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)\(^1\)–\(^4\)

Angela S Donin, Claire M Nightingale, Christopher G Owen, Alicja R Rudnicka, Mary C McNamara, Celia J Prynne, Alison M Stephen, Derek G Cook, and Peter H Whincup

**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* 2010;92:776–83.

**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 concentrations (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.

---

1 From the Division of Community Health Sciences, St George’s, University of London, London, United Kingdom (ASD, CMN, CGO, ARR, MCC, DGC, and PHW), and the Medical Research Council, Human Nutrition Research, Cambridge, United Kingdom (CJP and AMS).

2 Supported by the Wellcome Trust (grant no. 068362/Z/02/Z), the British Heart Foundation (grant no. PG06/003), and the Medical Research Council National Prevention Research Initiative (NPRI) (grant no. GO501295). This phase of the NPRI received support from the following organizations: the British Heart Foundation; Cancer Research UK; the Department of Health; Diabetes UK; the Economic and Social Research Council; the Medical Research Council; the Health and Social Care Research and Development Office for Northern Ireland; the Chief Scientist Officer, Scottish Government Health Directorate; the Welsh Assembly Government; the Food Standards Agency; and the World Cancer Research Fund. ASD is supported by a British Heart Foundation PhD Studentship (ref. FS/08/022/24946).

3 Present address for MC McNamara: Food Standards Agency, London, WC2B 6NH, United Kingdom.

4 Address correspondence to AS Donin, Division of Community Health Sciences, St George’s, University of London, Cranmer Terrace, London, SW17 0RE, United Kingdom. E-mail: adonin@sgul.ac.uk.

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 using Actigraph GT1M 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 country. 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).
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 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

<table>
<thead>
<tr>
<th></th>
<th>White European (n = 512)</th>
<th>Black African (n = 285)</th>
<th>Black Caribbean (n = 188)</th>
<th>South Asian (n = 534)</th>
<th>Other (n = 507)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>10.00 (9.96, 10.03)</td>
<td>9.90 (9.86, 9.95)</td>
<td>9.90 (9.85, 9.96)</td>
<td>10.02 (9.99, 10.06)</td>
<td>10.06 (9.94, 9.91)</td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>4.51 (4.44, 4.58)</td>
<td>4.36 (4.27, 4.44)</td>
<td>4.57 (4.46, 4.68)</td>
<td>4.51 (4.44, 4.58)</td>
<td>4.58 (4.52, 4.45)</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>2.62 (2.56, 2.68)</td>
<td>2.51 (2.43, 2.59)</td>
<td>2.71 (2.62, 2.81)</td>
<td>2.64 (2.58, 2.70)</td>
<td>2.70 (2.64, 2.58)</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>1.55 (1.52, 1.58)</td>
<td>1.56 (1.52, 1.60)</td>
<td>1.55 (1.51, 1.60)</td>
<td>1.48 (1.45, 1.51)</td>
<td>1.51 (1.53, 1.50)</td>
</tr>
<tr>
<td>Triglyceride (mmol/L)</td>
<td>0.81 (0.78, 0.84)</td>
<td>0.72 (0.69, 0.76)</td>
<td>0.77 (0.73, 0.82)</td>
<td>0.93 (0.90, 0.97)</td>
<td>0.97 (0.86, 0.83)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>139.2 (138.6, 139.8)</td>
<td>143.2 (142.4, 144.0)</td>
<td>143.5 (142.5, 144.5)</td>
<td>138.8 (138.2, 139.5)</td>
<td>139.5 (139.9, 139.3)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>35.4 (34.7, 36.2)</td>
<td>38.1 (37.1, 39.2)</td>
<td>39.4 (38.0, 40.7)</td>
<td>34.2 (33.4, 34.9)</td>
<td>34.9 (36.3, 35.5)</td>
</tr>
<tr>
<td>Ponderal index (kg/m^3)</td>
<td>13.2 (13.0, 13.4)</td>
<td>13.0 (12.8, 13.3)</td>
<td>13.4 (13.1, 13.7)</td>
<td>12.8 (12.6, 13.0)</td>
<td>13.0 (13.3, 13.1)</td>
</tr>
<tr>
<td>Sum of skinfold thickness (mm)</td>
<td>41.5 (39.7, 43.4)</td>
<td>39.8 (37.6, 42.2)</td>
<td>39.4 (36.7, 42.5)</td>
<td>42.1 (40.2, 44.1)</td>
<td>44.1 (41.6, 39.8)</td>
</tr>
<tr>
<td>Fat mass index (kg/m^2)</td>
<td>1.82 (1.75, 1.90)</td>
<td>1.84 (1.74, 1.94)</td>
<td>1.84 (1.72, 1.96)</td>
<td>1.87 (1.79, 1.95)</td>
<td>1.95 (1.91, 1.83)</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1816 (1770, 1862)</td>
<td>1847 (1787, 1907)</td>
<td>1796 (1723, 1869)</td>
<td>1920 (1871, 1969)</td>
<td>1969 (1822, 1775)</td>
</tr>
<tr>
<td>Fat (% of energy)</td>
<td>34.4 (33.8, 35.0)</td>
<td>32.7 (32.0, 33.5)</td>
<td>33.9 (32.9, 34.8)</td>
<td>35.5 (34.9, 36.1)</td>
<td>36.1 (33.9, 33.3)</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>13.2 (12.9, 13.5)</td>
<td>11.8 (11.4, 12.2)</td>
<td>12.4 (11.9, 12.9)</td>
<td>12.6 (12.3, 13.0)</td>
<td>13.0 (12.8, 12.5)</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>11.4 (11.2, 11.7)</td>
<td>11.0 (10.6, 11.3)</td>
<td>11.3 (10.9, 11.7)</td>
<td>11.7 (11.4, 12.0)</td>
<td>12.0 (11.3, 11.0)</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>6.3 (6.0, 6.5)</td>
<td>6.3 (5.9, 6.6)</td>
<td>6.5 (6.0, 6.9)</td>
<td>7.3 (7.0, 7.6)</td>
<td>7.6 (6.2, 5.9)</td>
</tr>
<tr>
<td>n–6:n–3</td>
<td>8.0 (7.6, 8.5)</td>
<td>8.1 (7.6, 8.7)</td>
<td>7.7 (7.1, 8.4)</td>
<td>8.4 (7.9, 8.9)</td>
<td>8.9 (7.7, 7.3)</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>52.2 (51.6, 52.9)</td>
<td>53.6 (52.8, 54.4)</td>
<td>52.1 (51.1, 53.1)</td>
<td>51.1 (50.4, 51.7)</td>
<td>51.7 (52.0, 51.3)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Black African–white European (n = 285)</th>
<th>Black Caribbean–white European (n = 188)</th>
<th>South Asian–white European (n = 534)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean difference (95% CI)</td>
<td>Mean difference (95% CI)</td>
<td>Mean difference (95% CI)</td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>-0.14 (-0.25, -0.04)</td>
<td>0.06 (-0.06, 0.18)</td>
<td>0.00 (-0.09, 0.10)</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>-0.10 (-0.20, -0.01)</td>
<td>0.09 (-0.02, 0.20)</td>
<td>0.03 (-0.06, 0.11)</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>0.01 (-0.04, 0.05)</td>
<td>0.00 (-0.05, 0.06)</td>
<td>-0.07 (-0.11, -0.03)</td>
</tr>
<tr>
<td>Triglyceride (mmol/L)</td>
<td>-0.11 (-0.16, -0.06)</td>
<td>-0.05 (-0.11, 0.02)</td>
<td>0.14 (0.09, 0.20)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>4.0 (3.0, 5.0)</td>
<td>4.3 (3.2, 5.4)</td>
<td>-4.0 (-1.2, 0.5)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>0.08 (0.04, 0.11)</td>
<td>0.11 (0.07, 0.16)</td>
<td>-0.04 (-0.06, -0.01)</td>
</tr>
<tr>
<td>Ponderal index (kg/m^2)</td>
<td>-0.01 (-0.03, 0.01)</td>
<td>0.02 (-0.01, 0.04)</td>
<td>-0.03 (-0.05, -0.01)</td>
</tr>
<tr>
<td>Sum of skinfold thickness (mm)</td>
<td>-0.04 (-0.11, 0.03)</td>
<td>-0.05 (-0.13, 0.03)</td>
<td>0.01 (-0.05, 0.08)</td>
</tr>
<tr>
<td>Fat mass index (kg/m^2)</td>
<td>0.01 (-0.05, 0.08)</td>
<td>0.01 (-0.06, 0.09)</td>
<td>0.03 (-0.03, 0.09)</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>31 (-41, 103)</td>
<td>-20 (-103, 63)</td>
<td>104 (40, 168)</td>
</tr>
<tr>
<td>Fat (% of energy)</td>
<td>-1.7 (-2.6, -0.7)</td>
<td>-0.6 (-1.6, 0.5)</td>
<td>1.1 (0.2, 1.9)</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>-1.4 (-1.9, -0.9)</td>
<td>-0.8 (-1.4, -0.2)</td>
<td>-0.6 (-1.0, -0.1)</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>-0.5 (-0.9, 0.0)</td>
<td>-0.1 (-0.6, 0.4)</td>
<td>0.3 (-0.1, 0.6)</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>0.0 (-0.4, 0.4)</td>
<td>0.2 (-0.3, 0.7)</td>
<td>1.1 (0.7, 1.5)</td>
</tr>
<tr>
<td>n-6/n-3 ratio</td>
<td>0.01 (-0.1, 0.1)</td>
<td>-0.03 (-0.1, 0.1)</td>
<td>0.04 (0.0, 0.1)</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>1.4 (0.4, 2.4)</td>
<td>-0.1 (-1.3, 1.0)</td>
<td>-1.1 (-2.0, -0.3)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Indian (n = 134)</th>
<th>Pakistani (n = 201)</th>
<th>Bangladeshi (n = 166)</th>
<th>P (no difference between South Asian subgroups)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethnic differences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>-0.02 (-0.17, 0.12)</td>
<td>0.01 (-0.12, 0.13)</td>
<td>0.02 (-0.12, 0.16)</td>
<td>0.89</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>-0.02 (-0.14, 0.11)</td>
<td>0.03 (-0.09, 0.14)</td>
<td>0.07 (-0.05, 0.19)</td>
<td>0.59</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>-0.05 (-0.11, 0.02)</td>
<td>-0.05 (-0.11, 0.00)</td>
<td>-0.12 (-0.18, -0.06)</td>
<td>0.09</td>
</tr>
<tr>
<td>Triglyceride (mmol/L) 1/2</td>
<td>0.16 (0.08, 0.25)</td>
<td>0.10 (0.03, 0.18)</td>
<td>0.20 (0.12, 0.29)</td>
<td>0.11</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>-0.01 (-1.34, 1.31)</td>
<td>0.47 (-0.70, 1.63)</td>
<td>-1.39 (-2.63, -0.14)</td>
<td>0.03</td>
</tr>
<tr>
<td>Weight (kg) 1/2</td>
<td>-0.03 (-0.08, 0.01)</td>
<td>-0.02 (-0.06, 0.02)</td>
<td>-0.05 (-0.09, -0.01)</td>
<td>0.44</td>
</tr>
<tr>
<td>Ponderal index (kg/m2) 1/2</td>
<td>-0.03 (-0.06, 0.00)</td>
<td>-0.03 (-0.05, 0.00)</td>
<td>-0.02 (-0.05, 0.01)</td>
<td>0.79</td>
</tr>
<tr>
<td>Sum of skinfold thickness (mm) 1/2</td>
<td>0.03 (-0.06, 0.14)</td>
<td>0.05 (-0.03, 0.14)</td>
<td>-0.01 (-0.10, 0.08)</td>
<td>0.38</td>
</tr>
<tr>
<td>Fat mass index (kg/m2) 1/2</td>
<td>0.05 (-0.04, 0.14)</td>
<td>0.01 (-0.07, 0.08)</td>
<td>0.03 (-0.05, 0.11)</td>
<td>0.64</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>55 (-43, 153)</td>
<td>131 (45, 217)</td>
<td>126 (34, 219)</td>
<td>0.30</td>
</tr>
<tr>
<td>Fat (% of energy)</td>
<td>0.48 (-0.79, 1.74)</td>
<td>1.01 (-0.09, 2.11)</td>
<td>1.94 (0.76, 3.12)</td>
<td>0.15</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>-0.27 (-0.95, 0.40)</td>
<td>-0.28 (-0.87, 0.32)</td>
<td>-1.08 (-1.71, -0.44)</td>
<td>0.06</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>-0.36 (-0.92, 0.21)</td>
<td>0.05 (-0.45, 0.55)</td>
<td>1.27 (0.73, 1.81)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>0.83 (0.23, 1.42)</td>
<td>0.73 (0.21, 1.26)</td>
<td>1.70 (1.14, 2.27)</td>
<td>0.01</td>
</tr>
<tr>
<td>n-6–n-3 1/2</td>
<td>0.12 (0.00, 0.25)</td>
<td>0.03 (-0.07, 0.14)</td>
<td>-0.02 (-0.12, 0.09)</td>
<td>0.11</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>0.29 (-1.06, 1.65)</td>
<td>-1.28 (-2.46, -0.10)</td>
<td>-2.45 (-3.72, -1.18)</td>
<td>0.004</td>
</tr>
</tbody>
</table>

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). 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.

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 Caribbean 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

<table>
<thead>
<tr>
<th>Dietary adjustment</th>
<th>Cholesterol</th>
<th>LDL cholesterol</th>
<th>HDL cholesterol</th>
<th>Triglyceride</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Difference</td>
<td>(95% CI)</td>
<td>P</td>
<td>Difference</td>
</tr>
<tr>
<td>Black African–white European differences (n = 285)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>-0.14 (-0.27, -0.02)</td>
<td>0.02</td>
<td>-0.10 (-0.20, 0.00)</td>
<td>0.05</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>0.03 (-0.21, 0.28)</td>
<td>0.80</td>
<td>0.03 (-0.16, 0.22)</td>
<td>0.74</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>-0.15 (-0.27, -0.03)</td>
<td>0.01</td>
<td>-0.11 (-0.21, -0.02)</td>
<td>0.02</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>-0.14 (-0.27, -0.02)</td>
<td>0.02</td>
<td>-0.10 (-0.20, 0.00)</td>
<td>0.05</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>-0.13 (-0.25, -0.01)</td>
<td>0.03</td>
<td>-0.09 (-0.19, 0.00)</td>
<td>0.06</td>
</tr>
<tr>
<td>Black Caribbean–white European differences (n = 188)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0.06 (-0.04, 0.16)</td>
<td>0.27</td>
<td>0.09 (0.00, 0.18)</td>
<td>0.06</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>0.16 (-0.01, 0.32)</td>
<td>0.07</td>
<td>0.16 (0.03, 0.30)</td>
<td>0.02</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>0.06 (-0.04, 0.16)</td>
<td>0.27</td>
<td>0.09 (0.00, 0.18)</td>
<td>0.06</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>0.07 (-0.03, 0.18)</td>
<td>0.19</td>
<td>0.10 (0.01, 0.19)</td>
<td>0.04</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>0.06 (-0.05, 0.16)</td>
<td>0.29</td>
<td>0.09 (0.00, 0.18)</td>
<td>0.06</td>
</tr>
<tr>
<td>South Asian–white European differences (n = 534)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0.01 (-0.10, 0.11)</td>
<td>0.91</td>
<td>0.03 (-0.05, 0.11)</td>
<td>0.51</td>
</tr>
<tr>
<td>Saturated fat (% of energy)</td>
<td>0.07 (-0.08, 0.22)</td>
<td>0.34</td>
<td>0.08 (-0.04, 0.19)</td>
<td>0.18</td>
</tr>
<tr>
<td>Monounsaturated fat (% of energy)</td>
<td>0.01 (-0.10, 0.11)</td>
<td>0.89</td>
<td>0.03 (-0.05, 0.12)</td>
<td>0.43</td>
</tr>
<tr>
<td>Polyunsaturated fat (% of energy)</td>
<td>0.06 (-0.09, 0.21)</td>
<td>0.46</td>
<td>0.07 (-0.05, 0.19)</td>
<td>0.24</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>0.00 (-0.11, 0.10)</td>
<td>0.93</td>
<td>0.02 (-0.06, 0.10)</td>
<td>0.61</td>
</tr>
</tbody>
</table>

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 also emphasized high intakes of pasta and rice, with nonleafy vegetables, milk, and fats; intake of fruit was limited, 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 intake. 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 Bangladeshi. 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 sug-
gested 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 pop-
ulation groups in the next generation.

We are grateful to Cathy McKay, Miranda Price, Andrea Wathern, and
Rahat Rafiq for their work on the organization of the CHASE study and
to the schools, parents, and children who participated in the CHASE study.
We also thank the dietary assessment team at the Medical Research Council
Human Nutrition Research Center, particularly Sarah-Jane Flaherty and
Jonathan Last for their diligent work in coding the dietary recalls from
the study.

The authors' responsibilities were as follows—PHW, DGC, AMS, and
ASD: study concept and design; ASD, MCM, PHW, DGC, AMS, CIP, and
CGO: acquisition of data; ASD, CMN, PHW, DGC, CIP, AMS, ARR, and
CGO: analysis and interpretation of the data; ASD and PHW: drafting
of the manuscript; ASD, CMN, CGO, ARR, MCM, CIP, AMS, DGC, and
PHW: critical revision of the manuscript; PHW, DGC, AMS, and CGO:
obtained funding; and PHW, DGC, and AMS: study supervision. The authors
did not declare any conflicts of interest.

REFERENCES

1. Wild S, McKeigue P. Cross sectional analysis of mortality by country of
2. Wild SH, Fischbacher C, Brock A, Griffiths C, Bhopal R. Mortality from
certain causes and circulatory disease by country of birth in England and
teristics relevant for coronary heart disease in men of Indian, West
4. Cappuccio FP, Cook DG, Atkinson RW, Strazzullo P. Prevalence, de-
tection, and management of cardiovascular risk factors in different ethnic
5. Chaturvedi N, McKeigue PM, Marmot MG. Relationship of glucose
intolerance to coronary risk in Afro-Caribbeans compared with Euro-
6. Office for National Statistics. Health Survey for England: the health of
health of minority ethnic groups. London, United Kingdom: National Centre
8. McKeigue PM, Marmot MG, Adelstein AM, et al. Diet and risk factors
for coronary heart disease in Asians in northwest London. Lancet 1985;
2:1086–90.
risk markers for ischaemic heart disease in Asian men and non-Asian in
cular mortality by age, sex, and blood pressure: a meta-analysis of in-
dividual data from 61 prospective studies with 55,000 vascular deaths.
prevention of cardiovascular disease: systematic review. BMJ 2001;322:
757–63.
12. Mensink RP, Zock PL, Kester AD, Katan MB. Effects of dietary fatty
acids and carbohydrates on the ratio of serum total to HDL cholesterol and
on serum lipids and apolipoproteins: a meta-analysis of 60 con-
Pakistani, European and African-Caribbean community in inner city
14. Sevak L, McKeigue PM, Marmot MG. Relationship of hyperinsulinaemia
to dietary intake in South Asian and European men. Am J Clin Nutr
lution of atherogenic diets in South Asian and Italian women after
African-Caribbeans in Britain: a migrant population and its second
17. Landman J, Cruickshank JK. A review of ethnicity, health and
nutrition-related diabetes in relation to migration in the United King-
differences in type 2 diabetes precursors in the UK: the Child
Heart and Health Study in England (CHASE Study). PLoS Med 2010;7:
e1000263.
19. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concen-
tration of low-density lipoprotein cholesterol in plasma, without use of
20. Owen CG, Nightingale CM, Rudnicka AR, Cook DG, Ekelund U,
Whincup PH. Ethnic and gender differences in physical activity levels
among 9-10-year-old children of white European, South Asian and
African-Caribbean origin: the Child Heart Health Study in England
the diets of South Asian, black African-Caribbean and white European
children in the United Kingdom: The Child Heart and Health Study in
22. Cameron ME, van Staveren WA. Manual on methodology for food con-
23. Whitty CJM, Ingersen LA, Mosleh AJ. Accuracy of dietary intake
data obtained by the USDA five-step multiple-pass method in men: an observa-
24. Food Standards Agency. McCance and Widdowson’s The Composition
of Foods, Sixth summary edition. Cambridge, United Kingdom: Royal
25. Tan SF, Wenlock RW, Buss DH. Second supplement to McCance and
Widdowson’s The composition of foods: immigrant foods. London.
26. Hobhouse W. The classic 1000 Indian recipes. London, United King-
intake data using fundamental principles of energy physiology. 1. Derivation of cut-off limits to identify under-recording. Eur J Clin Nutr
30. McKeigue PM, Marmot MG, Sydercombe Court YD, Cottier DE,
Rahman S, Niemersma RA. Diabetes, hyperinsulinaemia, and coronary
Differences in biological risk factors for cardiovascular disease between
different ethnic groups in the Whitehall II study. Atherosclerosis 1999;142:
279–86.
differences in cardiovascular risk: cross sectional comparison of British
33. Bingham SA, Nelson M. Assessment of food consumption and nutrient
intake. In: Margetts BM, Nelson M, eds. Design concepts in nutritional
epidemiology. Oxford, United Kingdom: Oxford Medical Publications,
aged 4 to 18 years. London, United Kingdom: The Stationary Office,
2000.
35. Abbots J, Harding S, Cruickshank K. Cardiovascular risk profiles in
UK-born Caribbeans and Irish living in England and Wales. Athero-
36. Merchant AT, Anand SS, Kelemen LE, et al. Carbohydrate intake and
37. Mather HM, Keen H. The Southall Diabetes Survey: prevalence of
in insulin resistance and body composition in United Kingdom adoles-
39. Basorun JO. Analysis of the relationships of factors affecting rice con-
sumption in a targeted region in Ekiti state, Nigeria. J Appl Quant