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Ethnic differences in blood lipids and dietary intake between UK children of black African, black Caribbean, South Asian, and white European origin: the Child Heart and Health Study in England (CHASE)[1–4]

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ABSTRACT

Background: Ischemic heart disease (IHD) rates are lower in UK black Africans and black Caribbeans and higher in South Asians when compared with white Europeans. Ethnic differences in lipid concentrations may play a part in these differences.

Objective: The objective was to investigate blood lipid and dietary patterns in UK children from different ethnic groups.

Design: This was a cross-sectional study in 2026 UK children (including 285 black Africans, 188 black Caribbeans, 534 South Asians, and 512 white Europeans) attending primary schools in London, Birmingham, and Leicester. We measured fasting blood lipid concentrations and collected 24-h dietary recalls.

Results: In comparison with white Europeans, black African children had lower total cholesterol (−0.14 mmol/L; 95% CI: −0.25, −0.04 mmol/L), LDL-cholesterol (−0.10 mmol/L; 95% CI: −0.20, −0.01 mmol/L), and triglyceride concentrations (proportional difference: −0.11 mmol/L; 95% CI: −0.16, −0.06 mmol/L); HDL-cholesterol concentrations were similar. Lower saturated fat intakes (−1.4%; 95% CI: −1.9%, −0.9%) explained the differences between total and LDL cholesterol. Black Caribbean children had total, LDL-cholesterol, HDL-cholesterol, and triglyceride concentrations similar to those for white Europeans, with slightly lower saturated fat intakes. South Asian children had total and LDL-cholesterol concentrations similar to those for white Europeans, lower HDL-cholesterol concentrations (−0.7 mmol/L; 95% CI: −0.11, −0.03 mmol/L), and elevated triglyceride concentrations (proportional difference: 0.14 mmol/L; 95% CI: 0.09, 0.20 mmol/L); higher polyunsaturated and monounsaturated fat intakes did not explain these lipid differences.

Conclusions: Only black African children had a blood lipid profile and associated dietary pattern likely to protect against future IHD. The loss of historically lower LDL-cholesterol concentrations among UK black Caribbeans and South Asians may have important adverse consequences for future IHD risk in these groups. *Am J Clin Nutr* doi: 10.3945/ajcn.2010.29533.

INTRODUCTION

In comparison with white Europeans, UK black Africans and black Caribbeans have lower ischemic heart disease (IHD) mortality rates, whereas UK South Asian adults have higher IHD mortality (1, 2). Marked differences in adult blood lipid concentrations have been reported between these groups, which may contribute to ethnic differences in IHD risk. In earlier adult studies, black Caribbeans had lower concentrations of total and LDL cholesterol, higher HDL-cholesterol concentrations, and low triglyceride concentrations compared with white Europeans, which is consistent with lower levels of IHD risk (3–6). In limited recent data in black African adults, a similar picture was apparent (7). South Asian adults, in contrast, have generally had lower total cholesterol and LDL-cholesterol concentrations than white Europeans, with lower HDL-cholesterol and higher triglyceride concentrationss (3, 4, 6, 8, 9); the former differences would be expected to reduce IHD risk and the latter to increase them (10). Dietary macronutrient intakes are strongly linked to blood lipids; diets high in saturated fat increase total and LDL cholesterol (11), whereas diets high in mono- and polyunsaturated fats increase HDL cholesterol, and diets high in carbohydrates (particularly simple sugars) increase triglyceride concentrations (12). In earlier studies, UK black Caribbean adults had lower dietary intakes of saturated fat and higher carbohydrate intakes (13); there is limited information for UK black African adults. UK South Asian adults have generally had lower saturated fat intake,

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whereas intakes of polyunsaturated fatty acids and complex carbohydrates have tended to be high (3, 8, 13, 14).

With increasing adaptation after migration to the United Kingdom, changes in nutrient intakes (particularly fat intakes) have been reported both in black Caribbean and South Asians, with patterns becoming closer to those of the host population (15, 16); such changes are particularly prominent among younger age groups (16). However, little is known about blood lipid and dietary patterns among UK children from different ethnic groups, which could provide important clues to emerging patterns of IHD risk in different ethnic groups in the next generation (17). We have therefore examined blood lipid and dietary macronutrient intake patterns among 9–10-y-old UK children of white European, black African, black Caribbean, and South Asian origin.

SUBJECTS AND METHODS

The Child Heart and Health Study in England (CHASE) examined the cardiovascular health of 9–10-y-old children of white European, black African, black Caribbean, and South Asian origin living in England. Full details are reported elsewhere (18). In brief, the study took place in 200 primary schools in London, Birmingham, and Leicester, which were sampled to include schools with a high prevalence of students of South Asian origin and schools with a high prevalence of students of black African or black Caribbean origin. Ethical approval was obtained from the relevant Multi-Centre Research Ethics Committee. Year 5 pupils (aged 9–10 y) were invited to participate. The investigation of blood lipids, diet, and nutrition described here was carried out in the final 85 study schools, which were surveyed during 2006 and 2007. A single research field team visited all schools in rotation. Students provided blood samples after an overnight fast for the measurement of total and HDL cholesterol and triglycerides; LDL cholesterol was obtained by using the Fredrickson-Friedewald equation (19). All blood analyses were carried out by investigators who were blind to participants' ethnicity. Height, weight, and skinfold thickness were measured; bioelectrical impedance was recorded by using the Bodystat 1500 (Bodystat Ltd, Isle of Man, United Kingdom) (18). Objective physical activity measurements were made by using Actigraph GT1M movement sensors (Actigraph, Pensacola, FL) over a 7 d period, as described in detail elsewhere (20).

Dietary intake

Dietary intake was assessed by 2 research nutritionists (ASD and MCM) by using a single, structured 24-h dietary recall (21), which followed the recommendations of the Nordic Cooperation Group of Dietary Researchers (22) and included several elements of the US Department of Agriculture (USDA) multiple pass method (23). Nutrient composition was analyzed at the Medical Research Council Human Nutrition Research Center by using the Diet In Nutrients Out (DINO) package (MRC, Cambridge, United Kingdom). Food and nutrient intakes were calculated, without knowledge of the child's ethnic status, by using the in-house food composition database based on McCance and Widdowson's *The Composition of Foods, 6th Edition* (24), supplemented by specific information on the composition of ethnic minority foods (25–27). Under- and overreporters were identified by using standard equations (28) as described elsewhere (21). Participants identified as underreporters or overreporters were included in the main analysis but excluded in specific sensitivity analyses.

Ethnicity and social class

Ethnicity was defined by using parental self-defined ethnicity for both parents or by using parentally defined child ethnicity. In a small number of participants for whom this information was not available (1.4%), child-defined place of origin of parents and grandparents was used to define ethnicity. 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." "Black African" and "'black Caribbean" are separately classified and refer to children whose parents originated in the same region; "black British" and "black other" are excluded. "South Asian" includes "Indian," "Pakistani," "Bangladeshi," and "Sri Lankan" (or a combination of these); "Indian," "Pakistani," and "Bangladeshi" groups are restricted to children whose parents both originated in the same county. The "other ethnicity" group includes all other categories of individual and mixed ethnic origins. Parents and children provided information on parental occupation, which was coded by using the SOC2000 classification (29).

Statistical methods

All analyses were carried out by using STATA version 10.1 (Stata Corp, College Station, TX). Distributions of variables were examined for normality and log transformed where necessary. Multilevel linear regression models taking account of the natural clustering of children within schools were used to provide adjusted means and ethnic differences in dietary intake, physical measures, and lipids by using XTMIXED and LINCOM commands (Stata Corp, College Station, TX). All analyses adjusted for sex, age in quartiles, month, observer (physical and dietary measurements), and day of the week (dietary measurements) as fixed effects; school was fitted as a random effect. In analyses in which the influence of dietary intake on ethnic differences in blood lipids was examined, classical measurement error models were used to allow for possible measurement error in dietary intake (CME command), based on repeat 24-h recalls collected over an average of 13 mo after initial assessment in 86 subjects. In these analyses, school was fitted as a cluster variable, because it could not be fitted as a random effect.

RESULTS

Among 3679 students invited from 85 schools, 2529 (69%) took part in the present study; participation rates were similar among white Europeans, black Africans, South Asians, and "other ethnicity" groups (69%, 70%, 71%, and 70%, respectively) and slightly lower among black Caribbeans (62%). Among these participants, 2026 (80%) fasted overnight, provided blood samples, and completed 24-h dietary recall information (mean age: 9.9 y; 95% reference range: 9.2–10.7 y; 52% girls). There were similar numbers of white European, South Asian, and other ethnicity (n = 512, 534, and 507, respectively) and smaller numbers of black Africans (n = 285) and black Caribbeans (n = 188). The demographic and measurement characteristics of

these participants were similar to those of the 503 participants with incomplete data. The proportions of children whose mothers were born in the United Kingdom were 64% for white Europeans, 6% for black Africans, 56% for black Caribbeans, 16% for South Asians, and 34% for other ethnicity. Data on mean blood lipids, physical measurements, and nutrient intakes for all boys and girls are summarized in the Supplemental Table under "Supplemental data" in the online issue.

Ethnic differences in blood lipids, physical measurements, and dietary intakes

Mean blood lipid values, physical measurements and dietary nutrient intakes are summarized for each ethnic group in **Table 1**. The corresponding differences (mean or proportional) from white Europeans are shown for black Africans, black Caribbeans and for South Asians in **Table 2**. South Asian subgroups (Indians, Pakistanis, and Bangladeshis) are presented separately in **Table 3**, with *P* values that formally test for differences between the South Asian subgroups.

Black Africans and black Caribbeans

Black African children had markedly lower mean total, LDL-cholesterol, and triglyceride concentrations than did white Europeans (Tables 1 and 2). Black African children were markedly taller than white Europeans but showed no appreciable difference in adiposity measures. They obtained markedly lower mean proportions of energy from fat and saturated fat and markedly higher proportions of energy from carbohydrates. In contrast, black Caribbean children had mean total, LDL- and HDL-cholesterol, and triglyceride concentrations similar to white Europeans. Proportions of energy obtained from fat and carbohydrate were similar to those in white Europeans; saturated fat intakes were lower. Height and adiposity patterns in black Caribbeans were similar to those observed in black Africans.

South Asians

In parallel analyses, South Asian children had mean total and LDL-cholesterol concentrations similar to those of white Europeans (Tables 1–3). Their mean HDL cholesterol was markedly lower, and triglyceride concentrations were higher. South Asian children were of similar height but had a lower ponderal index; their sum of skinfold thickness and fat mass index were similar to white Europeans. They had higher total energy intakes; the proportions of energy obtained from total fat and polyunsaturated fat were higher, whereas the proportions of energy obtained from saturated fat and carbohydrates were lower. Their n–6:n–3 ratios were similar to those of white Europeans. The differences in HDL cholesterol and triglyceride were generally observed in each of the 3 South Asian subcategories (Table 3) but appeared to be somewhat more marked among Bangladeshi children, who had the lowest HDL-cholesterol and the highest triglyceride concentrations, although these differences were not statistically significant. They also had particularly high intakes of polyunsaturated and monounsaturated fat and particularly low intakes of saturated fat and carbohydrate.

Contribution of dietary factors to ethnic differences in blood lipids

The influence of dietary factors on ethnic differences in blood lipids is shown in **Table 4** for black Africans, black Caribbeans, and South Asians by using regression models that also allow for imprecision in the measurement of dietary intake. Ethnic differences in blood lipids before adjustment for dietary factors are similar, but not identical, to differences shown in Table 2; in the

TABLE 1
Blood markers, physical measurements, and dietary intake by ethnic group[1]

	White European (n = 512)		Black African (n = 285)		Black Caribbean (n = 188)		South Asian (n = 534)		Other (n = 507)	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Age (y)	10.00	(9.96, 10.03)	9.90	(9.86, 9.95)	9.90	(9.85, 9.96)	10.02	(9.99, 10.06)	10.06	(9.94, 9.91)
Total cholesterol (mmol/L)	4.51	(4.44, 4.58)	4.36	(4.27, 4.44)	4.57	(4.46, 4.68)	4.51	(4.44, 4.58)	4.58	(4.52, 4.45)
LDL cholesterol (mmol/L)	2.62	(2.56, 2.68)	2.51	(2.43, 2.59)	2.71	(2.62, 2.81)	2.64	(2.58, 2.70)	2.70	(2.64, 2.58)
HDL cholesterol (mmol/L)	1.55	(1.52, 1.58)	1.56	(1.52, 1.60)	1.55	(1.51, 1.60)	1.48	(1.45, 1.51)	1.51	(1.53, 1.50)
Triglyceride (mmol/L)[2]	0.81	(0.78, 0.84)	0.72	(0.69, 0.76)	0.77	(0.73, 0.82)	0.93	(0.90, 0.97)	0.97	(0.86, 0.83)
Height (cm)	139.2	(138.6, 139.8)	143.2	(142.4, 144.0)	143.5	(142.5, 144.5)	138.8	(138.2, 139.5)	139.5	(139.9, 139.3)
Weight (kg)[2]	35.4	(34.7, 36.2)	38.1	(37.1, 39.2)	39.4	(38.0, 40.7)	34.2	(33.4, 34.9)	34.9	(36.3, 35.5)
Ponderal index (kg/m^3)[2]	13.2	(13.0, 13.4)	13.0	(12.8, 13.3)	13.4	(13.1, 13.7)	12.8	(12.6, 13.0)	13.0	(13.3, 13.1)
Sum of skinfold thickness (mm)[2]	41.5	(39.7, 43.4)	39.8	(37.6, 42.2)	39.4	(36.7, 42.3)	42.1	(40.2, 44.1)	44.1	(41.6, 39.8)
Fat mass index (kg/m^5)[2]	1.82	(1.75, 1.90)	1.84	(1.74, 1.94)	1.84	(1.72, 1.96)	1.87	(1.79, 1.95)	1.95	(1.91, 1.83)
Energy (kcal)	1816	(1770, 1862)	1847	(1787, 1907)	1796	(1723, 1869)	1920	(1871, 1969)	1969	(1822, 1775)
Fat (% of energy)	34.4	(33.8, 35.0)	32.7	(32.0, 33.5)	33.9	(32.9, 34.8)	35.5	(34.9, 36.1)	36.1	(33.9, 33.3)
Saturated fat (% of energy)	13.2	(12.9, 13.5)	11.8	(11.4, 12.2)	12.4	(11.9, 12.9)	12.6	(12.3, 13.0)	13.0	(12.8, 12.5)
Monounsaturated fat (% of energy)	11.4	(11.2, 11.7)	11.0	(10.6, 11.3)	11.3	(10.9, 11.7)	11.7	(11.4, 12.0)	12.0	(11.3, 11.0)
Polyunsaturated fat (% of energy)	6.3	(6.0, 6.5)	6.3	(5.9, 6.6)	6.5	(6.0, 6.9)	7.3	(7.0, 7.6)	7.6	(6.2, 5.9)
n−6:n−3[2]	8.0	(7.6, 8.5)	8.1	(7.6, 8.7)	7.7	(7.1, 8.4)	8.4	(7.9, 8.9)	8.9	(7.7, 7.3)
Carbohydrate (% of energy)	52.2	(51.6, 52.9)	53.6	(52.8, 54.4)	52.1	(51.1, 53.1)	51.1	(50.4, 51.7)	51.7	(52.0, 51.3)

[1] Values were adjusted for age quartiles, sex, observer (for physical and dietary measurements), time since last food intake (for lipids), month, and school (random effect). There were missing values for height, weight, ponderal index (n = 5), sum of skinfold thickness (n = 8), and fat mass index (n = 10).
[2] Values are geometric means for log-transformed variables.

TABLE 2
Ethnic differences (compared with white Europeans) in blood lipids, body build, and dietary intake[1]

	Black African–white European (n = 285)			Black Caribbean–white European (n = 188)			South Asian–white European (n = 534)		
	Mean difference	(95% CI)	P (no difference)	Mean difference	(95% CI)	P (no difference)	Mean difference	(95% CI)	P (no difference)
Total cholesterol (mmol/L)	−0.14	(−0.25, −0.04)	0.01	0.06	(−0.06, 0.18)	0.34	0.00	(−0.09, 0.10)	0.95
LDL cholesterol (mmol/L)	−0.10	(−0.20, −0.01)	0.03	0.09	(−0.02, 0.20)	0.10	0.03	(−0.06, 0.11)	0.53
HDL cholesterol (mmol/L)	0.01	(−0.04, 0.05)	0.78	0.00	(−0.05, 0.06)	0.95	−0.07	(−0.11, −0.03)	<0.001
Triglyceride (mmol/L)[2]	−0.11	(−0.16, −0.06)	<0.0001	−0.05	(−0.11, 0.02)	0.14	0.14	(0.09, 0.20)	<0.0001
Height (cm)	4.0	(3.0, 5.0)	<0.0001	4.3	(3.2, 5.4)	<0.0001	−0.4	(−1.2, 0.5)	0.39
Weight (kg)[2]	0.08	(0.04, 0.11)	<0.0001	0.11	(0.07, 0.16)	<0.0001	−0.04	(−0.06, −0.01)	0.02
Ponderal index (kg/m^3)[2]	−0.01	(−0.03, 0.01)	0.38	0.02	(−0.01, 0.04)	0.28	−0.03	(−0.05, −0.01)	0.01
Sum of skinfold thickness (mm)[2]	−0.04	(−0.11, 0.03)	0.26	−0.05	(−0.13, 0.03)	0.21	0.01	(−0.05, 0.08)	0.66
Fat mass index (kg/m^5)[2]	0.01	(−0.05, 0.08)	0.78	0.01	(−0.06, 0.09)	0.83	0.03	(−0.03, 0.09)	0.36
Energy (kcal)	31	(−41, 103)	0.40	−20	(−103, 63)	0.64	104	(40, 168)	0.001
Fat (% of energy)	−1.7	(−2.6, −0.7)	<0.001	−0.6	(−1.6, 0.5)	0.31	1.1	(0.2, 1.9)	0.01
Saturated fat (% of energy)	−1.4	(−1.9, −0.9)	<0.0001	−0.8	(−1.4, −0.2)	0.005	−0.6	(−1.0, −0.1)	0.01
Monounsaturated fat (% of energy)	−0.5	(−0.9, 0.0)	0.03	−0.1	(−0.6, 0.4)	0.60	0.3	(−0.1, 0.6)	0.15
Polyunsaturated fat (% of energy)	0.0	(−0.4, 0.4)	0.99	0.2	(−0.3, 0.7)	0.40	1.1	(0.7, 1.5)	<0.0001
n−6:n−3[2]	0.01	(−0.1, 0.1)	0.84	−0.03	(−0.1, 0.1)	0.46	0.04	(0.0, 0.1)	0.26
Carbohydrate (% of energy)	1.4	(0.4, 2.4)	0.007	−0.1	(−1.3, 1.0)	0.83	−1.1	(−2.0, −0.3)	0.01

[1] All ethnic differences apply to the difference from white Europeans and were adjusted for age quartiles, sex, observer (for physical and dietary measurements), time since last food intake (for lipids), month, and school (random effect). P values were derived from multilevel models based on maximum likelihood estimates. There were missing values for height, weight, ponderal index (n = 3), sum of skinfold thickness, and fat mass index (n = 4).

[2] Values are proportional differences for log-transformed variables.

TABLE 3
Ethnic differences in blood lipids, body build, and dietary intake between South Asian subgroups and white Europeans[1]

	Indian (n = 134)		Pakistani (n = 201)		Bangladeshi (n = 166)		P (no difference between South Asian subgroups)
	Mean difference	(95% CI)	Mean difference	(95% CI)	Mean difference	(95% CI)	
Total cholesterol (mmol/L)	−0.02	(−0.17, 0.12)	0.01	(−0.12, 0.13)	0.02	(−0.12, 0.16)	0.89
LDL cholesterol (mmol/L)	−0.02	(−0.14, 0.11)	0.03	(−0.09, 0.14)	0.07	(−0.05, 0.19)	0.59
HDL cholesterol (mmol/L)	−0.05	(−0.11, 0.02)	−0.05	(−0.11, 0.00)	−0.12	(−0.18, −0.06)	0.09
Triglyceride (mmol/L)[2]	0.16	(0.08, 0.25)	0.10	(0.03, 0.18)	0.20	(0.12, 0.29)	0.11
Height (cm)	−0.01	(−1.34, 1.31)	0.47	(−0.70, 1.63)	−1.39	(−2.63, −0.14)	0.03
Weight (kg)[2]	−0.03	(−0.08, 0.01)	−0.02	(−0.06, 0.02)	−0.05	(−0.09, −0.01)	0.44
Ponderal index (kg/m^3)[2]	−0.03	(−0.06, 0.00)	−0.03	(−0.05, 0.00)	−0.02	(−0.05, 0.01)	0.79
Sum of skinfold thickness (mm)[2]	0.03	(−0.06, 0.14)	0.05	(−0.03, 0.14)	−0.01	(−0.10, 0.08)	0.38
Fat mass index (kg/m^5)[2]	0.05	(−0.04, 0.14)	0.01	(−0.07, 0.08)	0.03	(−0.05, 0.11)	0.64
Energy (kcal)	55	(−43, 153)	131	(45, 217)	126	(34, 219)	0.30
Fat (% of energy)	0.48	(−0.79, 1.74)	1.01	(−0.09, 2.11)	1.94	(0.76, 3.12)	0.15
Saturated fat (% of energy)	−0.27	(−0.95, 0.40)	−0.28	(−0.87, 0.32)	−1.08	(−1.71, −0.44)	0.06
Monounsaturated fat (% of energy)	−0.36	(−0.92, 0.21)	0.05	(−0.45, 0.55)	1.27	(0.73, 1.81)	<0.0001
Polyunsaturated fat (% of energy)	0.83	(0.23, 1.42)	0.73	(0.21, 1.26)	1.70	(1.14, 2.27)	0.01
n−6:n−3[2]	0.12	(0.00, 0.25)	0.03	(−0.07, 0.14)	−0.02	(−0.12, 0.09)	0.11
Carbohydrate (% of energy)	0.29	(−1.06, 1.65)	−1.28	(−2.46, −0.10)	−2.45	(−3.72, −1.18)	0.004

[1] All ethnic differences apply to the difference from white Europeans and were adjusted for age quartiles, sex, observer (for physical and dietary measurements), time since food intake (for lipids), month, and school (random effect). Thirty-three South Asians could not be classified specifically as Indian, Pakistani, or Bangladeshi and were therefore omitted from South Asian subgroup analysis. P values represent statistical significance of heterogeneity of South Asian subgroups derived from a multilevel model by using likelihood ratio tests. There were missing values for height, weight, ponderal index (n = 2), sum of skinfold thickness, and fat mass index (n = 5).

[2] Values are proportional differences for log-transformed variables.

present analyses, school is fitted as a cluster variable and in the other tables as a random effect. Black African–white European differences in total and LDL cholesterol were effectively abolished by adjustment for saturated fat intake but were not materially affected by adjustments for other dietary macronutrients. The black African–white European difference in triglyceride was not materially affected by adjustment for dietary factors. Black Caribbean–white European lipid differences were not marked and were not materially affected by adjustment for dietary macronutrients. The South Asian–white European differences in HDL cholesterol and triglyceride were not materially affected by adjustment for intake of dietary macronutrients. Additional adjustment for height and adiposity made no difference to these findings (data not presented).

Further analyses

Ethnic differences in blood lipids and nutrient intakes were not affected by adjustment for socioeconomic status on the basis of parental occupation or parental education or by the exclusion of under- and overreporters. Additional adjustment for physical activity levels (activity counts per minute) and for lunch type (packed lunch, school dinners, or a combination) did not materially alter the results. Exclusion of participants with one or more parents who smoked did not materially affect the results. The replacement of the white European ethnic group with specifically white British children (n = 352) had no material effect on the pattern of ethnic differences in blood lipids and diet. Blood lipids, physical measurements, and dietary nutrient intakes did not differ appreciably between the "other ethnicity" group and the white European children.

DISCUSSION

Marked ethnic differences in blood lipid markers and dietary fat intakes are apparent in 9–10-y-old UK children. In some respects they match the ethnic differences reported in earlier studies (particularly in adults); in others they show important differences that suggest that patterns may be changing over time. Previous information on blood lipid and dietary patterns in black Africans is limited to the recent 2004 Health Survey for England (7), in which black African adults had markedly lower total and LDL-cholesterol concentrations than did white Europeans, as in the present study. Recent data for black Caribbeans from the same source (7) showed similar total and LDL-cholesterol concentrations in black Caribbean and white European adults, which is consistent with the present results. However, these patterns contrast with those reported for the 1980s and early 1990s, in which total and LDL-cholesterol concentrations in black Caribbeans were markedly lower (>0.5 mmol/L) than in white Europeans (3, 4, 6, 30); this change probably reflects a rise in total and LDL-cholesterol concentrations in black Caribbeans (7). Again, whereas HDL-cholesterol concentrations in black Caribbeans were similar to those of white Europeans both in the present study and in adults in the 2004 Health Survey for England (7), HDL-cholesterol concentrations had previously been higher in black Caribbean adults (0.1–0.2 mmol/L) during the 1980s and 1990s (3, 4, 30); this change may well reflect rising HDL-cholesterol concentrations in white Europeans (7). The slightly lower triglyceride concentrations in black Caribbean children are consistent with recent patterns in adults (7), although the adult differences appear to be slightly less marked than those in earlier studies (3, 4, 30). Although saturated fat intakes in black Caribbean children in the present study were

TABLE 4
Ethnic differences in blood lipids: effect of adjustment for dietary intake by using classical measurement error models[1]

	Cholesterol			LDL cholesterol			HDL cholesterol			Triglyceride[2]		
Dietary adjustment	Difference	(95% CI)	*P*	Difference	(95% CI)	*P*	Difference	(95% CI)	*P*	Difference	(95% CI)	*P*
Black African–white European differences (*n* = 285)												
None	−0.14	(−0.27, −0.02)	0.02	−0.10	(−0.20, 0.00)	0.05	0.01	(−0.03, 0.05)	0.77	−0.11	(−0.16, −0.06)	<0.001
Saturated fat (% of energy)	0.03	(−0.21, 0.28)	0.80	0.03	(−0.16, 0.22)	0.74	0.05	(−0.02, 0.13)	0.15	−0.15	(−0.22, −0.08)	<0.001
Monounsaturated fat (% of energy)	−0.15	(−0.27, −0.03)	0.01	−0.11	(−0.21, −0.02)	0.02	0.02	(−0.02, 0.07)	0.33	−0.14	(−0.20, −0.08)	<0.0001
Polyunsaturated fat (% of energy)	−0.14	(−0.27, −0.02)	0.02	−0.10	(−0.20, 0.00)	0.05	0.01	(−0.03, 0.05)	0.77	−0.11	(−0.16, −0.05)	<0.001
Carbohydrate (% of energy)	−0.13	(−0.25, −0.01)	0.03	−0.09	(−0.19, 0.00)	0.06	0.01	(−0.03, 0.06)	0.49	−0.12	(−0.18, −0.07)	<0.0001
Black Caribbean–white European differences (*n* = 188)												
None	0.06	(−0.04, 0.16)	0.27	0.09	(0.00, 0.18)	0.06	0.00	(−0.05, 0.06)	0.91	−0.04	(−0.10, 0.02)	0.18
Saturated fat (% of energy)	0.16	(−0.01, 0.32)	0.07	0.16	(0.03, 0.30)	0.02	0.03	(−0.04, 0.10)	0.40	−0.07	(−0.14, 0.01)	0.08
Monounsaturated fat (% of energy)	0.06	(−0.04, 0.16)	0.27	0.09	(0.00, 0.18)	0.06	0.00	(−0.05, 0.06)	0.90	−0.04	(−0.11, 0.03)	0.23
Polyunsaturated fat (% of energy)	0.07	(−0.03, 0.18)	0.19	0.10	(0.01, 0.19)	0.04	0.00	(−0.05, 0.06)	0.89	−0.04	(−0.10, 0.02)	0.22
Carbohydrate (% of energy)	0.06	(−0.05, 0.16)	0.29	0.09	(0.00, 0.18)	0.06	0.00	(−0.05, 0.06)	0.97	−0.04	(−0.10, 0.03)	0.23
South Asian–white European differences (*n* = 534)												
None	0.01	(−0.10, 0.11)	0.91	0.03	(−0.05, 0.11)	0.51	−0.08	(−0.11, −0.04)	<0.0001	0.16	(0.09, 0.22)	<0.0001
Saturated fat (% of energy)	0.07	(−0.08, 0.22)	0.34	0.08	(−0.04, 0.19)	0.18	−0.06	(−0.10, −0.01)	0.01	0.14	(0.07, 0.21)	<0.0001
Monounsaturated fat (% of energy)	0.01	(−0.10, 0.11)	0.89	0.03	(−0.05, 0.12)	0.43	−0.08	(−0.12, −0.04)	<0.0001	0.17	(0.10, 0.25)	<0.0001
Polyunsaturated fat (% of energy)	0.06	(−0.09, 0.21)	0.46	0.07	(−0.05, 0.19)	0.24	−0.07	(−0.11, −0.03)	<0.001	0.17	(0.10, 0.26)	<0.0001
Carbohydrate (% of energy)	0.00	(−0.11, 0.10)	0.93	0.02	(−0.06, 0.10)	0.61	−0.08	(−0.12, −0.05)	<0.0001	0.17	(0.10, 0.24)	<0.0001

[1] Values were adjusted for sex, age quartiles, month, and time since last intake of food, with clustering for school (robust SEs) and measurement error in dietary intake variable by using classical measurement error modeling with 89 replicates. *P* values were derived from classical measurement error models based on maximum likelihood estimates.

[2] Values are proportional differences for log-transformed variables.

marginally lower than those in white Europeans (by 0.8%), this may well reflect a change from earlier adult studies, in which saturated fat intakes were markedly lower (≈2.5% less) in black Caribbeans (13, 16). In South Asians, the higher triglyceride and lower HDL-cholesterol concentrations observed in the present study are consistent with both recent (6, 7) and earlier (3, 8, 9, 30–32) studies. However, the similar total and LDL-cholesterol concentrations observed in South Asian and white European children, although consistent with recent adult patterns in the 2004 Health Survey for England (7), differ from adult patterns in the 1980s and 1990s, when total and LDL-cholesterol concentrations in South Asians were markedly lower than those in white Europeans, by ≤0.8 mmol/L (4, 9, 31); differences in children were smaller (33). These changes may well reflect growing similarity in saturated fat intakes among South Asians and white Europeans. In studies in the 1980s and 1990s, the proportions of energy obtained from saturated fat were ≥3% lower in South Asians (8, 13, 14); the corresponding difference in the present study was 0.5%. This increasing similarity may reflect both increasing saturated fat intake in South Asians and a decline in white European populations (8, 13, 14).

The present study provided a unique resource for examining ethnic differences in childhood diet and blood lipids with high statistical power and precision in representative UK black Africans, black Caribbeans, and South Asians of Indian, Pakistani, and Bangladeshi origin. Comparisons of nutritional composition were strengthened by ensuring that each school included white European children for comparison (to limit the scope for confounding), and all analyses adjusted for the effect of school. Although response rates were only 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 blood lipids and dietary composition observed. Although the use of a single, structured 24-h recall provides an imprecise estimate of dietary intake in individuals, it provides a valid and unbiased estimate of dietary intake (34). The validity of the current data, discussed in detail elsewhere (21), is supported by the directions of associations between dietary macronutrient intakes and blood lipids (AS Donin, CM Nightingale, CG Owen, et al, unpublished data, 2010), which are consistent with those in a previous systematic review of the data from randomized controlled trials (12). There is also close agreement of nutrient intakes with the 2000 National Diet and Nutrition Survey, in which prospective, 7-d, weighed food diaries were used to assess food intakes (35).

Of the ethnic minority groups studied here, only black Africans have a blood lipid profile which, if sustained, is likely to provide protection against IHD in the next generation. The blood lipid profile in UK black Caribbeans is unlikely to offer appreciable protection against IHD risk, unlike the earlier pattern of lower total, LDL-cholesterol, and triglyceride concentrations and higher HDL-cholesterol concentrations. If sustained, these lipid patterns could lead to the loss of previously lower IHD levels in black Caribbean adults (1, 2). These lipid patterns, which are increasingly similar to the general population, have already been identified in young Caribbean adults living in the United Kingdom and linked to recent behavioral changes, particularly in diet (higher fat intakes), rather than to genetic factors (16, 36). The potential importance of recent dietary adaptation is further emphasized in the present study by preliminary analyses showing that black African and black Caribbean children whose mothers were born in the United Kingdom had higher saturated fat intakes and LDL-cholesterol concentrations than did those whose mothers were not born in the United Kingdom. The blood lipid profile in UK South Asians is likely to be associated with higher IHD risk. This is especially the case for the Bangladeshi children, who had the lowest HDL cholesterol and highest triglycerides among the South Asians. The disappearance of the lower total and LDL-cholesterol concentrations observed in South Asians in earlier studies could well accentuate further the higher IHD rates already observed in South Asian adults during the past 2 decades (1, 2).

The lower total and LDL cholesterol observed in black African children in the present study could be explained by their markedly lower dietary saturated fat intake. The similar concentrations of total and LDL cholesterol in black Caribbeans and South Asian children compared with white Europeans were accompanied by similar, or slightly lower, saturated fat intakes. These findings are broadly consistent with the evidence on the influence of saturated fat intake on total and LDL-cholesterol concentrations reported in earlier studies (12). However, the higher triglyceride and lower HDL-cholesterol concentrations among South Asians do not appear to be explained by ethnic differences in dietary fat and carbohydrate intake, a finding consistent with earlier reports in UK adults (3, 8), although at variance with a recent report from Canada in which high triglyceride and low HDL in South Asians could be partly accounted for by higher carbohydrate intake (37). In the present study population, the high-triglyceride–low-HDL cholesterol pattern is likely to reflect a greater degree of insulin resistance, which is marked both in South Asian adults (7, 9, 38) and children (33, 39) and has been described in the current study population, particularly in Bangladeshis (18). Similarly, the lower triglyceride concentrations in black African children do not appear to be explained by dietary differences.

The dietary patterns of black African children, which in the present study have a greater emphasis on carbohydrates (particularly rice and pasta) than do those of white Europeans, are consistent with recent evidence that rice consumption is becoming the predominant carbohydrate source in West African diets (40). Adherence to this dietary pattern is likely to reflect the relatively recent immigration of this population group, in which most parents (95%) were born outside the United Kingdom. In the longer established black Caribbean population, in which most parents (62%) were born in the United Kingdom, a continued dietary emphasis on rice, pasta, and vegetables was accompanied by higher meat consumption, which could contribute to the higher saturated fat intakes and total and LDL-cholesterol concentrations. In the South Asian population, dietary composition also emphasized high intakes of pasta and rice, with nonleafy vegetables, milk, and fats; intake of fruit was limited, particularly for Bangladeshis. However, meat intake was similar to that for white Europeans, which could contribute to the increasingly similar saturated fat intakes among South Asian children.

In conclusion, among the ethnic groups studied, only black African children have a lipid profile that is likely to be protective against future IHD risk. The UK black African population is likely to benefit from maintaining these dietary patterns; wider adoption of their dietary patterns (high in pasta and rice, vegetables, and fruit; low in meat and sugar intake) would also be

relevant for IHD prevention in the general population, as suggested elsewhere (17). Changes in the dietary patterns of UK black Caribbeans and UK South Asians have occurred, with adverse effects on their blood lipid profiles. Efforts to limit the loss of traditional dietary patterns, or to modify the newly adopted patterns, could help to control IHD risk in these population groups in the next generation.

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