Dietary survey of diabetics

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SUMMARY This study of 168 diabetic children from Tyneside and Teesside aimed to record what the children actually ate and to compare this with both their prescribed diet and current recommendations. The amounts of energy consumed were similar to those expected of non-diabetic children, but the components of the diabetic children's diets were different, consisting of more fat and fibre, but less sugars and carbohydrates. They ate more carbohydrate than prescribed but less than current recommendations as there was a shortfall between the amount prescribed and that suggested in the recommendations. Diabetic control was related to the amount of fibre consumed and to compliance with the prescribed diet, but not to the proportion of energy taken as carbohydrate. The insulin dose was slightly lower in those children eating more fibre.

The modification of diet has been a cornerstone of the treatment of diabetes mellitus for many years, although a great variety of prescriptions have been used.¹ Typically, dietary treatment restricted carbohydrate to approximately 40% of the energy intake and limited added sucrose. Compliance with and benefits from such regimens have been claimed to be poor.^{2,3}

It has recently been suggested that this policy leads to an increased fat intake which may contribute to the diabetic's liability to vascular complications.⁴ Furthermore, benefits from eating increased amounts of fibre have been reported⁵ and disputed.⁶ This information led to revised recommendations for the diets of diabetics.⁴ Briefly, these recommendations suggest that energy intake is of prime importance, but that only 35% of the energy should be provided by fat, which implies a carbohydrate intake of at least 50%. Most of this carbohydrate should be consumed as polysaccharides rich in fibre. It is still considered important to exclude rapidly absorbed mono- and disaccharides. These recommendations are similar to those suggested for the general population.⁷

The aim of this study was to investigate the relations between intake, recommendations, and prescribed diet in children with diabetes.

Methods

Between July 1983 and March 1984 children attending the diabetic clinics at the Royal Victoria In-

firmary and the General Hospital, Newcastle upon Tyne; the Queen Elizabeth Hospital, Gateshead; North Tees General Hospital; and Middlesbrough General Hospital were invited to take part in a detailed audit. The study was described in detail to the parents (and children) both orally and in a letter. Ethical approval for the study was obtained from the appropriate local committees.

As part of this audit, current practice was assessed by means of a diary kept by the parents or child, or both, for three consecutive days. In it they were asked to record all dietary intake and the insulin regimen. The amount of food consumed was estimated in household measures and the time of consumption was also recorded. This information was then converted at an interview (lasting approximately 30 minutes) on the fourth day to estimates of the weight of each item consumed. Computerised food tables⁸ were subsequently used to calculate the intake of nutrients. This procedure has been used previously and is described more fully elsewhere.⁹

At a special clinic a structured questionnaire was used to obtain social information, and the child was examined physically. The parent or child completed a test of practical skills and a multiple choice questionnaire to assess knowledge of diabetes. A blood sample was also requested for estimation of glycosylated haemoglobin A1 (HbA1) and random C peptide.

Intakes were compared with recommendations for groups of children,¹⁰ and the amount of carbohydrate recommended for diabetics was calculated as

50% of this recommended energy intake⁴ as appropriate for age and sex. Compliance with the dietary prescription was calculated by subtracting the weight of carbohydrate prescribed from that consumed.

The data were analysed using the statistical package for the social sciences. Pearson's *r* correlation coefficients were calculated to test for relations between variables. Partial correlation coefficients were calculated in order to control for the effect of any variables that might have confounded the relation between dependent and independent variables.

Results

A total of 234 children were attending the clinics at the time of the study. Seven children taking part in another study and two who had severe psychological problems were not, however, invited to take part. One hundred and seventy (75.5% of those invited) completed the study. Useful dietary records were obtained from 98 boys and 70 girls, and further discussion is limited to these children.

Seventy (42%) families were classified into socioeconomic group 1, (professional and managerial), 68 (40%) into group 2 (clerical and craftsmen), 19 (12%) into group 3 (semi- and unskilled labourers), and 11 (6%) into group 4 (either unknown, unclassified, or retired). Their age distribution is shown in Table 1 together with some other clinical details. Subsequent analysis by age was made to correspond with the age groups given in the tables of 'Recommended amounts of food energy and nutrients for groups of people in the United Kingdom'.¹⁰

The intakes of energy and carbohydrate are summarised in Table 2 together with the recommended and prescribed daily amounts of carbohydrate. The mean energy intakes were within 10% of those recommended. The mean carbohydrate in-

takes, however, were consistently below those recommended (averaging 84%), only 25 children (15%) consuming more. The mean amount of carbohydrate prescribed was only 71% of the recommended level. Carbohydrate intake therefore averaged 120% of that prescribed, and only 16 (9.5%) children ate less than this. Table 2 also shows the intake of sugars and fibre and the composition of the energy intake related to age and sex. For comparison Table 2 includes results from a recent local dietary survey of non-diabetic children in which an identical survey procedure was used.^{9 11} The relatively low contribution of carbohydrate to the energy intake of the diabetic children can be seen. Only eight children consumed 50% or more of their energy in this form. Total sugars contributed less to the energy intake than in the Northumberland study,⁹ but fat contributed slightly more. Total sugars constituted a lower proportion of the carbohydrate intake. Furthermore, the lactose intake of the diabetic children (mean 19.2 g boys, 18.7 g girls) contributed 25% of the sugars consumed, compared with 13% in the previous study (17.1 g boys, 13.4 g girls). The fibre intakes of the diabetic children were also higher.

The Figure shows the energy intakes of the boys and girls related to their ages. Superimposed on this are the predicted energy intakes for non-diabetic children.¹² The intake of the diabetic girls seems to match the predictions closely while the boys' intake tends to be slightly below the predicted value.

The relation between the single HbA1c measurement and mean dietary intake is summarised in Table 3. As HbA1c was correlated to C peptide ($r = -0.319$, $P < 0.01$), this was controlled for in these calculations. The age of the child was related to the intake of several nutrients (energy $r = 0.610$, $P < 0.01$; carbohydrate $r = 0.575$, $P < 0.01$; % carbohydrate $r = -0.079$, $P > 0.05$; sugars $r = 0.240$, $P < 0.01$; % sugars $r = -0.242$, $P < 0.01$; and fibre (g/MJ) $r = -0.226$, $P < 0.01$), and was also used as a

Table 1 Age distribution of those subjects who completed the dietary survey together with their mean (SD) duration of diabetes, insulin dose, weight and glycosylated haemoglobin (HbA1c)

	Age group						
	<5	5-7	7-9	9-11	11-13	13-15	15+
Sex							
Boys	9	11	11	17	26	16	8
Girls	2	5	7	12	18	19	7
Duration of diabetes (yrs)	2.0 (0.7)	1.8 (1.1)	2.9 (1.9)	3.8 (2.1)	4.3 (2.9)	5.5 (3.1)	4.7 (4.0)
Insulin dose (U/kg)	0.78 (0.12)	0.84 (0.20)	0.88 (0.19)	0.84 (0.25)	0.89 (0.29)	1.00 (0.32)	0.88 (0.31)
Weight (kg)	18.6 (1.4)	23.4 (2.7)	26.9 (3.5)	34.6 (4.9)	41.7 (6.6)	47.1 (7.3)	58.3 (5.7)
HbA1c (%)	10.1 (1.7)	10.0 (1.7)	9.5 (2.2)	10.7 (2.4)	10.3 (2.1)	12.1 (1.9)	10.2 (3.4)

Table 2 Mean daily intake of energy and proportion of energy from fat, carbohydrate (CHO) and sugars. The mean daily carbohydrate intake compared with the amount of carbohydrate prescribed and recommended are also shown. The intake of sugars as a proportion of the carbohydrate and fibre in relation to the energy intake and for comparison comparable figures from a recent local survey^{9,11} are included

	No	Energy (MJ)	CHO (g)		Prescribed	Proportion of energy (%)		Sugars/ CHO (%)	Fibre per MJ (g/MJ)
			Intake	Recommended		Fat	CHO		
Age group 2.5-9 yrs									
Boys	31	6.9 (1.5)	183 (35.2)	224 (21.9)	159 (29.4)	42 (4.7)	43 (4.3)	35 (8.9)	2.8 (1.0)
Girls	14	7.0 (1.3)	182 (27.1)	222 (24.6)	158 (23.8)	44 (4.5)	42 (4.4)	39 (6.8)	2.6 (0.9)
9-12 yrs									
Boys	31	8.9 (1.2)	238 (34.5)	291 (15.3)	202 (19.3)	43 (4.5)	43 (4.2)	31 (6.8)	2.6 (0.7)
Girls	19	8.8 (1.2)	238 (38.0)	257 (7.5)	192 (19.7)	43 (4.5)	43 (4.2)	36 (2.3)	2.3 (0.5)
12-17 yrs									
Boys	36	10.1 (1.8)	263 (55.7)	330 (23.9)	214 (28.8)	44 (4.1)	42 (4.1)	30 (7.0)	2.2 (0.6)
Girls	37	9.0 (1.5)	240 (42.4)	270 (0.0)	199 (27.9)	43 (3.9)	43 (4.5)	33 (7.5)	2.2 (0.6)
Northumberland study									
11.5-14 yrs									
Boys	193	9.5 (1.5)	289 (47.6)	—	—	40 (3.0)	49 (3.2)	43 (6.0)	1.5 (0.3)
Girls	212	8.5 (1.4)	256 (48.5)	—	—	40 (2.8)	48 (3.3)	44 (6.7)	1.6 (0.3)

Figure Energy intake of diabetic boys and girls related to the predicted energy intakes for non-diabetic children.

Table 3 Partial correlation coefficients between dietary variables and glycosylated haemoglobin (HbA1) controlled for C peptide and age*

Variables		Second order
Dependent controlling		HbA1
		C peptide+age
Independent		
Energy (kJ)		+0.163*
Sugars (g)		-0.001
CHO (g)		+0.118
Sugars (%)		-0.125
CHO (%)		-0.089
Sugars (% CHO)		-0.107
Fibre (g/MJ)		-0.169*
Fibre (g)		-0.031
Compliance†		+0.164*

*Only 150 subjects had successful estimations of their HbA1. C peptide and diet made.

†CHO intake minus CHO prescribed, ie the greater the discrepancy between CHO prescribed and CHO consumed the higher was the HbA1.

controlling variable. Energy, fibre (in relation to energy) and compliance with prescriptions for carbohydrate were the only factors found to relate to HbA1. The data were analysed for boys and girls separately and gave similar results.

There was an inverse relation between insulin dose and the intake of fibre (g) after controlling for C peptide and age ($r = -0.182$, $P < 0.05$). The equivalent value for fibre per unit of energy (g/mJ) was $r = -0.156$, $P = 0.058$. Insulin dose was not related to the other dietary variables.

There was a weak relation between duration of diabetes and % energy consumed as carbohydrate ($r = +0.126$, $P = 0.05$) and prescription of carbohydrate ($r = -0.123$, $P = 0.06$), suggesting that the patients who had developed diabetes recently were prescribed a more appropriate diet but actually ate less carbohydrate.

Discussion

This study has shown that there is still a tendency to prescribe amounts of carbohydrate well below those suggested in current recommendations. It was conducted at five clinics at which nine consultants and five dietitians were working, and hence no consistent dietary policy was observed. All clinics supported, in principle, the current dietary recommendations, but the slight negative relation between duration of diabetes and carbohydrate prescribed suggests that the recommendations were being applied to newly diagnosed patients more than to those with long standing disease. Some still used the 'rule of thumb' method of calculating the carbohydrate allowance—100 g plus 10 g for each year of life. The energy intakes of these diabetic children were broadly in line with those predicted for non-diabetic children, a finding similar to that of Kinmonth and Baum.¹³ Therefore, in order to comply with their allowance the diabetic children were forced to complete their energy balance by consuming extra fat, and, to a smaller extent, protein. Even so their intakes of carbohydrate were above the prescribed amounts, although this was partly due to the methodology employed, which counted the carbohydrate in all foods and drinks even those usually considered to be carbohydrate free, for example cabbage and tomatoes. Widdowson, in her pre-war study of 13 diabetic children aged 5 to 17 years, concluded that their diets were lower in energy and carbohydrate but higher in fat and protein than the diets of non-diabetic children.¹⁴ She suggested that the lower energy intakes were the result of the diabetic children leading more 'sheltered' and hence less active lives, which is now actively discouraged.

Although the children generally consumed more carbohydrate than prescribed, they consumed less than might have been expected for non-diabetic children. This is evidence of the effort made to comply with dietary instructions. Compliance, as defined here, was also found to be related to control. Account should also be taken, however, of what the child might have eaten had it not been for the dietary instructions. Although this cannot be known with certainty for our patients, it seems likely that apart from the differences in fat and carbohydrate intake, these children would have eaten more sugars (not lactose) but less fibre. Sucrose was used very little, whereas saccharine, proprietary diabetic foods, and modified recipes were much in evidence, indicating compliance despite the difficulties associated with dietary modifications.

The low prescriptions of carbohydrate may have been due to failure to review the diet often enough. Calculations show that the 'rule of thumb' method of calculating carbohydrate allowance underestimates recommended intakes for groups of subjects, especially for boys, and the margin increases with age. Carbohydrate allowances at approximately 50% of the predicted energy intake for non-diabetic children can be calculated using modifications of the regression equations of Whitehead, Paul, and Cole;¹² boys: carbohydrate (g) = $135 + 19.0 \text{ years} - 0.375 \text{ years}^2$; girls: carbohydrate (g) = $119 + 21.2 \text{ years} - 0.81 \text{ years}^2$. Extreme caution is advised, however, when using these methods because subjects can vary so much and there has been a tendency for the energy intake of children to fall over recent years.¹² The best method of prescribing carbohydrate is probably based on an assessment of previous energy intake. There is, however, the possibility that achieving the new recommended intakes without resort to larger intakes of refined carbohydrate is not practical. If the underprescription of carbohydrate could be successfully corrected it is likely that the intake of fibre would further increase.

The findings that the amount of fibre (g/MJ) correlated negatively with HbA1 and weakly with insulin dose are in agreement with suggestions¹⁵ that unabsorbable carbohydrate (fibre) may improve control by decreasing insulin requirements. No relation was found between the proportion of the energy consumed as carbohydrate and HbA1 or insulin dose (Table 3), suggesting that the improvement in tolerance with a high carbohydrate diet¹⁶ may be due to an increase in fibre. Caution must be urged, however, before extrapolating these results because the glycaemic response to a meal varies with the sources of carbohydrate¹⁷ and the different fibre fractions.¹⁸ Neither of these were identified in this study, and it is not known to what extent the lower

HbA1 values were associated with these specific dietary variables. The children in this study, however, were eating diets which were, to a large extent, self selected indicating that fibre may be a practical aid to control. Some experimental diets seem to be very unrealistic.

One experimental study has reported that the benefits of a high fibre, high carbohydrate diet may only apply to those children still producing endogenous insulin.⁶ This thesis is not supported by our observations of 168 children who were continuing with their normal routines and dietary practices. There is a complex interaction, however, between parent knowledge, socioeconomic group, fibre intake, and control (unpublished observations), and so it is possible that fibre intake may only be related to HbA1 as a covariate.

Diet is commonly mentioned as the major problem encountered when looking after a diabetic child. Dietary recommendations for diabetics, however, are now similar to those for the general population.⁷ This fact should be utilised when giving dietary instructions; bringing the intakes of children with diabetes more in line with the rest of the family (or vice versa) may lead to a considerable improvement in lifestyle.

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