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Ethnic and Socioeconomic Influences on Childhood Blood Pressure: The Child Heart and Health Study in England (CHASE)

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Abstract

Objectives—Compared to UK white European adults, UK black African-Caribbean adults have higher mean systolic (SBP) and diastolic (DBP) blood pressure; UK South Asian adults have higher mean DBP but lower SBP. Information on blood pressure (BP) in UK children from different ethnic groups is limited. The aim of this study was to compare BP levels in UK children of black African-Caribbean, South Asian and white European origin.

Methods—BP and body build were measured in 5,666 children in a cross-sectional study of UK primary school children of South Asian, black African-Caribbean, and white European origin aged 9-10 years. Ethnic and socioeconomic differences in BP were obtained from multilevel linear regression models.

Results—After adjustment for height and adiposity, black African-Caribbean children had lower mean SBP than white Europeans (difference 1.62 mmHg, 95% CI 0.86, 2.38 mmHg), while mean DBP was similar (difference 0.58 mmHg, 95%CI -0.12, 1.28 mmHg). The lower SBP was particularly marked in black African rather than Caribbean children (p=0.002). South Asian children had lower mean SBP (difference 1.10 mmHg, 95%CI 0.34, 1.86 mmHg) than white Europeans and higher mean DBP (difference 1.07 mmHg, 95%CI 0.37, 1.76 mmHg). The higher mean DBP was particularly marked among Indian and Bangladeshi, rather than Pakistani, children (p=0.01). BP was unrelated to socioeconomic circumstances; ethnic differences in BP were not affected by socioeconomic adjustment.

Conclusions—A BP pattern similar to that in adults is present in UK South Asian but not in UK black African-Caribbean children at 9-10 years.

Condensed abstract—UK black African-Caribbean adults have higher mean SBP and DBP; UK South Asian adults have higher mean DBP but lower SBP. Ethnic and socioeconomic differences in blood pressure were examined in a cross-sectional study of 5,666 UK primary school children aged 9-10 years of South Asian, black African-Caribbean, and white European origin. UK South Asian children showed a similar pattern to adult South Asians; black African-

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Caribbean children did not. Blood pressure was unrelated to socioeconomic circumstances. Adult blood pressure differences emerge at different ages in different ethnic groups.

Keywords

ethnic groups; cardiovascular diseases; blood pressure; cross-sectional studies; child; England

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Introduction

In the UK, there are marked differences in adult cardiovascular disease (CVD) mortality between ethnic groups. UK black Africans and black Caribbeans have higher stroke mortality than white Europeans but lower coronary heart disease (CHD) mortality [1, 2]. UK South Asians have higher risks of stroke and CHD than white Europeans [1-3]. Raised adult blood pressure is a major risk factor for CHD and stroke [4]. Individual studies and systematic reviews have concluded that UK black Africans and black Caribbeans have higher systolic (SBP) and diastolic blood pressure (DBP) than white Europeans in adulthood [5]. UK South Asians, in contrast, have higher DBP but lower SBP than white Europeans, with heterogeneity reported among South Asian groups; specifically Bangladeshi adults tend to have lower SBP and DBP than Indians and Pakistanis [6].

Childhood blood pressure is an important precursor of adult blood pressure and cardiovascular risk. Blood pressure tracks with increasing strength from early childhood [7] and population-wide differences in blood pressure may emerge before adult life [8]. However, the extent to which ethnic differences in blood pressure in the UK are established in childhood remains uncertain. A recent review [9] found that only a few studies had measured blood pressure in pre-pubertal UK children from different ethnic groups with inconsistent results between studies and with limited numbers of children representing each ethnic group.

We have therefore examined ethnic differences in blood pressure in a large study of 9-10 year-old children with similar numbers of participants of white European, South Asian and black African and Caribbean origin. In the analysis, we have particularly examined the influence of height and adiposity (both important predictors of blood pressure levels in children [8]) and socioeconomic circumstances (previously proposed to explain ethnic differences in cardiovascular risk [10, 11]) on ethnic differences in childhood blood pressure. Fat mass index and skinfold thickness have been used as markers of adiposity because they have greater validity in multi-ethnic populations than body mass index [12]. Following other investigators, we have taken a multidimensional approach to socioeconomic circumstances, including markers based on occupation, education and household amenities [13-15].

Methods

The Child Heart and Health Study in England (CHASE)

The study is an investigation of the cardiovascular health of British school children aged 9-10 years of white European, South Asian and black African-Caribbean origin. The study

was approved by the Multicentre Research Ethics Committee (Wales). Informed written consent was obtained from each pupil's parent or guardian. Full details of the study design have been reported elsewhere [16, 17]. In brief, the study took place between 2004 and 2007 in 200 primary schools in London, Leicester and Birmingham sampled to include 100 schools with a high proportion (20-80%) of South Asian pupils and 100 schools with a high proportion (20-80%) of black African-Caribbean pupils. Assessments were carried out during school terms by a single research team which visited schools in different areas in rotation. Participating children provided a fasting blood sample and had physical measurements including blood pressure and anthropometry. Participants and their parents both completed questionnaires.

Blood pressure

Seated blood pressure was measured in the right arm (with the arm pendant at chest level) by one of three trained observers after a period of five minutes rest. Two blood pressure measurements were made one minute apart using an Omron 907 blood pressure recorder [18], which underwent a calibration check every two weeks. Three cuff sizes (child, small adult, large adult) were selected according to the arm circumference using the manufacturers' instructions. Mean SBP and DBP for each participant was obtained from the two readings, which were adjusted to the small adult cuff size as described previously [19].

Height and adiposity

Height was measured to the last completed millimetre using a portable stadiometer (Chasmors Ltd, London, UK). Bioimpedance (leg to arm) was measured using a Bodystat 1500 body composition analyser (Bodystat Ltd, Isle of Man, UK). Fat mass was calculated using equations derived for children using dual-emission X-ray absorptiometry [20], and presented as fat mass index (FMI) standardized for height (fat mass/m^5) [12]. Right-sided skinfolds (biceps, triceps, subscapular, suprailiac) were measured and summed for analysis.

Ethnicity

Ethnicity of the child was based on the ethnicity of both parents or the child as reported by the parent; in the 1% where this was not available the ethnicity of the child was derived from information on the place of birth of parents and grandparents provided by the child. 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). 'South Asian' includes 'Indian,' 'Pakistani,' 'Bangladeshi,' and 'Sri Lankan' (or a combination of these). 'Other Asian' includes Asians that are not of South Asian descent (mainly Afghanistan, China and Turkey). '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. The ethnic subcategories 'Indian', 'Pakistani', 'Bangladeshi' includes children whose parents both originated in the same country; 'black African' and 'black Caribbean' groups those who originated in the same region.

Socioeconomic circumstances

Information on parental occupation was sought both from parents and children and was coded using the UK National Statistics Socioeconomic Classification (NS-SEC) for the parent with the highest NS-SEC grade (professional and managerial; intermediate; semi-routine and routine; economically inactive; unclassified) [21]. Children were asked to provide information on who they lived with (one or two parents) and on the presence of household amenities (car, more than one car, garage, garden, freezer, dishwasher, home computer, telephone, internet connection) summed to define a score which we categorised in thirds for analysis. Parents were asked to provide information on their own highest educational qualification (up to 16y, NVQ & vocational, A-level, degree of either parent) and housing type (owner occupier or rent/other).

Statistical methods

All analyses were carried out in STATA (version 11.2; StataCorp LP, College Station, TX, USA). Blood pressure variables were approximately normally distributed. Ethnic and socioeconomic differences in blood pressure variables (as means and differences with their 95% confidence intervals) were obtained from multilevel linear regression models fitting school as a random effect in order to take account of the natural clustering of children within school; ethnicity was fitted first as main groups and then including subcategories. All analyses were adjusted for sex, age, month of assessment, blood pressure observer, room temperature and time of day of measurement fitted as fixed effects. The effects of adjustment for height, adiposity (fat mass index, sum of skinfolds) fitted as continuous variables, and socioeconomic circumstances on ethnic differences in blood pressure were then explored, having first confirmed that the associations between height, adiposity markers and blood pressure did not differ between ethnic groups (all tests for interaction $p > 0.05$). We repeated the adiposity adjustment using the skinfolds ratio (subscapular + suprailiac/ subscapular + suprailiac + biceps + triceps) [ref Ferreira et al] as a marker of fat distribution in place of the sum of skinfolds (a marker of overall adiposity).

As there was considerable missing data on parental education and housing type collected from the parental questionnaire, the effects of adjustment for socioeconomic circumstances were principally based on the sample with data on NS-SEC, household amenities and who the participants lived with; supplementary analysis using the smaller sample with complete data on all five measures of socioeconomic circumstances was undertaken for which results were similar and had no additional impact on ethnic differences in blood pressure (data not presented).

Main analyses were presented with boys and girls together, as previously reported patterns have been similar for both sexes [9, 22]; supplementary analyses examined sex-specific patterns. The likelihood ratio (LR) test was used to test interactions between gender and ethnicity and between ethnicity, body size and socioeconomic factors with Bonferroni correction of p-values for multiple testing [23]. Hypertension was defined as SBP and/or DBP $\geq 95^{th}$ percentile for age, sex and height [24].

Results

Of 8,641 children invited, 5,666 (66%) participated and had complete data on blood pressure, anthropometric measurements and ethnicity. Participation rates were similar among South Asians, other Asians and other ethnic groups (71%, 69% and 69% respectively) with slightly lower participation rates among white Europeans (66%) and black African-Caribbeans (63%). The mean age of the participants was 9.9 years and 49% were male. Slightly fewer children (n = 5543) had complete data on NS-SEC, household amenities and who they lived with (98%); data on parental education and housing tenure were available for 2945 participants for whom parental questionnaires were returned.

Associations for ethnicity with height and adiposity are shown in Table 1 and with socioeconomic circumstances in Supplemental Digital Content 1. Compared with white Europeans, black African-Caribbean children were particularly tall, had a slightly higher fat mass index but a lower sum of skinfolds. South Asian children were slightly shorter and other Asians more so; their fat mass index and sum of skinfolds were greater. Socioeconomic circumstances differed between ethnic groups. Black African-Caribbeans had similar NS-SEC patterns to white Europeans, but had fewer household amenities; the proportion of single parent families was high. South Asians and other Asians had higher proportions of parents in routine and manual occupations but similar or higher levels of household amenities, with a low proportion of single parent families.

Ethnicity and blood pressure

Mean blood pressure levels in children from each ethnic group are shown in Table 1. Adjusted ethnic differences in blood pressure are presented in Table 2 and ethnic sub-group differences in Table 3. In analyses adjusted for age and sex, black African-Caribbean children had similar mean SBP to white Europeans and higher mean DBP; South Asian children had a lower mean SBP and a higher mean DBP than white Europeans (Table 2). Other Asian children had similar SBP and higher DBP compared with white Europeans There was some heterogeneity within these main ethnic group patterns (Table 3). Mean SBP tended to be slightly higher among black Caribbeans but lower among black Africans ($p = 0.004$), however, there was no heterogeneity for DBP. Higher levels of DBP were particularly marked among Indian and Bangladeshi children rather than Pakistanis ($p=0.01$) but there was no heterogeneity amongst South Asian children in SBP.

Ethnic differences in blood pressure: effect of body size adjustment

Adjustment for height markedly influenced blood pressure differences between black African-Caribbean and white European children (Table 2). The SBP difference (previously null) became negative, particularly among black Africans (Table 3); the DBP difference (previously positive) became null. For South Asians and other Asians, adjustment for height had no material effect on the differences observed. Additional adjustment for overall adiposity (fat mass index, sum of skinfolds) slightly reduced the higher diastolic pressure among South Asian children, to 1.07 mmHg (95% CI 0.37, 1.76).. Adjustment using the skinfold ratio instead of the sum of skinfolds reduced the South Asian-white European DBP

differenceslightly more, to 0.88mmHg (95% CI 0.18, 1.58), which however remained highly statistically significant. ***?adjust analysis.

Socioeconomic differences in blood pressure: influence on ethnic differences

Analyses of the associations between socioeconomic characteristics and blood pressure in the whole study population, adjusted for ethnicity, are shown in Supplemental Digital Content 2. Socioeconomic measures showed no consistent associations with either SBP or DBP; these patterns were unaffected by adjustment for body size (data not presented). Adjustment of the ethnic differences in blood pressure for socioeconomic measures available for all participants (NS-SEC, household amenities, lone parent status) (Tables 2 and 3) had no material effect on the blood pressure differences observed. Additional adjustment for parental education and accommodation type made no material difference to the results (data not presented).

Gender differences

Ethnic differences in SBP and DBP are presented for boys and girls separately in Supplemental Digital Content 3. Patterns for girls and boys were generally similar and there were no significant differences in the associations between ethnic group and blood pressure.

Hypertension

The overall prevalence of hypertension (for age, sex and height) was 6.8% (95%CI 6.1-7.6) and differed between ethnic groups (p=0.02). Compared to white Europeans (7.4%, 6.0-9.0), Black African-Caribbean children had a lower prevalence of hypertension (5.0%, 3.9-6.3; p=0.01) whereas the prevalence was similar for South Asians (7.3%, 5.9- 8.9, p=0.86), Other Asians (8.8%, 6.3-12.1, p=0.44) and the “Other” group (7.3%, 5.9-9.2, p=0.97). There was little evidence for heterogeneity within these main ethnic groups, although black Caribbeans had a marginally higher prevalence (5.9%, 4.3-8.0) than black Africans (4.3%, 3.1-5.9) (p=0.17) and Pakistanis a lower prevalence (6.4%, 4.4-9.0) than Indians (8.3%, 6.1-11.1) and Bangladeshis (8.2%, 5.6-11.9) (p=0.51). The ethnic group differences in hypertension reflected the height-adjusted ethnic differences in blood pressure levels.

Discussion

In this school-based study of UK children aged 9-10 years, small ethnic differences in blood pressure were apparent which were dependent on height in black African-Caribbeans, but not in South Asians. In black African-Caribbean children, SBP was similar and DBP higher before adjustment, while SBP was lower and DBP similar after adjustment. South Asian children had lower SBP and higher DBP, while other Asian children had similar SBP and higher DBP; these differences were little affected by height adjustment. There were some BP differences within the main ethnic groups; black Africans had lower SBP than black Caribbeans, while Indians and Bangladeshis tended to have higher DBP than Pakistanis. Socioeconomic circumstances had no appreciable association with blood pressure and did not contribute to the ethnic differences in blood pressure.

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Comparison with previous studies

In UK adults, most studies have reported higher SBP and DBP in adults of African descent (i.e. studies comprising black Africans and black Caribbeans) compared to white Europeans [5]. The results of the present study suggested that this adult pattern is not apparent in UK black African-Caribbeans at 9-10 years of age. This is consistent with the findings of the Determinants of Adolescent Social Well-being and Health (DASH) Study, which reported little difference in SBP and DBP at 11-13 years between black African-Caribbeans and white Europeans [22], though black African-Caribbeans had higher blood pressures at 14-16 years [25]. The results are also broadly consistent with other previous UK studies[9] and with the findings of previous studies in the USA including the Pediatric Task Force, which reported little consistent evidence of black-white differences in blood pressure before 17 years [26, 27].

The finding of lower SBP and higher DBP in South Asian compared to white European children in CHASE is consistent with the patterns observed in UK South Asian adults [6]. Some previous studies in UK children have yielded similar findings [9]; we and Harding reported lower SBP and higher DBP in UK Asian children and adolescents [22, 28], while Clark reported both higher SBP and DBP [29]. However, other studies (including the Health Survey for England) have not shown consistent differences [30-32]. Although earlier studies in adult South Asians have tended to show that lower SBP was observed in those of Pakistani and Bangladeshi origins [6], this finding has not been consistent [33] and was not apparent in CHASE. However, the observation that DBP was particularly high among Indian children in the present study was consistent with patterns observed in 11-13 year-olds in the DASH Study [22].

Associations between low socioeconomic status and higher blood pressure levels have been reported in adults [34]. Our finding of no association between socioeconomic circumstances and blood pressure in 9-10 year-olds, despite using a variety of indicators (including parental education), is consistent with the results of many other studies and reviews in children which failed to demonstrate clear socioeconomic differences in blood pressure [34, 35]. Although it is possible that associations between low socioeconomic status and blood pressure have recently begun to emerge, particularly in UK white European children [36], the present study provides no evidence for such associations and emphasises that socioeconomic differences between ethnic groups do not explain ethnic differences in blood pressure, at least in children.

Previous studies from the US and Australia have suggested that ethnic differences in blood pressure may differ according to levels of adiposity (e.g. normal weight vs. overweight) [27, 37, 38], however we did not find evidence in support of this in the UK population.

Strengths and limitations

Particular strengths of CHASE are its large size (designed to detect modest differences in blood pressure between main ethnic groups) and its robust sampling strategy, providing balanced representation of children of Indian, Pakistani, Bangladeshi, black African and black Caribbean origin living in the three cities in which the highest proportions of UK

South Asians and black African-Caribbeans reside (more than two-thirds of each of these population groups) [39]. This enabled statistically powerful comparisons between the main ethnic groups as well as exploration of the heterogeneity of blood pressure associations within the South Asian and black African-Caribbean groups [6]. Detailed information on adiposity was available, using markers which are more robust than body mass index for comparisons across ethnic groups [12, 40, 41]. Overall response rates were moderate, however, they were comparable with or higher than previous studies [31, 42]. Although response rates varied (black African-Caribbeans in particular having slightly lower rates than other ethnic groups) these differences were modest and the characteristics of respondents with incomplete data did not differ appreciably from those with complete data. The wide range of data on socioeconomic factors allowed us to take a multi-dimensional approach to the measurement of socioeconomic circumstances, as widely recommended [13-15]. Blood pressure measurements were made using a validated automated instrument which was regularly checked and calibrated throughout the study. However, our study may overestimate BP levels because BP was measured on only one occasion and did not therefore allow for regression to the mean which normally occurs on repeated measurement [24]. Nevertheless, the prevalence of hypertension was similar to other studies in children [27].

Interpretation

The results of the present study suggest that ethnic differences in blood pressure in the adult pattern have emerged by the age of 9-10 years in UK South Asian children, but not in black African-Caribbean children. This suggests that key determinants of ethnic differences in blood pressure operate at different stages of the life course in these different ethnic groups. Among South Asians, these determinants are established by the age of 9-10 years. Among black African-Caribbeans, the results of the present study, combined with evidence from longitudinal studies suggesting that ethnic differences are emerging by 14-16 years [25], suggest that early adolescence is likely to be an important period for the emergence of the determinants of black African-Caribbean-white European differences in blood pressure – if such differences continue to emerge in the present cohort of children. The potential importance of the childhood blood pressure differences observed will depend on the extent to which they persist (or increase) with age into early adult life, when their relation to cardiovascular risk will be particularly marked [4]. The differences could have public health relevance, given that even modest differences in the blood pressure of population groups will affect cardiovascular risk [24, 43]. However, the differences are likely to be too small to influence clinical diagnosis and management of blood pressure in individuals.

Identifying the determinants of emerging ethnic differences in blood pressure, particularly the South Asian differences in the adult pattern, is not straightforward, especially as the patterns appear to differ between SBP and DBP. The differences do not appear to solely reflect the higher levels of adiposity among South Asian children (adiposity is strongly related to blood pressure in all ethnic groups) or their fat distribution. Moreover, height, another important determinant of blood pressure in childhood, was similar among South Asians and white Europeans. Other determinants of blood pressure operating in childhood which could be important here include physical activity [44] and insulin resistance [45]. We have previously reported that these South Asian children have lower levels of physical

activity and higher insulin resistance than white Europeans [16, 17]. In the present study, preliminary analysis suggests that adjustment for physical activity has little or no effect on the South Asian-white European blood pressure difference, while adjustment for insulin resistance could account for about one third of the difference (data not presented). Childhood diet and nutritional factors could be important; these include sodium and potassium intakes (not available in the present study) and micronutrient status. Vitamin D status is particularly implicated as a determinant of ethnic differences in blood pressure. [ref Kohli J Hypertension 2012]. Prenatal influences, particularly related to fetal undernutrition and low birth weight, have been implicated in the development of high blood pressure [46]. A low number of nephrons at birth seen in lower birth weight babies has previously been proposed as a model for the development of hypertension [47] and recent studies have demonstrated an association between low birth weight and narrower retinal arteriole calibre both in children and adults [48]. Such observations would be consistent with the developmental origins (Barker) hypothesis that microcirculatory adaptations in utero could increase the risk of hypertension and CVD [49]. Although birth weight data are not currently available in the present study, UK South Asian babies are still consistently lighter at birth than white Europeans by approximately 300 grams [50]. Such a difference, if causally related to blood pressure, could help to explain the higher DBP among South Asians, though not their lower SBP. Other prenatal exposures (for example maternal smoking in pregnancy) could be important, but the direction of ethnic differences in the prevalence of maternal smoking (low among South Asians) suggests this is not likely to be important.

Conclusion

The results of the present study suggest that modest ethnic differences in blood pressure have emerged by the age of 9-10 years. The blood pressure patterns observed in South Asian children (higher DBP and slightly lower SBP compared with white Europeans) are consistent with reported adult patterns and appear to be independent of adiposity and height. The importance of the higher DBP level observed in South Asian children for future cardiovascular prevention depends on the extent to which it increases further with age and is accompanied by an emerging increase in SBP. The blood pressure patterns in black African-Caribbean children (lower SBP and similar DBP to white Europeans after height adjustment) do not correspond with adult patterns, which (if they emerge in this cohort) are likely to do so during adolescence. Socioeconomic circumstances appear unrelated to blood pressure in these children and appear to play no part in the ethnic differences in blood pressure observed. Understanding the reasons for the early emergence of ethnic differences in blood pressure (particularly among South Asians) is an important research priority.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Mean (95CI) blood pressure and anthropometric variables by ethnic group

	white European	black African-Caribbean	South Asian	Other Asian	Other	p†
	n=1318	n=1545	n=1497	n=352	n=954	
% male	50.2	46.9	48.8	46.3	50.9	0.22
Age (years)	9.95 (9.91, 9.99)	9.95 (9.91, 9.99)	9.94 (9.90, 9.98)	9.94 (9.89, 9.99)	9.94 (9.90, 9.98)	0.84
SBP (mmHg)	105.0 (104.4, 105.6)	104.9 (104.3, 105.4)	104.0 (103.3, 104.6)	105.4 (104.2, 106.5)	105.3 (104.6, 106.0)	0.01
DBP (mmHg)	62.3 (61.7, 62.8)	63.2 (62.7, 63.7)	63.5 (62.9, 64.0)	64.0 (63.0, 65.0)	63.1 (62.5, 63.8)	0.003
Height (cm)	139.1 (138.8, 139.5)	143.0 (142.6, 143.3)	138.7 (138.3, 139.0)	138.2 (137.5, 138.9)	140.1 (139.7, 140.5)	<0.001
FMI (kg/m^5) ‡	1.75 (1.70, 1.81)	1.81 (1.76, 1.86)	1.87 (1.81, 1.92)	1.88 (1.78, 1.99)	1.81 (1.75, 1.88)	0.02
SS (mm) ‡	41.3 (40.1, 42.4)	39.9 (38.9, 40.9)	43.2 (42.1, 44.4)	43.0 (40.8, 45.2)	40.9 (39.6, 42.3)	<0.001

#Abbreviations: SBP systolic blood pressure, DBP diastolic blood pressure, FMI fat mass index, SS sum of skinfolds

†SBP, DBP, height, FMI, SS: p-value for test of heterogeneity among ethnic groups using mixed effects linear regression with adjustment for age, sex, observer, month, time of day (blood pressure), room temperature (blood pressure) and school (random effect); age and sex adjusted for clustering.

‡Geometric mean

Table 2

Main ethnic group differences (compared to white Europeans) in blood pressure (mmHg) with adjustments

		Additional adjustments *		
	Basic model *	**Height**	**Height, adiposity**	**Height, adiposity, SExsx**†
Systolic pressure				
black African-Caribbean	-0.12 (-0.90, 0.67)	-1.93 (-2.70, -1.16)	-1.62 (-2.38, -0.86)	-1.59 (-2.36, -0.82)
South Asian	-0.99 (-1.80, -0.18)	-0.81 (-1.58, -0.03)	-1.10 (-1.86, -0.34)	-1.11 (-1.88, -0.34)
Other Asian	0.48 (-0.77, 1.74)	0.88 (-0.32, 2.08)	0.52 (-0.65, 1.69)	0.55 (-0.63, 1.73)
Other	0.32 (-0.55, 1.20)	-0.14 (-0.98, 0.70)	-0.13 (-0.95, 0.69)	-0.11 (-0.93, 0.72)
p ≠	0.02	<0.001	<0.001	<0.001
Diastolic pressure				
black African-Caribbean	0.96 (0.27, 1.66)	0.21 (-0.49, 0.92)	0.58 (-0.12, 1.28)	0.59 (-0.11, 1.30)
South Asian	1.23 (0.51, 1.94)	1.31 (0.60, 2.01)	1.07 (0.37, 1.76)	0.99 (0.28, 1.70)
Other Asian	1.76 (0.65, 2.86)	1.92 (0.83, 3.02)	1.64 (0.56, 2.72)	1.61 (0.53, 2.70)
Other	0.83 (0.06, 1.61)	0.64 (-0.12, 1.41)	0.70 (-0.05, 1.45)	0.73 (-0.02, 1.48)
p ≠	0.003	<0.001	0.01	0.02

*All models based on 5543 subjects with adjustments for age, sex, blood pressure observer, room temperature, time of day, month, and school (random effect)

†SE: markers of socioeconomic position - NS-SEC, household amenities, lone parent.

≠p: test of overall differences in blood pressure between ethnic groups.

Table 3

Ethnic sub-group differences (compared to white Europeans) in blood pressure (mmHg) with adjustments

			Additional adjustments *					
	Basic model*	p(2) §	Height	p(2) §	Height, adiposity	p(2) §	Height, adiposity, SE†	p(2) §
Systolic pressure								
black Caribbean	0.70 (-0.33, 1.73)		-1.09 (-2.09, -0.10)		-0.86 (-1.85, 0.12)		-0.87 (-1.86, 0.12)	
black African	-0.95 (-1.87, -0.02)	0.004	-2.78 (-3.68, -1.88)	0.002	-2.46 (-3.35, -1.57)	0.003	-2.41 (-3.31, -1.52)	0.004
Indian	-0.22 (-1.37, 0.93)		-0.27 (-1.37, 0.83)		-0.44 (-1.52, 0.63)		-0.49 (-1.58, 0.59)	
Pakistani	-1.24 (-2.32, -0.17)		-1.22 (-2.24, -0.19)		-1.48 (-2.49, -0.48)		-1.50 (-2.52, -0.49)	
Bangladeshi	-1.18 (-2.47, 0.11)	0.27	-0.61 (-1.85, 0.62)	0.32	-1.05 (-2.26, 0.16)	0.25	-1.10 (-2.33, 0.13)	0.28
p(1) ‡	0.003		<0.001		<0.001		<0.001	
Diastolic pressure								
black Caribbean	1.02 (0.11, 1.93)		0.28 (-0.63, 1.20)		0.59 (-0.32, 1.49)		0.57 (-0.34, 1.48)	
black African	0.76 (-0.06, 1.58)	0.60	0.00 (-0.82, 0.82)	0.57	0.37 (-0.44, 1.19)	0.66	0.40 (-0.42, 1.22)	0.73
Indian	2.14 (1.12, 3.16)		2.12 (1.11, 3.13)		1.97 (0.98, 2.95)		1.83 (0.83, 2.83)	
Pakistani	0.32 (-0.63, 1.26)		0.33 (-0.61, 1.27)		0.11 (-0.82, 1.03)		0.04 (-0.90, 0.97)	
Bangladeshi	1.56 (0.42, 2.70)	0.01	1.79 (0.66, 2.93)	0.01	1.45 (0.34, 2.57)	0.004	1.38 (0.24, 2.51)	0.01
p(1) ‡		<0.001		<0.001		<0.001		0.001

*All models based on 5543 subjects with adjustments for age, sex, blood pressure observer, room temperature, time of day, month, and school (random effect)

†SE: markers of socioeconomic position - NS-SEC, household amenities, lone parent.

‡p(1): test of overall differences in blood pressure between ethnic groups.

§p(2): tests of differences within the main ethnic groups, i.e. between black Caribbean and black African children and between Indian, Pakistani and Bangladeshi children.