Nutritional composition of the diets of South Asian, black African-Caribbean and white European children in the United Kingdom: The Child Heart and Health Study in England (CHASE)

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In the UK, South Asian adults have increased risks of CHD, type 2 diabetes and central obesity. Black African-Caribbeans, in contrast, have increased risks of type 2 diabetes and general obesity but lower CHD risk. There is growing evidence that these risk differences emerge in early life and that nutritional factors may be important. We have therefore examined the variations in nutritional composition of the diets of South Asian, black African-Caribbean and white European children, using 24 h recalls of dietary intake collected during a cross-sectional survey of cardiovascular health in eighty-five primary schools in London, Birmingham and Leicester. In all, 2209 children aged 9–10 years took part, including 558 of South Asian, 560 of black African-Caribbean and 543 of white European ethnicity. Compared with white Europeans, South Asian children reported higher mean total energy intake; their intakes of total fat, polyunsaturated fat and protein (both absolute and as proportions of total energy intake) were higher and their intakes of carbohydrate as a proportion of energy (particularly sugars), vitamin C and D, Ca and haem Fe were lower. These differences were especially marked for Bangladeshi children. Black African-Caribbean children had lower intakes of total and saturated fat (both absolute and as proportions of energy intake), NSP, vitamin D and Ca. The lower total and saturated fat intakes were particularly marked among black African children. Appreciable ethnic differences exist in the nutritional composition of children's diets, which may contribute to future differences in chronic disease risk.

Ethnicity: South Asian children: African-Caribbean children: Diet: 24-Hour recalls

Compared with white Europeans, South Asians living in the UK have increased risks of CHD, type 2 diabetes and central obesity[1–5]. Black African-Caribbeans living in the UK have increased risks of type 2 diabetes and general obesity but have lower risks of CHD[2,3,5,6]. Ethnic differences in the nutritional composition of diets could play an important role in these differences in disease risk, which are currently unexplained[7]. Nutrient composition is important in the aetiology of CHD, type 2 diabetes and obesity[8]. In particular, excessive consumption of energy-dense foods is associated with increased risks of overweight and obesity[8], while high total and saturated fat intakes increase risks of insulin resistance[9], impaired glucose tolerance[10], raised LDL-cholesterol levels and CHD[11]. High intakes of sugars may increase serum TAG and reduce HDL-cholesterol[12–14]. Low fibre (NSP) intake is associated with higher insulin resistance, raised total and LDL-cholesterol and an increased risk of obesity[15,16] and stroke[17]. Low intakes of micronutrients, including folate[8], vitamin C[18] and vitamin D[19], have been associated with increased risks of CVD and type 2 diabetes. The nutritional composition of adult diets differs between ethnic groups in the UK, in ways that could contribute to explaining ethnic differences in disease. In particular, intakes of total and polyunsaturated fat have been reported to be high among South Asians[20–22]; a recent report has suggested that saturated fat intakes may now also be higher[23]. Intakes of fruit and green vegetables may be low in South Asians[24], though this pattern has not been observed in all studies[3]. In contrast, among black African-Caribbeans, intakes of fat (particularly saturated fat) may be low and carbohydrate intake high[3,20,22,25].

There is growing evidence that the differences in chronic disease risk between South Asians, black African-Caribbeans and white Europeans may originate early in life. Compared with white Europeans, British South Asian children and adolescents have markedly increased risks of clinical type 2 diabetes[26] and have higher fasting insulin levels from about 10 years of age onwards[27,28]. Higher prevalences of overweight and obesity have been reported in South Asian and black African-Caribbeans in childhood and adolescence[3,29,30]. However, little is known about the nutritional composition

of diets among British children of different ethnic groups. We therefore carried out a detailed assessment of nutritional composition during a recent survey of cardiovascular health in 9- to 10-year-old children of different ethnic origins. We report here on ethnic variations in nutritional composition between South Asians, black African-Caribbeans and white European children, and also present data separately for South Asian children of Indian, Pakistani and Bangladeshi origin, and for black African-Caribbean children of African and Caribbean origin.

Subjects and methods

The Child Heart Health Study in England (CHASE) is examining the cardiovascular health of 5000 9- to 10-year-old children of white European, South Asian and black African-Caribbean origin living in England. The investigation of diet and nutrition was carried out in a sub-study of approximately 2000 children (CHASE-2000) studied between February 2006 and February 2007. Ethical approval was obtained from the relevant Multi-Centre Research Ethics Committee. Participating schools were identified on the basis of the pupil ethnicity, using information obtained from the UK Government Department for Education and Skills. All state primary schools in London, Birmingham and Leicester with between 15 and 50 % pupils of white European origin were identified. Two separate random samples of forty-three and forty-two schools were taken including (a) schools with a high prevalence (20–80 %) of South Asian pupils, stratified by Indian, Pakistani and Bangladeshi origin, and (b) schools with a high prevalence (20–80 %) of African-Caribbean pupils, stratified by African and Caribbean origin. Schools that did not agree to participate (30 %) were replaced by a school with a similar ethnic composition and in the same borough. Invitation letters (translated where necessary) were sent to parents or guardians of pupils in year 5 classes.

A single research field team visited schools in different areas in rotation during school terms in order to carry out survey assessments. Parents completed a questionnaire on their self-defined ethnic origin and that of the child and on occupation and educational attainment. Children provided information on parental and grand-parental place of birth. Ethnicity was defined on the basis of parental self-defined ethnicity for both parents, or (where not available) parentally defined child ethnicity, or (where not available) child-defined geographic origin of parents and grandparents. In the present analyses, 'white European' includes children whose ethnic origin was defined as 'white British', 'white Irish' and 'white European' (or a combination of these) and excludes 'white other'. 'South Asian' includes 'Indian', 'Pakistani', 'Bangladeshi' and 'Sri Lankan' (or a combination of these). 'Black African-Caribbean' includes 'black African', 'black Caribbean', 'black British' and 'black other' (or a combination of these). The 'other' ethnic group includes all other categories of individual and mixed ethnic origins.

Weight and height were measured by one of three research nurses, weight with an electronic digital scale (Tanita Inc., Tokyo, Japan) and height (measured to the last complete millimetre) with a portable stadiometer (Chasmors Ltd, London, UK); BMI (weight (kg)/height (m^2)) was calculated. Food intake was assessed by two research nutritionists

(A. S. D. and M. C. M.). The 24 h recall method was chosen because it provides valid information in children in this age group[31–34], is suitable for large-scale survey use[35], and does not require high levels of literacy. A single, structured 24 h dietary recall interview was carried out, which followed the recommendations of the Nordic Cooperation Group of Dietary Researchers[36] and included several elements of the United States Department of Agriculture (USDA) multiple-pass method[37]. All interviews were carried out in English (the language in which all children were being taught) in private, without a carer or teacher present. The interviewer orientated the child on the previous day, enquiring about events and activities in which the child had participated[32]. A list of foods and beverages consumed the previous day was constructed, together with the time and occasion on which each item was consumed. A detailed description was made of the food consumed. Photographs of food items and different portion sizes were used[38] to help the child report the quantity of food consumed. Final probing was carried out for any forgotten items, particularly drinks and snacks. Questions were asked to identify whether this was a 'usual' day in terms of dietary intake for the child. The data were then entered and analysed for nutrient composition by experienced dietary coders at the Medical Research Council Human Nutrition Research Centre (MRC-HNR) using the Diet In Nutrients Out (DINO) package, which generates a food code and an associated weight for each item of food and drink recorded. Age-specific portion sizes were determined from the National Diet and Nutrition Survey of Young People[27]. Food and nutrient intakes were calculated using the in-house food composition database based on McCance and Widdowson's *The Composition of Foods*, 6th edition[39]. The nutrient contents of foods that were not already in the DINO database were calculated from recipes obtained from various sources including the second supplement to McCance and Widdowson's *The Composition of Foods 1985: Immigrant Foods*[40], the MRC-HNR in-house database of food composition tables for the Gambia and authoritative international recipe books[41,42].

In order to identify potential under- and over-reporters, standard equations were used to estimate BMR which are age and sex specific and based on the measured weight of the child[43]. These were multiplied by lower and upper cut-off physical activity levels (PAL) of 1·1 and 2·2 (assuming an average PAL of 1·55)[44] to provide estimates of minimum total energy expenditure (to identify probable under-reporters) and maximum energy expenditure (to identify probable over-reporters). These estimates were compared with reported energy intakes, and, if found to be below the estimated minimum expenditure or over the maximum expenditure, children were identified as under-reporters or over-reporters, respectively[45]. Participants identified as under-reporters or over-reporters were included in the main analysis but were excluded in specific sensitivity analyses (reported in the Results section).

Statistical analysis

All analyses were carried out using STATA (version 10.1; StataCorp LP, College Station, TX, USA). Distributions of nutrient composition variables were examined for normality and

log transformed where necessary. Multilevel linear regression models taking account of the natural clustering within school were used to provide adjusted means and ethnic differences in nutrient composition (using XTMIXED and LINCOM commands). All analyses adjusted for sex, age in quartiles, month, day of the week and interviewer, all as fixed effects.

Results

Overall, 2255 children (mean age 9·9 years, 95 % reference range 9·2, 10·7 years) participated, with an overall response rate of 70 %. Response rates were slightly higher among white Europeans (71 %), South Asians (73 %) and other ethnic groups (70 %) compared with black African-Caribbeans (65 %). Among the 2255 participants, 2209 (98 %) provided information of acceptable quality (1065 boys and 1144 girls; 558 were South Asian, 560 black African-Caribbean, 543 white European, and 548 of other ethnic origin). Recall assessments could not be completed in forty-six children because the child did not cooperate (*n* 37), had language difficulties (*n* 5) or because of time constraints (*n* 4). The prevalence of under-reporting was 21 % (24 % of boys, 19 % of girls) and over-reporting was 6·7 % (4·7 % of boys, 8·7 % of girls). Under-reporting prevalence varied by ethnic group; 27 % of black African-Caribbean children, 21 % of white European children, 15 % of South Asian children and 23 % of children of other ethnicity were under-reporters. As expected, under-reporters were heavier than other children (mean difference

6·7 (95 % CI 5·8, 7·7) kg); this difference did not vary markedly between boys and girls or between children of different ethnic groups.

The nutritional composition of the whole study population is summarised in Table 1. Mean total energy intake was higher in boys, though the proportions of energy derived from fat, carbohydrate and protein were similar in both sexes. Among micronutrients, intakes of vitamin B_{12} and Fe were higher among boys. Nutrient composition did not vary appreciably with age over the narrow age range studied (data not presented), but varied slightly by interviewer. Nutritional composition varied by month of the year, but there was no consistent seasonal trend (data not presented). Nutritional composition also varied by day of the week; total energy intakes and proportions of energy derived from fat and protein were higher on Sundays than on weekdays while micronutrient intakes tended to be lower (data not presented). Adjustments were made for month, day of the week and interviewer in subsequent analyses.

Nutritional composition of diets among children from different ethnic groups

Data on the nutritional composition of the diets of children of South Asian, black African-Caribbean, white European and other ethnic origin are presented in Table 2, in analyses which take account of differences in age and sex, month of year and day of week, with school fitted as a random effect.

Table 1. Nutritional composition of children's diets: by sex

(Mean values and standard deviations or geometric means and interquartile ranges (IQR)*)

	Boys (*n* 1065)				Girls (*n* 1144)				P (difference)†
	Mean	SD	Geometric mean	IQR	Mean	SD	Geometric mean	IQR	
Energy (kJ)	7856	2137			7646	2046			0·01
Energy (kcal)	1867	509			1817	488			0·01
Fat (g)	72·3	26·9			71·0	26·1			0·30
Fat (% energy)	34·1	6·6			34·5	6·4			0·11
Saturated fat (g)	26·6	11·1			26·3	11·1			0·55
Saturated fat (% energy)	12·6	3·4			12·7	3·5			0·15
Monounsaturated fat (g)	24·2	9·9			23·3	9·3			0·03
Monounsaturated fat (% energy)	11·4	2·9			11·3	2·8			0·50
Polyunsaturated fat (g)	13·5	8·0			13·7	7·5			0·61
Polyunsaturated fat (% energy)	6·4	3·1			6·7	3·0			0·02
Carbohydrate (g)	258·6	71·8			251·1	68·5			0·01
Carbohydrate (% energy)	52·1	7·0			51·9	6·8			0·49
Sugars (g)	111·5	46·0			108·7	44·6			0·09
Sugars (% energy)	22·3	7·2			22·4	7·0			0·92
Starch, dextrins (g)	144·6	45·2			140·2	42·8			0·02
Starch, dextrins (% energy)	29·3	6·3			29·1	6·1			0·54
Total NSP (g)	11·7	4·9			11·9	4·6			0·42
Protein (g)	62·3	20·6			60·2	19·9			0·01
Protein (% energy)	13·4	3·3			13·3	3·3			0·39
Vitamin B_{12} (μg)			3·0	2·8			2·8	2·6	0·02
Folate (μg)			201	117			198	113	0·29
Vitamin C (mg)			78·6	96·5			83·8	94·2	0·09
Vitamin D (μg)			1·6	1·9			1·6	2·0	0·45
Ca (mg)			718	443			712	410	0·53
Fe (mg)			9·1	4·3			8·6	3·9	0·002
Haem Fe (mg)			0·18	0·50			0·14	0·40	<0·001

* Means and standard deviations or IQR are based on the raw data.
† *P* values for sex difference adjusted for age in quartiles, day of week, month, interviewer and school (random effect).

Table 2. Nutritional composition of children's diets: by ethnic group*

(Means or geometric means and 95 % confidence intervals)

	White European (n 543; 271 boys)		South Asian (n 558; 264 boys)		Black African-Caribbean (n 560; 261 boys)		Other (n 548; 269 boys)	
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI
Energy (kJ)	7634	7446, 7823	8042	7842, 8242	7665	7478, 7853	7688	7500, 7876
Energy (kcal)	1814	1769, 1859	1911	1864, 1959	1821	1776, 1866	1827	1782, 1871
Fat (g)	70·8	68·5, 73·2	76·9	74·4, 79·4	69·0	66·6, 71·3	70·4	68·0, 72·8
Fat (% energy)	34·5	34·0, 35·1	35·6	35·0, 36·2	33·2	32·7, 33·8	34·0	33·4, 34·5
Saturated fat (g)	27·2	26·2, 28·2	27·3	26·2, 28·4	25·0	24·0, 26·0	26·5	25·5, 27·5
Saturated fat (% energy)	13·2	12·9, 13·5	12·7	12·3, 13·0	12·0	11·7, 12·3	12·8	12·5, 13·1
Monounsaturated fat (g)	23·6	22·7, 24·5	25·4	24·4, 26·3	23·0	22·1, 23·9	23·5	22·6, 24·4
Monounsaturated fat (% energy)	11·5	11·2, 11·7	11·7	11·4, 12·0	11·2	10·9, 11·4	11·3	11·1, 11·6
Polyunsaturated fat (g)	12·8	12·1, 13·5	15·9	15·1, 16·6	13·3	12·6, 14·0	12·7	12·0, 13·4
Polyunsaturated fat (% energy)	6·3	6·0, 6·6	7·4	7·1, 7·7	6·4	6·1, 6·7	6·2	5·9, 6·4
Carbohydrate (g)	252·3	246·0, 258·7	258·5	251·7, 265·2	256·3	250·0, 262·6	252·4	246·0, 258·7
Carbohydrate (% energy)	52·1	51·5, 52·7	50·9	50·2, 51·5	53·0	52·3, 53·6	51·9	51·3, 52·5
Sugars (g)	116·1	111·9, 120·3	101·2	96·7, 105·7	112·0	107·8, 116·2	110·8	106·6, 115·0
Sugars (% energy)	23·8	23·2, 24·5	19·8	19·1, 20·5	22·9	22·3, 23·6	22·7	22·0, 23·3
Starch, dextrins (g)	134·2	130·2, 138·3	154·9	150·6, 159·2	141·6	137·6, 145·6	139·4	135·3, 143·4
Starch, dextrins (% energy)	27·8	27·2, 28·4	30·6	30·0, 31·3	29·4	28·8, 30·0	28·7	28·1, 29·3
Total NSP (g)	11·8	11·3, 12·2	12·8	12·3, 13·3	11·0	10·5, 11·4	11·5	11·1, 12·0
Protein (g)	57·3	55·5, 59·2	65·7	63·7, 67·6	60·2	58·4, 62·1	61·9	60·0, 63·7
Protein (% energy)	12·7	12·4, 13·0	13·6	13·3, 14·0	13·3	13·0, 13·6	13·6	13·3, 13·9
Vitamin B₁₂ (μg)†	2·8	2·6, 3·0	2·9	2·7, 3·1	3·0	2·8, 3·3	3·1	2·9, 3·3
Folate (μg)†	204	196, 212	196	187, 204	200	192, 208	197	189, 205
Vitamin C (mg)†	85·1	78·9, 91·8	73·9	68·1, 80·1	85·9	79·6, 92·6	80·2	74·3, 86·5
Vitamin D (μg)†	1·9	1·8, 2·1	1·4	1·2, 1·5	1·7	1·6, 1·8	1·6	1·5, 1·7
Ca (mg)†	742	712, 773	699	669, 731	693	665, 722	725	695, 755
Fe (mg)†	8·7	8·4, 9·0	9·4	9·0, 9·7	8·6	8·3, 8·9	8·7	8·4, 9·0
Haem Fe (mg)†	0·15	0·13, 0·19	0·12	0·10, 0·15	0·20	0·17, 0·25	0·19	0·16, 0·23

* Means adjusted for age in quartiles, sex, day of week, month, interviewer and school (random effect).
† Geometric mean.

Patterns of nutritional composition among the white European group and the 'other ethnicity' group were very similar. There were, however, marked differences in nutritional composition between South Asians and white Europeans, summarised in Table 3, and between black African-Caribbeans and white Europeans, summarised in Table 4.

South Asians: comparisons with white Europeans

Total energy intake was higher among South Asians, mainly reflecting higher intakes of total fat and total protein, which contributed to greater percentages of total energy intake than in white Europeans. Saturated fat provided a lower percentage of energy and polyunsaturated fat a higher percentage of energy among South Asians, but the contribution of monounsaturated fat was not markedly different. Total carbohydrate intake was similar, but total carbohydrate intake as a percentage of energy was lower. This particularly reflected lower intakes of sugars (both in absolute amounts and as percentages of energy) while starch intakes were higher. NSP intake was higher among South Asians. Intakes of several micronutrients, including vitamin C, vitamin D and Ca were lower, though total Fe intake was higher.

Differences in nutritional composition between white Europeans and South Asians specifically of Indian, Pakistani and Bangladeshi origin are shown in Table 3. The higher total energy intakes, the higher proportions of energy obtained from fat, polyunsaturated fat, starch and protein and the lower proportions of energy from saturated fat and sugars observed in all South Asians were particularly marked among the Bangladeshi children (who also showed particularly high intakes of monounsaturated fat) and to a lesser extent the Pakistani children; Indian children generally showed nutrient intake patterns closer to those of white Europeans. Similarly, low micronutrient intakes (particularly of vitamin C and Ca) were particularly marked among Bangladeshi children, who also had lower folate intakes. Bangladeshi children had lower NSP intake than white Europeans, while Indian and Pakistani children had higher intakes.

Black African-Caribbeans: comparisons with white Europeans

Total energy intake was similar among black African-Caribbean and white European children (Tables 2 and 4). However, black African-Caribbeans derived lower percentages of energy from total and saturated fat and higher percentages of energy from protein and carbohydrate. Monounsaturated fat and polyunsaturated fat intakes did not differ markedly from white European intakes. Intake of starch was markedly higher while intakes of NSP and sugars tended to be lower. Black African-Caribbean children had lower intakes of Ca and vitamin D but a higher intake of haem Fe.

Differences in nutritional composition between white Europeans and black African-Caribbeans specifically of African and Caribbean origin are shown in Table 4. Black African children had particularly low percentages of energy intake from total and saturated fat and obtained a higher

Table 3. Ethnic differences in nutritional composition of children's diets: South Asians compared with white Europeans*

(Mean differences or percentage differences and 95 % confidence intervals)

	South Asian									
	All South Asian (n 558; 264 boys)			South Asian subgroups						
				Indian (n 137; 73 boys)		Pakistani (n 210; 100 boys)		Bangladeshi (n 175; 75 boys)		
	Mean difference	95 % CI	P (no difference)*	Mean difference	95 % CI	Mean difference	95 % CI	Mean difference	95 % CI	P (no difference between South Asian subgroups)
Energy (kJ)	408	147, 669	0·002	204	−202, 610	559	205, 913	482	104, 859	0·25
Energy (kcal)	97	35, 159	0·002	48	−49, 145	133	49, 218	115	25, 205	0·25
Fat (g)	6·1	2·8, 9·4	<0·001	2·7	−2·4, 7·9	7·6	3·1, 12·0	8·5	3·8, 13·3	0·10
Fat (% energy)	1·0	0·2, 1·8	0·01	0·4	−0·8, 1·7	1·0	−0·1, 2·1	1·8	0·6, 2·9	0·23
Saturated fat (g)	0·1	−1·3, 1·5	0·85	−0·1	−2·3, 2·1	1·4	−0·5, 3·3	−0·9	−3·0, 1·1	0·17
Saturated fat (% energy)	−0·6	−1·0, −0·1	0·01	−0·3	−0·9, 0·4	−0·3	−0·8, 0·3	−1·2	−1·8, −0·6	0·03
Monounsaturated fat (g)	1·8	0·6, 3·0	0·003	−0·3	−2·1, 1·6	1·9	0·3, 3·5	4·2	2·4, 5·9	<0·001
Monounsaturated fat (% energy)	0·2	−0·1, 0·6	0·19	−0·4	−0·9, 0·2	0·0	−0·5, 0·5	1·2	0·7, 1·7	<0·0001
Polyunsaturated fat (g)	3·0	2·1, 4·0	<0·0001	2·1	0·6, 3·6	2·7	1·4, 4·0	4·5	3·1, 5·9	0·02
Polyunsaturated fat (% energy)	1·1	0·7, 1·5	<0·0001	0·8	0·2, 1·4	0·8	0·2, 1·3	1·8	1·2, 2·3	0·01
Carbohydrate (g)	6·1	−2·7, 14·9	0·17	6·9	−6·7, 20·6	10·4	−1·5, 22·3	2·0	−10·7, 14·7	0·61
Carbohydrate (% energy)	−1·2	−2·1, −0·4	0·005	0·3	−1·0, 1·6	−1·3	−2·5, −0·2	−2·5	−3·8, −1·3	0·003
Sugars (g)	−14·9	−20·5, −9·2	<0·0001	−14·9	−23·7, −6·1	−5·8	−13·5, 1·9	−24·5	−32·7, −16·3	<0·001
Sugars (% energy)	−4·0	−4·9, −3·1	<0·0001	−3·3	−4·7, −2·0	−2·6	−3·8, −1·5	−6·2	−7·5, −4·9	<0·0001
Starch, dextrins (g)	20·7	15·2, 26·1	<0·0001	21·5	13·1, 30·0	16·1	8·7, 23·5	25·9	18·1, 33·8	0·09
Starch, dextrins (% energy)	2·8	2·0, 3·6	<0·0001	3·6	2·4, 4·8	1·4	0·4, 2·5	3·6	2·4, 4·7	<0·001
Total NSP (g)	1·1	0·5, 1·7	<0·001	3·7	2·8, 4·6	1·5	0·7, 2·3	−1·3	−2·2, −0·5	<0·0001
Protein (g)	8·3	5·8, 10·9	<0·0001	1·3	−2·6, 5·2	9·6	6·2, 13·0	13·7	10·0, 17·3	<0·0001
Protein (% energy)	0·9	0·5, 1·3	<0·0001	−0·4	−1·0, 0·3	1·0	0·4, 1·5	1·9	1·3, 2·5	<0·0001
Vitamin B₁₂ (μg)†	3·6	−5·8, 13·9	0·47	−7·0	−19·7, 7·8	16·4	2·3, 32·4	1·0	−12·0, 15·9	0·03
Folate (μg)†	−4·2	−9·1, 1·1	0·12	0·1	−7·8, 8·7	−1·6	−8·4, 5·8	−10·6	−17·2, −3·4	0·05
Vitamin C (mg)†	−13·2	−21·6, −3·8	0·01	−6·0	−19·7, 10·1	−10·6	−22·2, 2·6	−21·7	−32·4, −9·2	0·12
Vitamin D (μg)†	−29·9	−37·8, −21·1	<0·0001	−29·9	−41·7, −15·7	−25·9	−36·9, −12·9	−36·8	−46·8, −25·0	0·29
Ca (mg)†	−5·8	−11·0, −0·3	0·04	1·6	−6·8, 10·8	2·1	−5·3, 10·1	−18·8	−25·1, −12·0	<0·0001
Fe (mg)†	7·4	2·7, 12·4	0·002	10·4	2·9, 18·5	8·8	2·4, 15·7	4·2	−2·4, 11·2	0·37
Haem Fe (mg)†	−19·6	−36·8, 2·1	0·07	−71·7	−80·4, −59·3	−12·2	−36·4, 21·3	53·8	8·9, 117·0	<0·0001

* Differences (South Asian minus white European in all cases) are adjusted for age in quartiles, sex, day of week, month, interviewer and school (random effect). Thirty-six South Asians could not be classified specifically as Indian, Pakistani or Bangladeshi and are therefore omitted from South Asian subgroup analysis.
† Percentage difference.

Table 4. Ethnic differences in nutritional composition of children's diets: black African-Caribbeans compared with white Europeans*

(Mean differences or percentage differences and 95% confidence intervals)

	Black African-Caribbean							
	All black (n 560; 261 boys)			Black African-Caribbean subgroups				
				Black African (n 309; 136 boys)		Black Caribbean (n 210; 105 boys)		
	Mean difference	95% CI	P (no difference)*	Mean difference	95% CI	Mean difference	95% CI	P (no difference between black subgroups)
Energy (kJ)	31	−217, 279	0·81	76	−217, 369	25	−307, 358	0·73
Energy (kcal)	7	−52, 66	0·82	17	−53, 87	6	−74, 85	0·74
Fat (g)	−1·9	−5·0, 1·3	0·24	−2·8	−6·5, 0·9	−0·5	−4·7, 3·7	0·34
Fat (% energy)	−1·3	−2·1, −0·5	<0·001	−2·0	−2·9, −1·1	−0·6	−1·6, 0·4	0·01
Saturated fat (g)	−2·1	−3·5, −0·8	0·002	−2·7	−4·3, −1·1	−1·3	−3·1, 0·5	0·17
Saturated fat (% energy)	−1·2	−1·6, −0·8	<0·0001	−1·5	−2·0, −1·0	−0·8	−1·4, −0·3	0·02
Monounsaturated fat (g)	−0·5	−1·7, 0·6	0·37	−0·9	−2·2, 0·5	0·0	−1·5, 1·5	0·31
Monounsaturated fat (% energy)	−0·3	−0·7, 0·0	0·07	−0·5	−0·9, −0·1	−0·1	−0·5, 0·4	0·07
Polyunsaturated fat (g)	0·5	−0·5, 1·4	0·32	0·4	−0·7, 1·4	0·4	−0·8, 1·6	0·95
Polyunsaturated fat (% energy)	0·1	−0·2, 0·5	0·54	0·0	−0·4, 0·4	0·1	−0·4, 0·6	0·58
Carbohydrate (g)	4·0	−4·4, 12·3	0·35	9·2	−0·6, 19·0	−0·2	−11·3, 11·0	0·11
Carbohydrate (% energy)	0·8	0·0, 1·7	0·05	1·6	0·7, 2·6	0·0	−1·1, 1·1	0·01
Sugars (g)	−4·1	−9·4, 1·3	0·14	−4·1	−10·4, 2·2	−4·2	−11·4, 2·9	0·93
Sugars (% energy)	−0·9	−1·7, −0·1	0·04	−1·0	−2·0, 0·0	−0·9	−2·0, 0·2	0·92
Starch, dextrins (g)	7·4	2·2, 12·6	0·01	12·6	6·5, 18·7	3·8	−3·1, 10·7	0·02
Starch, dextrins (% energy)	1·6	0·9, 2·3	<0·0001	2·5	1·6, 3·3	0·8	−0·1, 1·8	0·003
Total NSP (g)	−0·8	−1·4, −0·3	0·004	−0·7	−1·3, −0·1	−0·8	−1·5, 0·0	0·90
Protein (g)	2·9	0·5, 5·3	0·02	3·1	0·3, 5·9	3·0	−0·2, 6·2	0·91
Protein (% energy)	0·6	0·2, 1·0	0·003	0·5	0·1, 1·0	0·6	0·1, 1·1	0·85
Vitamin B$_{12}$ (μg)†	9·7	0·2, 20·1	0·04	14·4	2·9, 27·3	5·9	−6·1, 19·5	0·21
Folate (μg)†	−2·2	−7·0, 2·9	0·39	3·6	−2·4, 9·9	−5·9	−12·0, 0·6	0·01
Vitamin C (mg)†	0·9	−8·3, 11·1	0·85	1·5	−9·4, 13·7	1·2	−11·1, 15·1	0·96
Vitamin D (μg)†	−12·1	−21·5, −1·6	0·03	−14·2	−24·9, −2·1	−9·4	−22·1, 5·3	0·53
Ca (mg)†	−6·6	−11·4, −1·5	0·012	−4·1	−9·9, 2·1	−8·0	−14·3, −1·3	0·29
Fe (mg)†	−1·2	−5·3, 3·2	0·59	2·0	−3·0, 7·4	−3·2	−8·6, 2·6	0·09
Haem Fe (mg)†	32·0	5·5, 65·1	0·015	22·8	−5·4, 59·3	52·1	13·1, 104·5	0·22

* Differences (black African-Caribbean minus white European in all cases) are adjusted for age in quartiles, sex, day of week, month, interviewer and school (random effect). Forty-one black African-Caribbeans could not be classified specifically as black African or black Caribbean and are therefore omitted from black African-Caribbean subgroup analysis.
† Percentage difference.

percentage of energy from carbohydrate (particularly from starch). They had markedly higher folate intakes than black Caribbean children. Black Caribbean children appeared to have fat and carbohydrate intakes much closer to those of white Europeans.

The patterns of ethnic differences described between South Asians, black African-Caribbeans and white Europeans were similar in boys and girls. In further analyses, the ethnic differences were not affected by adjustment for socio-economic status based on parental occupation or parental education. Additional adjustment for height (a strong proxy marker of socio-economic status[46]) also had no material effect on the results. The replacement of the white European ethnic group by white British children (*n* 372) had little effect on the pattern of ethnic differences observed. In sensitivity analyses excluding under-reporters (*n* 476) and over-reporters (*n* 149), the pattern of ethnic differences in nutrient intakes observed was not materially altered.

Discussion

The results of this detailed study of 9- to 10-year-old children suggest that there are marked ethnic differences in nutritional composition in the UK. Compared with white Europeans, children of South Asian origin appeared to have higher intakes of total energy, total and polyunsaturated fat, protein and starch (both absolute and as proportions of energy), while their intake of sugars and many micronutrients appeared lower. These differences were particularly marked among the children of Bangladeshi origin. Black African-Caribbean children, in contrast, had lower intakes of total and saturated fat (both absolute and as proportions of energy). Intakes of sugars and NSP were also lower, while intakes of protein and starch were higher. Ca intake was lower and Fe intake higher. The differences in fat and starch intake were particularly marked among black African children.

Agreement with previous studies

The possibility that energy intakes are higher in South Asians, though consistent with one previous report in adults[47], has not been observed in several other studies in adults, which showed little or no difference in energy intakes between South Asians and white Europeans[20–22]. The higher fat intakes (in particular, higher percentage of energy derived from polyunsaturated fats) and lower intakes of micronutrients observed among South Asians in the present study are consistent with differences both in fat intake and vitamin C intake reported in earlier studies in adults[20–24,48]. However, thehigher saturated fat intakes reported in a recent study of South Asian adults were not confirmed here[23]. The lower fat intakes (in particular, the lower percentage of energy derived from saturated fat) reported for black African-Caribbean children are consistent with the differences in fat intake reported in earlier studies in adults[22]. The nutrient intake patterns observed in the present study closely reflect ethnic differences in food group items consumed by the children. In preliminary analyses in comparison with white Europeans, South Asian children derived much higher proportions of energy from pasta and rice, fats, milk and 'other vegetables' and lower proportions from potatoes, leafy vegetables, breakfast cereals,

cheese and yoghurts, and fruit and nuts. Black African-Caribbean children, in contrast, obtained greater proportions of energy from meat, milk, pasta and rice and 'other vegetables' in their diets and much less from potatoes, breads, fats, fish, cheese and yoghurt and fruit and nuts. These differences could well help to explain both macronutrient and micronutrient intakes between these groups.

Strengths and limitations of the present study

The strengths and limitations of the study merit consideration. The present study was based in three cities which together account for more than two-thirds of South Asians and black African-Caribbeans living in the UK and specifically included South Asian children of Indian, Pakistani and Bangladeshi origin and black African-Caribbean children of black African and black Caribbean origin. Comparisons of nutritional composition were strengthened by being conducted on a within-school basis, to limit the scope for confounding, especially for socio-economic factors. Although response rates were moderate (probably reflecting the appreciable social deprivation of the population studied), response rates did not differ markedly by ethnic group and are unlikely to account for the ethnic differences in dietary composition observed. A single structured 24 h recall assessment was used because it has been previously shown to provide a valid and unbiased estimate of usual dietary intake in individuals, making it particularly suitable for group-level comparisons in children of this age[32–34] as well as in adults[31]. The method is more suitable than food-frequency approaches for this age group[49], does not demand high levels of literacy and is particularly suitable for large-scale surveys[35]. The use of direct interviews without involving a carer has the advantage of providing a more complete picture of nutrient intake (including foods eaten outside the home) which is not biased by the presence of the carer[33]. The validity of the estimates of nutrient intakes obtained using the 24 h recall method in the present study is supported by several observations. First, estimates of all nutrient intakes were positively correlated with estimates obtained using prospective 4 d dietary diaries in a sub-study in 500 children (AS Donin, CM Nightingale, CG Owen, AR Rudnicka, MC McNamara, CJ Prynne, AM Stephen, DG Cook and PH Whincup, unpublished results). Second, overall intakes of both macronutrients and micronutrients in the present study are close to those of 7- to 10-year-old children in the 2000 National Diet and Nutrition Survey (NDNS)[50], which used prospective, 7 d weighed food diaries to assess food intakes; the prevalence of under-reporting of total energy intake was also similar to (though slightly lower than) under-reporting rates reported in the NDNS for the 7- to 10-year age group (29 % for boys and 27 % for girls). Third, the patterns of ethnic differences in nutrient intakes in the present study are substantially consistent with those reported in previous studies in adults[20,22,47]. Although the present study was primarily based on nutrient intake assessments for weekdays during school terms, these account for at least half the days in the year at this age and are likely to be reasonably representative; the exclusion of holiday periods is likely to have led to underestimation rather than overestimation of the extent of ethnic differences in nutrient intakes. Although the reporting of dietary intake (particularly energy

intake) is known to be influenced by participant characteristics (particularly body weight), there is little evidence that reporting of nutrient intakes varies by ethnic group[22]. The higher reported energy intakes observed in South Asian children in the present study could reflect true differences, but they may also reflect a specific problem in the assessment of portion sizes in this group. In the present study, most South Asian children reported a distinctive pattern of meal intake, having two full meals in the later part of the day (one immediately on returning home, with a family meal later in the evening). Further investigation will be needed to resolve whether the meal pattern has resulted in overestimation of total energy intake, though it would not be expected to affect estimates of macronutrient intakes expressed as proportions of total energy.

Implications of ethnic differences in nutritional composition for future chronic disease risk

The persistence of the differences in nutritional composition between South Asian and white European children observed in the present study could have important consequences for longer-term risks of obesity, CHD and type 2 diabetes among the South Asians. If substantiated in further studies, the higher total energy intakes observed for South Asian children, primarily derived from fat and protein, may induce positive energy balance and be responsible for appreciable increases in risks of longer-term overweight and obesity[51,52], particularly at the lower levels of physical activity reported in South Asians[53]. Long-term increases in overweight and obesity from childhood onwards may themselves increase risks of CHD and type 2 diabetes[54]. The high average total fat intake among South Asian children (accounting for about 36 % of energy intake) suggests that most of these children exceed the Committee on Medical Aspects of Food and Nutrition Policy (COMA) recommendation for a maximum of 35 % of energy to be derived from fat. The higher overall fat intake may have implications for long-term risks of type 2 diabetes and CHD[55]; high polyunsaturated fat intakes have been associated with higher fasting serum insulin levels in young Asian Indians[39]. The higher intakes of starch in South Asians may enhance glycaemic response, reducing insulin sensitivity and increasing TAG levels[56]. The lower levels of micronutrient intakes observed in South Asians, particularly of vitamin C, vitamin D and Ca, could also affect long-term disease risks. In adults, vitamin C intake shows a graded inverse relationship with risks of type 2 diabetes and CVD, even within the normal range[57,58]. Evidence suggests that low vitamin D intake and (in particular) low circulating levels of vitamin D and Ca may be associated with increased risks of insulin resistance, type 2 diabetes and CHD[59–61]. The particularly marked nutritional differences between Bangladeshi and white European children are consistent with the markedly higher risks of type 2 diabetes and CHD among UK Bangladeshi adults[2,3]. It is also possible that genetic factors modify the influence of nutrient intakes on risks of CVD and type 2 diabetes, and that Asian populations could be particularly susceptible[62], though this has still to be established.

For the black African-Caribbeans, the lower proportions of energy derived from total and saturated fat would be expected to lead to a favourable lipid profile, particularly lower LDL-cholesterol, which would be expected to reduce the rate of coronary atherosclerotic plaque development and CHD[63]. Such findings are consistent with the lower long-term risks of CHD observed in black African-Caribbean adults[2,3,5]. However, the finding that total and saturated fat intakes were particularly low among black Africans, while those of black Caribbeans are closer to those of white Europeans, suggests that the diets of the black Caribbean population may have become increasingly westernised since migration, and that the protection against CHD previously experienced by black African-Caribbean adults[2,5] may be increasingly concentrated among black Africans during the next generation. The effects of the slightly higher starch intakes among black African-Caribbeans remain uncertain, though they could have adverse long-term effects on insulin sensitivity[56]. The lower intakes of NSP among black African-Caribbean children could have important adverse long-term effects, impairing satiety signals and appetite control[16], and increasing long-term risk of obesity[64], diabetes[65,66] and stroke[67]. The lower intakes of Ca and vitamin D (more so for Ca in African-Caribbeans, and for vitamin D in South Asians), particularly if reflected in low overall circulating vitamin D levels, could be relevant to increased longer-term risks of type 2 diabetes and CVD[59,61].

Conclusions

There are substantial differences in the nutritional composition of the diets of children of South Asian, black African-Caribbean and white European origin living in the UK. The persistence of these dietary differences into adult life could contribute to the continuation of the current pattern of ethnic differences in chronic disease into the next generation.

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