51·2	4·47	49·8	3·88	48·8	4·89	0·005
Energy from starch (%)	23·0	4·01	22·5	3·50	22·8	4·39	NS
Energy from sugars (%)	26·9	4·61	25·1	5·61	24·0	6·34	0·05
Energy (MJ)	7·57	1·06	7·21	0·98	7·55	1·04	NS
Protein (g)	53·1	10·1	50·4	10·8	51·8	13·4	NS
Vitamin A (μg)	580	334	516	237	451	162	NS
Thiamin (mg)	1·15	0·27	0·99	0·22	0·91	0·36	0·0005
Riboflavin (mg)	1·81	0·55	1·50	0·39	1·18	0·35	0·0001
Vitamin B_6 (mg)	1·52	0·42	1·36	0·38	1·13	0·35	0·0001
Vitamin B_{12} (μg)	3·61	1·36	3·37	1·18	2·81	1·03	0·05
Nicotinic acid equivalent (mg)	24·7	4·80	22·5	4·65	21·3	5·86	0·005
Folate (μg)	190	53·5	165	43·4	136	42·7	0·0001
Vitamin C (mg)	64·5	38·4	57·4	46·1	44·2	20·3	NS
Vitamin D (μg)	2·25	1·01	2·06	1·02	1·64	0·66	0·05
Calcium (mg)	842	219	812	280	739	247	NS
Iron (mg)	10·2	4·10	8·69	2·18	8·10	2·66	0·01
Fat (g)	72·6	13·4	74·6	13·3	79·3	14·1	NS
Total carbohydrate (g)	248	37·3	228	29·7	234	40·4	0·05
Total starch (g)	109	24·3	102	22·1	106	20·8	NS
Total sugar (g)	129	27·2	114	24·0	118	40·4	0·05
NSP (g)	8·80	2·94	7·24	2·07	7·57	1·85	0·005

* ANOVA; significant at $P < 0·05$.

significance of relationships between individual nutrients (selected as the dependent variable) and frequency of RTEBC consumption or social class or age mother left full-time education (all selected as independent variables). The results revealed an inverse association between the frequency of RTEBC consumption and percentage energy from fat ($P < 0·01$) and a positive association between RTEBC consumption and thiamin ($P < 0·05$), riboflavin ($P < 0·0005$), vitamin B_6 ($P < 0·001$), vitamin B_{12} ($P < 0·05$), folate ($P < 0·0005$) and vitamin D ($P < 0·05$). In addition, the frequency of RTEBC consumption was inversely associated with percentage energy from fat ($P < 0·0005$) and positively associated with percentage energy from carbohydrate ($P < 0·01$), total sugars ($P < 0·05$), NSP ($P < 0·01$), thiamin ($P < 0·005$), riboflavin ($P < 0·0001$), vitamin B_6 ($P < 0·005$), vitamin B_{12} ($P < 0·05$), folate ($P < 0·001$), nicotinic acid equivalent ($P < 0·01$) and Fe ($P < 0·01$). This suggests that the relationships reported between the frequency of RTEBC consumption and daily nutrient intakes were independent of both social class and mother's education.

To investigate whether children who ate RTEBC had different energy and nutrient intakes during the rest of the day, energy and nutrient intake at breakfast was subtracted from the mean daily intake of each subject to form a new variable 'diet minus breakfast'. No significant differences were found in the 'diet minus breakfast' of children who ate RTEBC-containing breakfasts six to seven times per week compared with children who ate RTEBC-containing breakfasts less frequently or not at all.

Table 8. *Mean daily energy and nutrient intakes as a percentage of dietary reference values (Department of Health, 1991) by weekly frequency of ready-to-eat breakfast cereal (RTEBC) consumption in a sample of 136 primary-schoolchildren in Edinburgh*

(Mean values and standard deviations)

	6–7 times (*n* 64)		4–5 times (*n* 41)		0–3 times (*n* 31)	
Variable	Mean	SD	Mean	SD	Mean	SD
Percentage EAR						
Energy	96	12·8	94	11·6	96	11·8
Percentage RNI						
Protein	188	35·8	178	38·2	183	47·5
Vitamin A	116	66·8	103	47·5	90	32·4
Thiamin	164	39·1	142	30·9	130	51·9
Riboflavin	181	55·3	150	38·5	118	45·5
Vitamin B_6	152	41·6	136	38·0	113	34·8
Vitamin B_{12}	361	136	337	118	280	103
Nicotinic acid equivalent	206	40·0	188	38·7	117	48·8
Folate	127	35·7	110	28·9	91	28·5
Vitamin C	215	128	191	154	147	67·9
Calcium	153	39·8	148	50·9	134	45·0
Iron	117	47·1	100	25·1	93	30·5

EAR, estimated average requirement; RNI, reference nutrient intake.

DISCUSSION

The important points highlighted by this study are that (1) children's mean daily intakes exceeded RNI for most nutrients; (2) those who ate RTEBC nearly every day had higher micronutrient intakes both at breakfast and overall than those who ate RTEBC less frequently or not at all; (3) daily percentage energy from fat was significantly lower in those who ate RTEBC frequently. One criticism of the study could be that the percentage of children participating in the weighed intake (51%) was low. However, as discussed previously (pp. 421–422), it was believed that the sample recruited was a representative sample of the Edinburgh population of 7–8-year-old children.

Results on the type of breakfast mainly selected by the children in the present study mirrored work on older children which identified RTEBC as the most popular choice of breakfast (Morgan *et al.* 1986; Gardner Merchant, 1991). However, very few children in the present study regularly missed breakfast compared with the 9% of 11–16-year-olds reported by Gardner Merchant (1991) and the 20% of 11–16-year-olds reported by Curry & Todd (1992), probably because the children here were younger.

A number of authors have reported the important contribution that breakfast makes to energy and nutrient intakes in children. Livingstone (1991), Magarey *et al.* (1987) and Spyckerelle *et al.* (1992) reported findings which suggested that breakfast supplied 6–20% of overall energy intake in children ranging from 5 to 15 years. In the present study the figure was 14%, which is less than the 20% reported by Magarey *et al.* (1987) in their study of 8-year-olds. In terms of the contribution to micronutrient intakes, Magarey *et al.* (1987) observed that children in their study received a 'significant proportion' of overall Fe, Ca and riboflavin intakes from breakfasts. Results from the present study support the findings of others that breakfast is an important source of micronutrients in children's diets.

The percentage of total sugars provided by breakfast in the present study (16%) exceeded estimations by Hackett *et al.* (1986) and Morgan *et al.* (1981) who both reported

a figure of 3% in studies on adolescents. The contribution of breakfast to NSP intakes (16%) was less than the 25% of Southgate dietary fibre reported by Magarey *et al.* (1987) in 8-year-olds, although it is acknowledged that the two fibre definitions are not entirely comparable. Further information on the contribution of breakfast to NSP intakes in children is required as published data are scarce.

The finding that regular RTEBC consumers had increased overall daily micronutrient intakes agrees with the findings of Albertson & Tobelmann (1993), Sommerville & O'Reagan (1993) and Crawley (1993), although in contrast to the study of Emmett *et al.* (1993), higher NSP intakes were not seen in frequent consumers of RTEBC, perhaps because few children in this survey selected whole-grain or bran-enriched cereals (e.g. only one child ate All Bran). The effect on overall intakes in the present study is likely to be due to the high micronutrient density of the breakfast meal and its high-carbohydrate, high-total-sugars, low-fat profile, since the frequency of RTEBC consumption was not found to influence energy and nutrient intakes at other meals during the day.

Considering that, on average, children in the present study appeared to be taking adequate amounts of most micronutrients, it may seem superfluous to highlight the contribution of RTEBC to nutrient intake. However, since the role of RTEBC in supplying folate and Fe was large, it may be that the satisfactory micronutrient intakes seen in this sample were partly due to the consumption of RTEBC. Encouraging a regular intake of both breakfast in general and RTEBC in particular may be considered as a means to increase micronutrient intakes in older children who are often found to have lower than recommended intakes of certain vitamins and minerals (Department of Health, 1989; McNeill *et al.* 1991). It has already been found by Crawley (1993) that teenagers who regularly consume breakfast cereal are more likely to meet RNI (Department of Health, 1991) for 'B' vitamins, Fe, Ca and Zn. A second, possibly more important, reason for highlighting the role of RTEBC is the finding that children regularly consuming RTEBC had lower fat intakes and higher carbohydrate intakes. The Department of Health (1991) suggests that fat should comprise no more than 35% of food energy and that carbohydrates should comprise no less than 50%. It is likely that this reference value could apply to children. In the present study, breakfasts frequently containing RTEBC were lower in fat (22% energy) compared with breakfasts containing RTEBC less frequently (25% energy and 34% energy respectively), while a frequent consumption of RTEBC-containing breakfasts was associated with low mean daily fat intakes (36% *v.* 39% energy and 40% energy respectively). Mean fat intake in the total sample of children in the present study exceeded the Department of Health (1991) recommendation at 37% of food energy, while mean fat intake was even higher than this in lower-social-class children (i.e. children from social classes IV and V and those from single parent, no occupation homes) at 40% of food energy (Ruxton *et al.* 1996). Percentage energy from fat in Crawley's (1993) study of teenagers was also found to be significantly lower in high-breakfast-cereal consumers compared with low-breakfast-cereal consumers (39·8% *v.* 43·0%), although still not close enough to the Department of Health (1991) recommendation. The Scottish Office (1993) has stressed the importance of reducing fat in children's diets and making up for the 'lost' energy by increasing the intake of carbohydrate foods such as cereals. The present paper suggests that this advice may be valid.

CONCLUSIONS

A frequent consumption of RTEBC in this sample of 7–8-year-old children was associated with increased intakes of micronutrients both at breakfast and in the overall daily diet. Children who ate RTEBC six to seven times per week had higher mean daily intakes of NSP

and certain micronutrients than children who ate RTEBC less than five times per week or not at all. Percentage energy from fat at breakfast and overall was closer to the Department of Health (1991) reference value of 35% food energy in frequent consumers of RTEBC breakfasts. It is concluded that breakfast, particularly one containing RTEBC, is an important contributor to the high overall micronutrient intakes previously reported in this group of children and that encouraging an increased intake of this food should be seen as a means of reducing percentage energy from fat intakes in children, especially those from lower social classes where the highest fat intakes were seen.

It would be useful to look at the contribution of breakfast and breakfast cereals to energy and nutrient intakes in older children, such as the age groups studied by the Department of Health (1989), since it has been reported that low intakes of selected vitamins and minerals are prevalent amongst certain groups such as teenage girls. A tentative conclusion from the present paper is that encouraging increased intakes of RTEBC in older schoolchildren may lead to higher intakes of micronutrients.

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REFERENCES

Albertson, A. M. & Tobelmann, R. C. (1993). Impact of ready-to-eat cereal consumption on the diets of children 7–12 years old. *Cereal Foods World* **38**, 428–434.

Chao, E. S. M. & Vanderkooy, P. S. (1989). An overview of breakfast nutrition. *Journal of the Canadian Dietetic Association* **50**, 225–228.

Crawley, H. F. (1993). The role of breakfast cereals in the diets of 16 to 17 year old teenagers in Britain. *Journal of Human Nutrition and Dietetics* **6**, 205–216.

Curry, C. & Todd, J. (1992). *Health Behaviours of Scottish Schoolchildren. Report 1: National and Regional Patterns.* Edinburgh: Health Education Board for Scotland.

Department of Health (1989). *Diets of British Schoolchildren. Report on Health and Social Subjects* no. 36. London: H.M. Stationery Office.

Department of Health (1991). *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. Report on Health and Social Subjects* no. 41. London: H.M. Stationery Office.

Emmett, P. M., Symes, C. L. & Heaton, K. W. (1993). The contribution of breakfast cereals to non-starch polysaccharide intakes in English men and women. *Journal of Human Nutrition and Dietetics* **6**, 217–222.

Gardner Merchant (1991). *What Today's Children are Eating.* London: Burson-Marsteller.

Hackett, A. F., Rugg-Gunn, A. J., Appleton, D. R. & Coombs, A. (1986). Dietary sources of energy, protein, fat and fibre in 375 English adolescents. *Human Nutrition: Applied Nutrition* **40A**, 176–184.

Livingstone, M. B. E. (1991). Children's food and snacking. *CHO International Dialogue* **2**, 1–4.

Livingstone, M. B. E., Prentice, A. M., Coward, W. A., Strain, J. J., Black, A. E., Davies, P. S. W., Stewart, C. M., McKenna, P. G. & Whitehead, R. G. (1992). Validation of estimates of energy intakes by weighed dietary record and diet history in children and adolescents. *American Journal of Clinical Nutrition* **56**, 29–35.

McNeill, G., Davidson, L., Morrison, D. C., Crombie, I. K., Keighran, J. & Todman, J. (1991). Nutrient intake in school children: some practical considerations. *Proceedings of the Nutrition Society* **50**, 37–43.

Magarey, A., Nichols, J. & Boulton, J. (1987). Food intake at age 8. Distribution and food density by meal. *Australian Paediatric Journal* **23**, 217–221.

Meyers, A. F., Sampson, A. E., Weitzman, M., Rogers, B. L. & Kayne, H. (1989). School breakfast program and school performance. *American Journal of Diseases in Children* **143**, 1234–1239.

Morgan, K. J., Zabik, M. E. & Leveile, G. A. (1981). The role of breakfast in nutrient intake of 5 to 12 year old children. *American Journal of Clinical Nutrition* **34**, 1418–1427.

Morgan, K. J., Zabik, M. E. & Stampley, G. L. (1986). Breakfast consumption patterns of US children and adolescents. *Nutrition Research* **6**, 635–646.

Office of Population Censuses and Surveys (1990). *Classification of Occupations.* London: H.M. Stationery Office.

Ruxton, C. H. S., Kirk, T. R. & Belton, N. R. (1996). The influence of social class on nutrient intakes and dietary patterns in a sample of Edinburgh school children. *International Journal of Food Sciences and Nutrition* **47** (In the Press).

Scottish Office (1993). *Scotland's Health. A Challenge to Us All.* Edinburgh: H.M. Stationery Office.

Sommerville, J. & O'Reagan, M. (1993). The contribution of breakfast to micronutrient adequacy of the Irish diet. *Journal of Human Nutrition and Dietetics* **6**, 223–228.

Spyckerelle, Y., Herbeth, B. & Deschamps, J.-P. (1992). Dietary behaviour of an adolescent French male population. *Journal of Human Nutrition and Dietetics* **5**, 161–168.
Tanner, J. M. & Whitehouse, R. H. (1975). Revised standards for triceps and subscapular skinfolds in British children. *Archives of Disease in Childhood* **50**, 142–145.
Walker, A. R. P., Walker, B. F., Jones, J. & Ncongwane, J. (1982). Breakfast habits of adolescents in four South African populations. *American Journal of Clinical Nutrition* **36**, 650–656.

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