Emergence of Ethnic Differences in Blood Pressure in Adolescence

The Determinants of Adolescent Social Well-Being and Health Study

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Abstract**—**The cause of ethnic differences in cardiovascular disease remains a scientific challenge. Blood pressure tracks from late childhood to adulthood. We examined ethnic differences in changes in blood pressure between early and late adolescence in the United Kingdom. Longitudinal measures of blood pressure, height, weight, leg length, smoking, and socioeconomic circumstances were obtained from London, United Kingdom, schoolchildren of White British (n=692), Black Caribbean (n=670), Black African (n=772), Indian (n=384), and Pakistani and Bangladeshi (n=402) ethnicity at 11 to 13 years and 14 to 16 years. Predicted age- and ethnic-specific means of blood pressure, adjusted for anthropometry and social exposures, were derived using mixed models. Among boys, systolic blood pressure did not differ by ethnicity at 12 years, but the greater increase among Black Africans than Whites led to higher systolic blood pressure at 16 years (+2.9 mm Hg). Among girls, ethnic differences in mean systolic blood pressure were not significant at any age, but while systolic blood pressure hardly changed with age among White girls, it increased among Black Caribbeans and Black Africans. Ethnic differences in diastolic blood pressure were more marked than those for systolic blood pressure. Body mass index, height, and leg length were independent predictors of blood pressure, with few ethnic-specific effects. Socioeconomic disadvantage had a disproportionate effect on blood pressure for girls in minority groups. The findings suggest that ethnic divergences in blood pressure begin in adolescence and are particularly striking for boys. They signal the need for early prevention of adverse cardiovascular disease risks in later life. **(*Hypertension*. 2010;55:1063-1069.)**

Key Words: ethnicity ■ blood pressure ■ adolescence ■ growth ■ social circumstances

The cause of ethnic variations in cardiovascular risk remains a scientific challenge. Elevated blood pressure (BP) in populations of African origin and excess coronary events in populations of South Asian origin are widely documented.[1] BP is an established risk factor for cardiovascular disease, and the evidence for BP tracking from late childhood to adulthood is strong.[2] Remarkably little is known about the change in BP over time in these ethnic groups and, in particular, in childhood and adolescence. In the United States, Black-White differences in BP in girls become apparent from ≈13 years of age.[3–7] What factors drive the emergence of this BP difference, when many earlier-life determinants are already operating, are not clear. Cruickshank et al[8] showed recently that lower birth weights of Blacks accounted for Black-White differences in BP in adolescence, with the strength of the association between birthweight and BP being the same for both groups. In the Coronary Artery Risk Development in Young Adults Study, obesity and lifestyle factors accounted for the differences in mean BP and in hypertension in African American subjects.[9] There are few longitudinal studies and none to our knowledge comparing several ethnic groups in similar locations in childhood. On the basis of baseline data in the Determinants of Adolescent Social Well-Being and Health (DASH) Study,[10] we reported a general lack of ethnic differences in BP in early adolescence in the United Kingdom,[11] despite more overweight in Black girls of African origin.[12,13]

Here, we use the longitudinal data in DASH to examine ethnic differences in changes in BP in relation to growth between early and late adolescence. Although the impact on BP and change in BP from height and weight change are well studied, little is known about the effect of growth in leg length (LL), a key indicator of nutritional status. In adulthood, shorter LL is associated with higher levels of mean

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BP.[14] Black African and Black Caribbean children have longer LL than White British children in early adolescence.[15] We examined the extent to which this might influence ethnic differences in age-related increases in BP and how such growth differences are related to social and psychosocial factors.

Methods

Design and Sample

The DASH longitudinal study and ethics approval are described elsewhere.[10] Briefly, 6643 pupils aged 11 to 13 years took part in 2003–2004, and 4779 took part in the follow-up survey in 2005–2006. The overall response rate among those invited to take part in the follow-up was 88%. At follow-up, physical measurements were conducted on selected ethnic groups (n=3124): White United Kingdom (response rate: 85%; n=730), Black Caribbeans (97%; n=722), Black Africans (98%; n=846), Indians (95%; n=403), Pakistanis (87%; n=278), and Bangladeshis (80%; n=145). Missing data on BP and anthropometry led to the exclusion of 204 children (White British: n=38; Black Caribbean: n=52; Black African: n=74; Indians: n=19; Pakistanis: n=16; and Bangladeshis: n=5). The Pakistanis and Bangladeshis were combined because of relatively small sample sizes and are referred to as "other South Asians." These 2 groups are generally more disadvantaged than Indians.[16,17]

Explanatory Factors and Outcomes

Ethnicity was mainly self-defined. Pupils who reported "Black British" or "Asian British" or who did not report their own ethnicity were classified using parental ethnicity and parental and grandparental country of birth. For reporting convenience, we referred to White United Kingdom as "White," the combined Pakistani and Bangladeshi group as "other South Asians," and Black Africans and Black Caribbeans as "Black African origin" (if trends were similar). Socioeconomic circumstances (SECs) were measured using 17 standard of living items (expressed as tertiles, using the thresholds of the measure at baseline for the entire longitudinal sample) and parental employment (≥1 parent employed versus no parent employed). Smoking status was categorized as ever smoked or not. Psychological well-being was measured using the mean total difficulties score from the Goodman Strengths and Difficulties Questionnaire.[18]

Protocols for anthropometric measurements were taken from the World Health Organization manual.[19] Fieldworkers were trained for 5 days before the start of fieldwork and were recertified during the study. Height and sitting height were measured using portable stadiometers and standard height stools and weight using Salter electronic scales. Subischial LL was derived as standing height (sitting height minus height of stool) and body mass index (BMI) as weight (in kilograms) divided by height (in meters squared). *Z* scores of height, weight, and LL were based on the 1990 standards for British children.[20,21]

Pubertal status was assessed using the Tanner questionnaire, supervised by a nurse.[22] Prepuberty (Tanner stage 1 for breasts or genitalia and pubic hair) and early puberty (Tanner stages 2 and 3 for breasts and genitalia) were combined, because <5% were classified as part of the prepubertal group. Late puberty consisted of Tanner stages 4 and 5 for breasts and genitalia.

Systolic BP (sBP) and diastolic BP (dBP) were measured using validated OMRON M5-I instruments and appropriately sized cuffs, for the first reading after the pupil had sat quietly for a timed 5 minutes, with ≥1 minute between subsequent readings. The average of the second and third readings was used in analysis. Ambient air temperature was recorded with a digital thermometer. Height-percentile–specific BP at ≥95th percentile levels was classified as high BP using US normative BP tables for children and adolescents.[23]

Statistical Analysis

Repeated measures of all of the explanatory and outcome variables were obtained from the same subjects at baseline and at follow-up. At baseline the average age was 12.6 years, with a range of 11.2 to 14.5 years. At follow-up, the average was 15.2 years, with a range of 13.8 to 16.9 years. We used information on all of the ages simultaneously in linear mixed models to estimate the predicted means of sBP or dBP between 12 and 16 years old. The predictions were limited to the 12- to 16-year age range, because <2% of the sample was <12 years old at baseline or >16 years old at follow-up.

In each model, adjustment factors were selected with a stepwise selection approach. Separate models were used for boys and girls because of a significant 3-way interaction ($P<0.001$) among sex, ethnicity, and age. Age changes were modeled as polynomial functions of age, which formed the time dimension for the analysis. In each sex-specific model, quadratic and cubic functions of age were introduced. The choice of models that best fit depended on statistically significant functions of age. Ethnic differences were modeled as interactions between ethnic group and explanatory factors, including age. SEC, parental employment, smoking status, and psychological well-being were considered as time-dependent variables. The log-likelihood ratio test was used to identify statistically significant effects ($P<0.05$). Baseline *z* scores of height, weight, and LL were introduced in the model, as well as the changes in *z* scores for these variables between the baseline survey (11 to 13 years) and the follow-up survey (14 to 16 years). At baseline, these changes were set-up to 0. Inverse-probability weights were used to correct for nonresponse at wave 1 and attrition at wave 2.

Results

Compared with Whites, children of Black African origin were more likely to be socioeconomically disadvantaged. Smoking prevalence increased in every group, but the prevalence in each ethnic minority group remained lower than Whites. Ethnic minority groups generally reported better psychological well-being than Whites. White children had a faster pace of growth, and by 14 to 16 years their heights (boys: 171.6 cm; girls: 163.7 cm) were similar to those of Black African (boys: 171.9 cm; girls: 163.7 cm) and Black Caribbean (boys: 172.3 cm; girls: 163.3 cm) children, whereas Indians and other South Asians remained shortest (boys: 168 cm; girls: 157 cm; $P<0.001$). LL increased by ≈8 cm among boys and ≈2 cm among girls, with little difference by ethnicity. Adolescents of Black African origin retained a longer LL advantage over Whites (+3 cm in boys [$P<0.001$] and +2 to 3 cm in girls [$P<0.001$] at 14 to 16 years). At 14 to 16 years of age, mean BMI of Black Caribbean boys was higher than White boys ($P<0.001$), and at both ages it was higher in Black African origin girls ($P<0.001$) and lower in Indian girls ($P<0.05$) than in White girls (please see Table S1 and Figure S1 in the online Data Supplement at http://hyper.ahajournals.org).

Black Caribbean boys were more likely to be obese than White boys at 14 to 16 years of age, and girls of Black African origin were more likely to be overweight or obese at both ages (Table 1). At 11 to 13 years of age, mean sBP and the percentage with high sBP were lower in Black African boys compared with White boys. Mean dBP and the percentage with high dBP were higher among Indian boys at both ages and among other South Asian boys at 14 to 16 years of age.

Figure 1 shows predicted means of BP by age and ethnicity derived from the linear mixed models, adjusted for anthropometry and social and psychosocial exposures. These means differ from Table 1, mainly because of the adjustment for

Table 1. Overweight Status and BP at 11 to 13 and 14 to 16 Years of Age

Overweight Status and BP	Age, y	White United Kingdom	Black Caribbean	Black African	Indian	Pakistani/Bangladeshi
Boys						
No.		390	331	348	216	277
Age	11 to 13	12.56	12.62	12.66	12.52	12.57
	14 to 16	15.16	15.28	15.28	15.19	15.21
Percentage overweight	11 to 13	18.3	19.3	16.9	19.0	17.1
	14 to 16	12.6‖	15.3	14.6	14.5#	14.4
Percentage obese	11 to 13	5.3	10.5	6.9	7.8	8.0
	14 to 16	4.8	9.6*	5.6	6.0	6.9
Blood pressure						
Mean sBP (SE)**	11 to 13	109.3 (0.50)	108.6 (0.61)	107.8 (0.45)*	108.9 (0.74)	108.0 (0.65)
	14 to 16	114.2 (0.54)#	114.7 (0.60)#	115.2 (0.57)#	113.8 (0.72)#	114.0 (0.60)#
Percentage high	11 to 13	5.4	5.7	2.0†	6.9	6.9
	14 to 16	5.9	6.0	6.3	6.5	4.7
Mean dBP (SE)**	11 to 13	65.5 (0.35)	65.4 (0.47)	65.3 (0.33)	66.9 (0.55)*	65.3 (0.48)
	14 to 16	67.0 (0.37)#	67.7 (0.41)#	68.3 (0.38)*#	69.7 (0.50)‡#	69.6 (0.47)‡#
Percentage high	11 to 13	1.5	4.2	0.9	4.6*	2.9
	14 to 16	0.8	2.1	1.4	5.6†	3.6†
Girls						
No.		302	339	424	168	125
Age	11 to 13	12.58	12.59	12.60	12.51	12.55
	14 to 16	15.22	15.22	15.26	15.23	15.19
Percentage overweight	11 to 13	15.5	27.8‡	25.4†	21.8	18.2
	14 to 16	12.7	19.7*‖	22.0†§	15.3§	16.6
Percentage obese	11 to 13	4.7	13.9‡	8.4†	3.0	2.4
	14 to 16	4.6	12.1†	8.4	2.3	1.6
Blood pressure						
Mean sBP (SE)**	11 to 13	109.0 (0.53)	108.7 (0.48)	108.3 (0.46)	107.9 (0.73)	106.9 (0.84)
	14 to 16	107.6 (0.46)‖	108.4 (0.43)	108.1 (0.42)	106.3 (0.69)#	106.5 (0.80)
Percentage high	11 to 13	6.0	3.8	4.0	7.7	4.8
	14 to 16	1.0‖	0.9§	2.4	3.0§	2.4
Mean dBP (SE)**	11 to 13	67.7 (0.40)	67.3 (0.41)	66.9 (0.35)	68.5 (0.57)	67.2 (0.63)
	14 to 16	68.2 (0.37)	68.7 (0.38)‖	68.5 (0.32)#	70.0 (0.55)†	69.4 (0.68)‖
Percentage high	11 to 13	3.3	3.2	2.6	5.4	1.1
	14 to 16	2.6	1.2§	2.8	5.4	8.0

*Data were significantly ($P<0.05$) different from White United Kingdom in the same category.
†Data were significantly ($P<0.01$) different from White United Kingdom in the same category.
‡Data were significantly ($P<0.001$) different from White United Kingdom in the same category.
§Data were significantly ($P<0.05$) different from 11 to 13 years of age in the same ethnic group.
‖Data were significantly ($P<0.01$) different from 11 to 13 years of age in the same ethnic group.
#Data were significantly ($P<0.001$) different from 11 to 13 years of age in the same ethnic group.
**Blood pressure values are adjusted for age and ambient temperature and expressed as means (SE).

ethnic differences in anthropometry. For example, among boys at 14 to 16 years of age, mean sBP adjusted for anthropometry was 113.6 mm Hg among White British, 114.6 mm Hg among Black Caribbean, 115.7 mm Hg among Black African, 115.5 mm Hg among Indian, and 114.6 mm Hg among Pakistani/Bangladeshi subjects. The corresponding figures for girls were 107.8, 108.7, 108.3, 108.8, and 108.6. Striking differences in age trends in sBP by ethnicity and sex were observed. Among boys, sBP did not differ significantly by ethnicity at 12 years of age, but the greater average increase per year ($P<0.001$) for Black Africans (+3.08 mm Hg/y) compared with Whites (+1.99 mm Hg/y) led to them having significantly higher sBP at 16 years of age (+ 2.9 mm Hg; $P<0.05$). The age trends for dBP suggest earlier divergences and increasing disparity, with significantly higher dBP than Whites from 12 years of age for Indians (+2.2 mm Hg [$P<0.05$] increasing to +3.9 mm Hg at 16 years of age [$P<0.001$]), 14 years of age for other South Asians (+1.7 mm Hg [$P<0.01$] to +3.2 mm Hg at 16 years of age [$P<0.001$]), and from 15 years of age for Black Africans (+1.6 mm Hg [$P<0.05$] to +2.1 mm Hg at 16 years of age [$P<0.05$]).

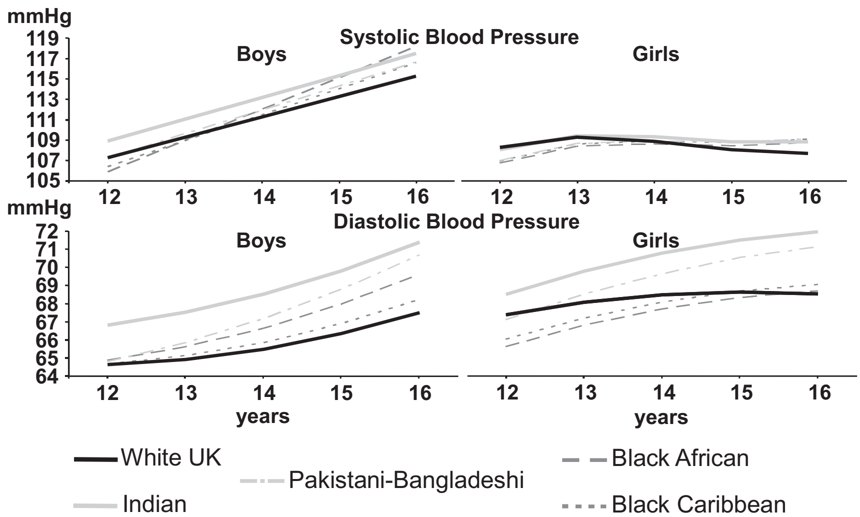

Figure 1. Trend in ethnic differences in blood pressure by age and sex. Predicted means were estimated from the mixed linear models adjusted on age, ethnicity, age×ethnicity interaction, anthropometry (*z* scores of BMI, height, and LL) at 11 to 13 years of age and change between 11 to 13 and 14 to 16 years of age, pubertal stage, ambient air temperature, and social and psychosocial exposures, with random effects on intercept and age parameter. Means were restricted to 12 to 16 years of age, where estimations were robust.

Among girls, ethnic differences in mean sBP were not significant, but the slopes reflected differential age trends. Between 12 and 16 years of age, sBP increased among Black Africans (+2.0 mm Hg) and Black Caribbeans (+2.2 mm Hg) but hardly changed among Whites (−0.6 mm Hg). Age-specific differences in dBP were more marked. At 12 years of age, dBP was lower among Black Caribbean (−1.3 mm Hg; $P<0.05$) and African (−1.8 mm Hg; $P<0.01$) girls than White girls, but the faster rise led to similar levels by 14 years of age. Indians had significantly higher dBP from 13 years (+1.7 mm Hg [$P<0.05$] increasing to +3.4 mm Hg [$P<0.01$] at 16 years of age) and other South Asians from 15 years of age (+1.2 mm Hg [$P=0.05$] to +2.6 mm Hg [$P<0.05$] at 16 years of age).

Table 2 shows the main effects associated with anthropometry, adjusted for social and psychosocial exposures. At 11 to 13 years of age, BMI, LL, and height were independent predictors of BP. Apart from height and dBP among boys and LL and sBP among girls, changes in anthropometric indices were also independent predictors.

Ethnicity-specific effects were examined using interactions. Of 36 interactions, only 2 were significant (ethnicity×LL for sBP and dBP among boys; ethnicity×SEC for sBP and dBP among girls). Adjusted for standing height, increasing LL was associated with decreasing BP across all of the ethnic groups, but among boys the decrease varied. For sBP, longer LL ($z=+1$) versus normal LL ($z=0$) was associated with a smaller decrease within Black African (−2.34 mm Hg; $P<0.001$), Black Caribbean (−1.73 mm Hg; $P<0.001$), and other South Asian (−1.24 mm Hg; $P<0.05$) boys than within White boys (−3.34 mm Hg; $P<0.001$). For dBP, longer LL was associated with a larger decrease within Indian boys (−2.00 mm Hg; $P<0.001$) than within White boys (−1.09 mm Hg; $P<0.01$).

Figure 2 shows the effect of the ethnicity×SEC tertile interaction ($P<0.05$) on sBP among girls. Within Whites, sBP decreased with increasing disadvantage, at 2.52 mm Hg lower in the most disadvantaged tertile than in the least disadvantaged tertile ($P<0.05$). Among Black Caribbean girls (and other minority groups, although not significant), sBP increased with increasing disadvantage, sBP being +2.16 mm Hg higher in the most disadvantaged than in the least disadvantaged tertile ($P<0.05$). These differences were linked to the age trends. Compared with Whites, minority groups had generally lower sBP in the least disadvantaged tertile at 12 years of age but higher sBP in the middle and most disadvantaged tertiles at later ages. Similar trends were observed for SEC and dBP (data not shown). The sample sizes in the most disadvantaged third tertile were small (Table S1), and trends for this tertile need to be interpreted with some caution, but the consistency with the trends for the middle tertile signals a possible emergent effect of disadvantage in late adolescence.

Discussion

Comparing BP differences of the same ethnic groups in different settings provides some clues about the impact of potentially modifiable contextual influences. Our findings on sex differences in age trends for children of African origin contrast with those observed for Black Americans in the United States. It is not clear at what age Black-White American differences in BP emerge among boys. Rosner et al[6] in their pooled analysis of 8 large epidemiological US studies of BP in 5- to 17-year–old subjects, covering the period 1979–1996, reported little ethnic difference. Muntner et al,[5] in their analysis of later, but only cross-sectional, data from the third National Health and Nutrition Examination Survey (1999–2000), found sBP to be higher in Black than in White boys in the wide age range of 13 to 17 years. Comparisons with these studies are not straightforward because of the different methods and times of surveys. Between 12 to 16 years (comparable ages in DASH), Muntner et al[5] reported generally lower age-adjusted sBP for both Black and

Table 2. Effects of Anthropometry at 11 to 13 Years of Age and Change Between 11 to 13 and 14 to 16 Years of Age on BP, Adjusted for Social Characteristics

	Boys		Girls	
Anthropometric, Social and Psychosocial Factors	Systolic BP Coefficient (95% CI)*	Diastolic BP Coefficient (95% CI)†	Systolic BP Coefficient (95% CI)‡	Diastolic BP Coefficient (95% CI)†
Anthropometry at baseline (11 to 13 y)				
BMI, *z* score	1.5 (1.1 to 1.8)**	1.2 (0.9 to 1.4)**	1.5 (1.2 to 1.9)**	1.4 (1.1 to 1.7)**
LL, *z* score	−2.3§ (−3.2 to −1.5)**	−1.1 (−1.7 to −0.5)§#	−0.9 (−1.7 to −0.1)‖	−0.6 (−1.3 to −0.1)‖
Height, *z* score	4.6 (3.6 to 5.5)**	1.4 (0.7 to 2.2)**	2.0 (1.1 to 2.9)**	1.1 (0.4 to 1.8)#
Change in anthropometry between baseline (11 to 13 y) and follow-up (14 to 16y)				
BMI, *z* score	2.2 (1.6 to 2.9)**	1.7 (1.2 to 2.2)**	2.3 (1.7 to 3.0)**	1.7 (1.2 to 2.2)**
LL, *z* score	−1.7 (−2.6 to −0.8)#	−1.2 (−1.9 to −0.5)#	−0.4 (−1.3 to 0.5)	−1.3 (−2.1 to −0.6)#
Height, *z* score	3.8 (2.5 to 5.0)**	0.7 (−0.2 to 1.7)	1.6 (0.6 to 2.7)#	1.5 (0.6 to 2.3)#
Time-dependent variables				
Smoking status, regular/occasional smoker vs nonsmoker	0.0 (−1.3 to 1.4)	−0.5 (−1.5 to 0.5)	−0.4 (−1.5 to 0.7)	−0.9 (−1.7 to 0.1)
Puberty stage, late vs early/middle	0.5 (−0.4 to 1.3)	−0.3 (−1.0 to 0.3)	−0.2 (−1.0 to 0.6)	0.2 (−0.5 to 0.8)
Born abroad, yes vs no	−1.0 (−2.0 to 0.1)	−1.1 (−1.8 to −0.3)#	−0.3 (−1.3 to 0.7)	0.1 (−0.7 to 0.9)
Socioeconomic status, most disadvantaged vs least disadvantaged	0.3 (−0.8 to 1.3)	0.0 (−0.9 to 0.8)	0.3 (−0.7 to 1.3)§	0.7 (−0.1 to 1.5)§
Parental employment, no employed parent vs ≥1 parent employed	0.2 (−0.8 to 1.1)	0.1 (−0.6 to 0.8)	−0.8 (−1.7 to 0.2)	−0.2 (−0.9 to 0.6)
Total difficulties score	0.0 (−0.1 to 0.1)	0.0 (−0.1 to 0.0)	0.0 (−0.1 to 0.0)	0.0 (−0.1 to 0.0)

*Coefficients were estimated with linear mixed models with random intercept and slope for age. Age and ethnicity were introduced as follows: age, ethnicity and interaction between age and ethnicity.

†Model as above with age and ethnicity introduced as follows: age, age^2, ethnicity, and age×ethnicity.

‡Model as above with age and ethnicity introduced as follows: age, age^2, age^3, ethnicity, and age×ethnicity.

§Only the main effect is shown, but an interaction between this variable and ethnicity was observed.

‖Data were statistically significant at $P<0.05$.

#Data were statistically significant at $P<0.01$.

**Data were statistically significant at $P<0.001$.

White boys than that reported by Rosner et al.[6] Age-adjusted mean sBPs here in DASH appear to be closer to those reported by Rosner et al[6] but slightly lower for Whites than White Americans at 11 to 13 years and slightly higher for Black Africans or Black Caribbeans then Black Americans at 14 to 16 years, hence the United Kingdom/US difference in ethnic effect. Another striking difference is that high BP and obesity in African-origin groups in the DASH Study appears to be much less common than in Black American adolescents in the United States (on the basis of the figures reported by Ostchega et al[24] and Ogden et al[25]). In contrast with our finding in the DASH Study, Black-White American differences in BP attenuate considerably with adjustment for BMI. A recent study, however, showed a higher prevalence of elevated BP among Black compared with White American boys aged <18 years even after controlling for BMI.[26] A US-United Kingdom comparison of children of African origin is complicated by the differences in migration history, with Africans in the United Kingdom being much more likely to be migrants or born to migrant parents than Black Americans in the United States. The history of Black Caribbeans reflects longer generational distance from West Africa than that of Africans in the United Kingdom but less than that of Black Americans. The trends signal a complex picture of greater risk of obesity but less increase in sBP in Black Caribbean boys than African boys in the DASH Study and a stronger effect of social disadvantage on BP in Black Caribbean than Black African girls.

Comparative data for children of South Asian origin of similar ages to those in the DASH Study are sparse. Higher body mass–adjusted mean BP and elevated BP at 5 to 14 years of age for those living in Pakistan compared with those for White children in the United States have been reported. Mean BP values cannot be compared from the published data. Using the same US thresholds for high BP as in the DASH Study, 8% to 11% of boys and 7% to 10% of girls 12 to 14 years of age were classified as having had high sBP in Pakistan in 1990–1994.[27] We disaggregated the other South Asian group in the DASH Study to enable a direct comparison with Pakistanis in the DASH Study and found a lower occurrence of high sBP (<6%) at these ages. The reported difference across 6 ethnic groups (as measured by mother tongue) within Pakistan is a sober reminder that ethnic groups as identified in the United Kingdom or other destination countries are very likely to be heterogeneous in terms of sociocultural or genetic heritage.

The steeper rise in mean sBP in Black African boys, the higher mean dBP in South Asian and Black African boys by

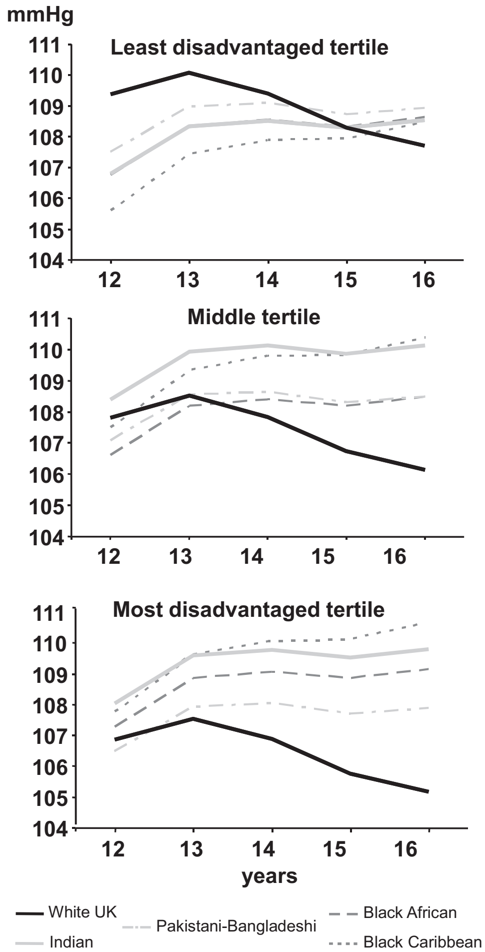

Figure 2. Girls, Trend in ethnic differences in blood pressure by age and tertiles of socioeconomic disadvantage. Predicted means were estimated from the mixed linear models adjusted on age, ethnicity, age×ethnicity interaction, anthropometry (*z* scores of BMI, height, and LL) at 11 to 13 years of age and change between 11 to 13 and 14 to 16 years of age, pubertal stage, ambient air temperature, social and psychosocial exposures, and ethnicity×tertiles of socioeconomic disadvantage interaction, with random effects on intercept and age parameter. Means were restricted to 12 to 16 years of age, where estimations were robust.

15 years of age, and the ethnic differences in age trends for sBP and dBP in girls occurred in context of reductions or no change in overweight or obesity across age. Asians are known to carry more fat[28] and Africans less fat[29] per unit of BMI than Whites. The relationship between BMI and BP, which varies within adults of African origin by geographic site[30,31] may be weaker for Black than for White Americans.[32] Similar to the Coronary Artery Risk Development in Young Adults Study,[33] however, we found a strong relationship between BMI and changes in BMI with BP with no detectable ethnic difference. In adult African populations, the relationship between BMI and BP varies across BMI, with a diminishing effect of increasing BMI.[34] We cannot rule out a lack of statistical power to detect this effect.

Previous studies have shown that lower birth weight is associated with higher BP in children and adults, although this is not always consistent across all populations.[35] Size at birth, early postnatal catch-up growth, and excess childhood weight gain have been shown to be associated with an increased risk of adult cardiovascular disease risk.[36,37] There are no longitudinal data on growth and later vascular disease in ethnic minorities in the United Kingdom. There are more low birth weight infants born to Black Caribbean and South Asian mothers compared with infants of White British mothers,[38] and there is some evidence of accelerated postnatal growth.[39] Lifestyle factors such as physical activity[40] and salt consumption[41] are also associated with BP levels in adults and may also play a role in the causal pathways in youth.[42]

Our analyses have some limitations. BP was measured on a single occasion, 3 times at each survey, and a more precise estimate would have been obtained from multiple measures over several visits. Measuring SEC in children is problematic. At 11 to 13 years of age, most could not report parental occupation or education. The distribution of our SEC measure changed between waves, with decreases in the proportions that were most disadvantaged. It is plausible that this group, although smaller, may be more disadvantaged at 14 to 16 years of age than at 11 to 13 years of age, which could have amplified the ethnic effect of disadvantage on BP at 14 to 16 years of age. A major strength of the DASH Study is the large sample sizes that allow detailed results by ethnicity and sex to be presented. The same methods at both waves were used to measure all of the explanatory factors and BP so that the changes observed are unlikely to be because of differences in study protocols.

Perspectives

We have shown that ethnic differences in BP appear in adolescence to be striking for boys. By 13 to 15 years of age, Black African boys had lost the BP advantage that they had over their White peers at younger ages. The age-related increases were also greater for some minority groups, particularly children of Black African origin. Our findings suggest that currently known preventive efforts to restrain rise in BP (dietary, weight gain, and physical activity) might well be targeted at early ages across all of the ethnic groups. These measures might also be applicable internationally, in the Indian subcontinent, sub-Saharan Africa, and the Caribbean. Whether and how the effects of growth, notably in LL, weight, and perhaps of social disadvantage, retain ethnic-specific impacts at older ages require further follow-up.

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Disclosures

None.

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