Nutrient intake in schoolchildren: some practical considerations

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The diet of schoolchildren has been a sensitive issue throughout this century. The observation that recruits to the army during the Boer War were below desirable growth standards opened interest in a topic which has never since left the agenda for discussions on nutrition policy in this country. In the last decade concerns have centred on the possibility that dietary habits of schoolchildren, notably their high levels of consumption of sugar and high-fat snack foods and low consumption of fruit, vegetables and fibre, contribute to the development of dental caries and to degenerative diseases later in life. More recently the possibility of inadequacy of the diet of schoolchildren has been brought to the attention of scientists and the public by the publication of a report suggesting that low vitamin and mineral intake may impair mental function (Benton & Roberts, 1988). It seems as important now as ever before to be able to assess the adequacy of schoolchildren's diets and to identify possible health risks associated with current dietary practices.

In 1983 the Department of Health and Social Security (DHSS) carried out a survey of the dietary habits of 3591 children aged 10–14 years in England, Wales and Scotland (DHSS, 1989), using the 7 d weighed-intake method. This study provides a benchmark against which future studies will be compared. Other studies are likely to be based on smaller sample sizes and to have access to less resources and manpower than the DHSS survey. Practical aspects of the design and interpretation of such studies need to be considered to optimize the quality and validity of the data collected.

We have recently carried out a survey of dietary intake in 12-year-old schoolchildren in Dundee which has highlighted some of the practical considerations and problems of small-scale dietary studies in schoolchildren. The survey was carried out as an assessment of nutrient intake before a randomized controlled trial of the effects of vitamin and mineral supplements on verbal and non-verbal IQ, the results of which have been reported elsewhere (Crombie *et al.* 1990). While the primary hypothesis under test did not relate to the level of nutrient intake in the children, the baseline dietary information was seen as essential for the interpretation of the findings of a supplementation study. If a significant effect of supplementation were found, it is useful to know whether the intake of the nutrient under question is below recommended daily allowances (RDA) or whether these require upward revision. Whether an effect of supplementation is found or not, it is also necessary to know whether the intake of the nutrient(s) in question is unusually high or low relative to other groups of children to whom the findings might be considered relevant, and, if conflicting findings between similar studies are found, to determine whether the nutrient intakes of the different study groups explain the differences in the results obtained.

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The children studied for this purpose were the ninety-four first-year secondary school pupils in a Dundee school. The mean age of the children was 12 years 4 months at the time of the dietary survey. Weight-for-age was on average 102% of the NCHS 50th centile (World Health Organization, 1983) for boys and 97% for girls. Equivalent values for height-for-age were 97% in boys and 99% in girls. Parents of the children were invited to a meeting in the school to outline the study, and parental consent was required for each child to participate. Due to the requirement to complete the dietary data collection before the start of the randomized controlled trial, all the dietary information was collected in four 1-week periods, with eighteen to twenty-six children studied each week. The dietary data collection was carried out from the base of the school, as there was insufficient time and manpower to visit and instruct the children and parents in their own homes.

For the week of recording, each child was issued with a PETRA electronic scale (Bingham *et al.* 1985) and a specially designed notebook. Each group of children was given a 40 min period of instruction on the use of the scale by the dietitian (L.D.). The scales were left in a central store during the day except at lunchtime, so snacks had to be recorded in the notebook. The tapes were reviewed by the dietitian on the second and sixth days of the week of recording, and any problems were dealt with when the children came to collect their scales.

The PETRA scales were chosen for the present study rather than the more usual digital scales because it was felt that the children would find it easier to record spoken rather than written information, and because it was hoped that the fact that the scales do not display portion weight to the user would reduce the likelihood of alterations in eating habits. The scales proved robust (only one child had technical problems with the scales) and were popular with the children due to their novelty value. Disadvantages of these scales were the requirement for taring the scales with an empty vessel before each weighing, the need for which is not obvious to the subject, and the possibility that high levels of background noise, e.g. in the school canteen at lunchtime, could drown the recorded voice of the child describing the foods on the tape. However, these problems did not affect large numbers of the records.

The majority of problems encountered in the dietary data collection were problems which are common to all methods used to collect nutritional information in children. The children were not always aware of which variety of a food, e.g. type of spread or milk, they had eaten, although they could usually give very detailed information on the colour and flavour of sweets and snack foods. Sweets and snacks were often local specialities which provided some difficulties in coding from national food tables (Paul & Southgate, 1978; Tan *et al.* 1985). For information recorded in the notebooks and for some foods for which no plausible weight was recorded on the PETRA scale, a portion size had to be assumed using values for small portions from a recent publication (Crawley, 1988). This publication is based on data from dietary surveys in adults, and a similar publication based on the DHSS survey of diet in schoolchildren would be a valuable addition to the resources for estimating nutrient intake in schoolchildren. Most importantly, for some children there was evidence of a decline in interest in and diligence of recording over the 7 d of the study. This was suggested by a tendency to omit meals and snacks from the records as the week progressed, and in some children no dietary information at all was recorded on the later days of the study.

The process of deciding which data to reject has received little attention in literature on dietary methodology. It is usually assumed that a dietitian will recognize implausible

Table 1. *Day-to-day variation in nutrient intake over 7 d in eighteen 12-year-old girls from Dundee*

Day of record . . . Nutrient	1 Wed	2 Thurs	3 Fri	4 Sat	5 Sun	6 Mon	7 Tue	ANOVA*	Week *v*. weekend†
Energy (kJ)	9475	9225	9100	7650	8420	8415	7665	$P<0.005$	$P<0.001$
Protein (g)	60·8	62·2	53·4	49·8	63·6	62·4	54·0	$P<0.05$	NS
Fat (g)	99·3	94·7	97·0	83·8	87·4	90·2	82·0	NS	NS
Starch (g)	152·9	165·1	149·0	126·3	128·7	159·4	138·6	$P<0.005$	$P<0.01$
Sugar (g)	150·3	120·0	133·6	125·9	132·1	96·6	106·5	$P<0.001$	NS
Fibre (g)	14·9	16·1	16·6	12·5	12·1	15·7	12·6	$P<0.05$	$P<0.02$
Iron (mg)	9·8	11·1	10·9	8·2	12·1	11·4	9·4	NS	NS
Calcium (mg)	966	974	841	596	796	888	939	$P<0.001$	$P<0.001$
Vitamin A‡ (μg)	518	1124	492	1391	403	451	450	NS	NS
Vitamin C (mg)	30·4	39·8	31·4	34·0	24·1	27·1	21·9	NS	NS

NS, not significant.
* ANOVA of daily values.
† Paired *t* test weekdays *v*. weekend (two-tailed).
‡ Retinol equivalents.

records, although the criteria for rejection are rarely discussed. In the present study the records were first reviewed by the dietitian (L.D.), and the days which had an implausible record of foods, on the basis of the pattern of meal and snack intake on earlier days of the week, were noted. The records were then reviewed by a nutritionist who had had no involvement in the study, and using the same criteria she rejected fewer days. All the days rejected by the second nutritionist had also been rejected by L.D., and these were not processed further. After discussion it was decided to reject all days which had been rejected by L.D., with the realization that this might lead to the omission of data from children with the lowest nutrient intakes, and hence an over-estimate of the mean nutrient intake of the group. Children who had only one or two 'satisfactory' days were then excluded from the subsequent data analysis. Using this criterion the records of nineteen of the thirty-seven boys and fourteen of the fifty-seven girls were completely rejected, giving a response rate of 65% for children with three or more satisfactory days. This is a disappointingly low value when compared with the value of 75% satisfactory completion of 7 d weighed records in the DHSS (1989) study. Only 30% of the children in the present study succeeded in recording 7 d which were accepted by both the dietitian and nutritionist, suggesting that a smaller number of days may be a more realistic aim when manpower for surveys is limited. An alternative is to use diary–interview methods which have been found by one group to produce little fatigue in repeated use (Hackett *et al.* 1985).

The accepted records were analysed by the Microdiet programme (Bassham & Fletcher, 1985), and the mean nutrient intake for each child was used to calculate the arithmetic mean for the intake for each nutrient for boys and girls. The values for several of the micronutrients are limited by the missing values for the content of these nutrients in certain foods in the UK food composition database (Paul & Southgate, 1978), notably zinc and folate, but in this respect the results of the present study are comparable with those from other studies calculated from the same database. To give information on the variability of nutrient intake over the week, Table 1 shows the mean values for the intake

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Table 2. *Nutrient intakes of 12-year-old boys from Dundee compared with published values (n=18)*

(Mean values and standard deviations)

Nutrient	Mean	SD	Recommended intake (DHSS, 1979)*	DHSS (1979)* Scotland	DHSS (1979)* London and SE	Benton & Roberts (1988)†
Energy (kJ)	8960	1180	9681‡	8590	8790	7272
Protein (g)	61	15	66	62	61	62
Fat (g)	93	18	80§	87	88	58
Starch (g)	163	25	295§	n/a	n/a	n/a
Sugar (g)	117	28	43§	n/a	n/a	n/a
Fibre (g)	16	5	25§	n/a	n/a	n/a
Iron (mg)	10	2	12	10	10	9
Calcium (mg)	822	197	700	880	850	670
Zinc (mg)	8	2	15‖	n/a	n/a	6
Magnesium (mg)	232	59	350‖	n/a	n/a	200
Phosphorus (g)	1·1	0·2	1·2‖	n/a	n/a	1·0
Vitamin A (μg)**	494	268	725	620	840	1812
Vitamin B_1 (mg)	1·2	0·4	1·1	1·2	1·2	1·4
Vitamin B_2 (mg)	1·5	0·4	1·4	1·7	1·7	1·7
Vitamin B_3 (mg)††	27	6·5	16	27	26	n/a
Vitamin B_6 (mg)	1·1	0·4	1·6‖	1·1	1·2	1·6
Vitamin B_{12} (μg)	2·8	0·9	2·0¶	n/a	n/a	6·0
Folate (μg)‡‡	105	35	300	n/a	n/a	242
Vitamin C (mg)	47	32	25	43	56	126
Vitamin D (μg)	2·0	1·3	2·5¶	1·2	1·4	4·4
Vitamin E (mg)	4·8	1·4	8‖	n/a	n/a	6·3

DHSS, Department of Health and Social Security; n/a, not available.
* Values for 10–11-year-olds.
† Values which used 3 d dietary records and a US food composition database.
‡ Food and Agriculture Organization/World Health Organization/United Nations University (1985).
§ Derived from National Advisory Committee on Nutrition Education (1983).
‖ National Academy of Sciences/National Research Council (1974).
¶ World Health Organization (1970).
** Retinol equivalent.
†† Nicotinic acid equivalent.
‡‡ Total folate.

of ten nutrients for the eighteen girls for whom 7 d were accepted. As all records began on a Wednesday, this data also reflects changes in intake over the week of recording. Also shown are the significance levels of the day-to-day variation from analysis of variance, and of the comparison of weekday *v.* weekend days by paired *t* test. Energy and calcium intakes showed clear day-to-day variations with lower intakes at the weekend than during the week, while sugar and fibre intakes showed significant day-to-day variations but no strong weekday *v.* weekend effect. In the smaller group of ten boys for whom 7 d were accepted, no nutrients showed day-to-day variation or weekday *v.* weekend differences which were significant at the 1% level.

Tables 2 and 3 show the average nutrient intakes of boys and girls in relation to recommended practices (DHSS, 1979; National Advisory Committee on Nutrition

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Table 3. *Nutrient intakes of 12-year-old girls from Dundee compared with published values (n=43)*

(Mean values and standard deviations)

Nutrient	Mean	SD	Recommended intake (DHSS, 1979)*	DHSS (1979)* Scotland	DHSS (1979)* London and SE	Benton & Roberts (1988)†
Energy (kJ)	8140	536	8595‡	7640	7690	7590
Protein (g)	55	9	53	54	53	62
Fat (g)	85	17	70§	79	80	56
Starch (g)	143	29	262§	n/a	n/a	n/a
Sugar (g)	110	34	38§	n/a	n/a	n/a
Fibre (g)	15	4	25§	n/a	n/a	n/a
Iron (mg)	10	5	12	9	9	4
Calcium (mg)	767	191	700	740	700	672
Zinc (mg)	7	1	15‖	n/a	n/a	7
Magnesium (mg)	205	44	300‖	n/a	n/a	236
Phosphorus (g)	1·0	0·2	1·2‖	n/a	n/a	1·0
Vitamin A (μg)**	510	480	725	590	700	1813
Vitamin B_1 (mg)	1·0	0·3	0·9	1·0	1·0	1·5
Vitamin B_2 (mg)	1·4	0·5	1·4	1·4	1·4	1·7
Vitamin B_3 (mg)††	24	4	16	23	23	n/a
Vitamin B_6 (mg)	1·0	0·2	1·6‖	n/a	n/a	1·5
Vitamin B_{12} (μg)	3	2	2¶	n/a	n/a	3
Folate (μg)‡‡	90	22	300	n/a	n/a	250
Vitamin C (mg)	28	11	25	41	56	133
Vitamin D (μg)	1·8	0·9	2·5¶	1·2	1·2	3·2
Vitamin E (mg)	4·8	1·1	8‖	n/a	n/a	9·7

DHSS, Department of Health and Social Security; n/a, not available.

* Values for 10–11-year-olds.

† Values which used 3 d dietary records and a US food composition database.

‡ Food and Agriculture Organization/World Health Organization/United Nations University (1985).

§ Derived from National Advisory Committee on Nutrition Education (1983).

‖ National Academy of Sciences/National Research Council (1974).

¶ World Health Organization (1970).

** Retinol equivalent.

†† Nicotinic acid equivalent.

‡‡ Total folate.

Education, 1983) and to the intakes recorded in the DHSS (1989) survey and in a previous study of the effect of vitamin and mineral supplementation on IQ (Benton & Roberts, 1988). Comparison of the values between studies is limited by the fact that different studies have presented data for different nutrients, but three main findings emerge. First, compared with recommendations, the nutrient intakes of fat and sugar are high and those of starch and fibre are low, but in this respect the values are similar to those recorded in a number of studies in adults, and the proportion of energy derived from fat (39% for both boys and girls) is very similar to that seen in children of the DHSS (1989) survey. Second, the nutrient intakes of the children in Dundee are very similar to those of the DHSS (1989) survey apart from the slightly higher Ca intake in the Dundee girls, and the lower vitamin A and higher vitamin D intake in both boys and girls from

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Table 4. *Sources of nutrients by food group for 12-year-old boys and girls from Dundee*

(Mean values for boys and girls expressed as a percentage of nutrient derived from food group)

	B and R	Cer	P and R	Pot	Dai	M and F	O and F	C and S	F and V
Energy	13	4	3	16	12	16	3	29	4
Protein	15	4	3	8	22	32	0	10	5
Fat	6	1	2	17	17	25	7	22	3
Fibre	20	13	2	32	0	0	0	10	23
Sugar	2	2	2	1	4	0	0	80	9
Iron	19	8	2	13	5	24	0	18	10
Calcium	14	1	4	3	49	7	0	17	4
Vitamin A	2	0	3	0	35	13	16	17	13
Vitamin C	0	0	0	46	13	2	0	8	30

B and R, bread and rolls; Cer, other cereals; P and R, pasta and rice; Pot, potatoes (including crisps and chips); Dai, dairy products and eggs; M and F, meat, meat products and fish; O and F, oils, fats and spreads; C and S, confectionery, cakes and sweet drinks; F and V, fruit, vegetables and nuts.

Dundee. The striking difference between the vitamin A intakes may reflect the fact that the school studied was in a lower income area of Dundee, as the DHSS (1989) data for the UK as a whole show lower intakes of vitamin A in lower socio-economic groups. Third, when the data on intake of fourteen micronutrients is compared with the reported nutrient intakes of children in the Welsh study (Benton & Roberts, 1988), the Dundee children in the present study are seen to have similar or lower intakes of all micronutrients except for Fe in girls and Ca in both boys and girls.

If the nutrient intake data of these children is to form the basis of dietary advice, it is useful to analyse the data in terms of the proportion of nutrients provided by different food groups. These values were very similar for boys and girls, and Table 4 shows the mean values for percentage of nutrients derived from different food groups. The high proportion of energy and sugar provided by confectionery is striking, but the proportion of energy derived from confectionery is very similar to the value of 28% of energy derived from sweets, biscuits and puddings in a survey of adolescents in Glasgow in 1964 and 1971 (Durnin *et al.* 1974). It may be important to consider the possibility that the actual nutrient intake of children is not greatly different from that of children in previous decades or from the present-day adult population even though the foods from which these nutrients are derived are very different.

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