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BLOOD PRESSURE DIFFERENCES BY ETHNIC GROUP AMONG U.S. CHILDREN AND ADOLESCENTS

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Abstract

Large differences in blood pressure by ethnic group are apparent among adults. There is uncertainty as to whether similar differences by ethnic group exist among children and if so, the age of onset.

Blood pressure (BP) measurements were obtained from 58,698 children at 78,556 visits using data from the Pediatric Task Force data, a collection of 11 studies with BP data from children and adolescents age 1–17. Generalized estimating equation methods were used to identify sex-specific differences in body mass index (BMI)-adjusted rates of BP elevation and pre-hypertension by ethnic group.

Significant BMI-adjusted differences in rates of BP elevation were found between Hispanic boys vs. Caucasian boys (OR = 1.21, 95% CI = 1.07–1.37, p=0.002). No overall significant differences were found between African-American (AA) boys vs. Caucasian (Cauc) boys (OR = 1.03, 95% CI = 0.95–1.12, p=0.49); however, there was significant effect modification (p = 0.01) with significant differences found for normal weight boys (BMI < 85th percentile) (OR_{AA vs. Cauc} = 1.14, 95% CI = 1.03–1.27, p=0.01), but not for overweight boys (BMI ≥ 85th percentile) (OR_{AA vs. Cauc} = 0.90, 95% CI = 0.78–1.05, p=0.20). No overall ethnic group differences in BMI-adjusted rates of hypertension were found for girls.

Ethnic differences in prevalence rates of pediatric BP elevation that are not explained by obesity are present, primarily in boys. Whether these differences are due to genetic or environmental factors is unknown.

Keywords

blood pressure; hypertension; pediatrics; pediatric task force; pre-hypertension

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Conflict of Interest

None.

Introduction

We have recently published BP percentiles in normal weight children that are adjusted for age, sex and height¹. The analyses were based on children in the Pediatric Task Force Data Base with body mass index (BMI) < 85th percentile for a given age-sex group. Percentiles were obtained using quantile regression methods which were found to fit the data better than the previously used polynomial regression methods. The percentiles are slightly lower than previously published Task Force levels² which included both normal weight and overweight children in the normative database. We define a pre-hypertensive child as one whose systolic BP (SBP) or diastolic BP (DBP) is < 95th percentile and either ≥ 90th percentile or ≥ the adult threshold for pre-hypertension which is ≥120/80 mm Hg. BP elevation in children is defined as SBP and/or DBP ≥ 95th percentile.

An important issue in pediatric hypertension is whether prevalence varies by ethnic group. There are clear differences in the prevalence of hypertension by ethnic group in adults³, but results in children are more equivocal. A previous paper by our group⁴ compared African-American vs. Caucasian children using Task Force Data based on polynomial regression methods. Slight differences in mean BP were found between adolescent African-American girls vs. Caucasian girls that were mediated by body mass index (BMI) differences; no differences in mean BP were found between Caucasian and African-American boys. In the present report, we revisit these analyses using quantile regression methods since these were shown to be more accurate than polynomial regression methods. The latter assume that (a) the effect of height z-score is the same for all ages and (b) that distributions of pediatric BP are normally distributed, neither of which appear to be true for pediatric BP data. We use quantile regression methods with effects of age, height and age × height represented by cubic splines to estimate percentiles and expand the investigation by including Hispanic children as well. These methods provide for a more flexible response function relating BP to age and height and do not make assumptions of normality of residuals since separate sex-specific functions are used for each percentile. More details concerning these methods are provided elsewhere¹.

Methods

The dataset used for this analysis consisted of all children in the Pediatric Task Force Database². Normative data for BP as a function of age, gender and height have been determined for normal weight children. Normal weight children are defined as children whose BMI is < 85th percentile for their age and gender based on 2000 Center for Disease Control and Prevention (CDC) growth charts⁵. BP percentiles as a function of age, sex and height for normal weight children are available at the following website: (<http://www.geocities.com/bernardrosner/Pediatrics.html>). The goal of the present manuscript was to compare rates of pre-hypertension and BP elevation among Caucasian, African-American and Hispanic children in the Pediatric Task Force Database. Ethnic group was obtained by self-report. These analyses included both normal weight (BMI < 85th percentile) and overweight (BMI ≥ 85th percentile) children with BP standards based on normal weight children. We defined SBP elevation as SBP ≥ 95th percentile for a child's age, gender and height. A similar criterion was used with DBP (K5) for DBP elevation. In addition, we defined overall BP elevation as ≥ 95th percentile for either SBP or DBP. We defined systolic pre-hypertension as < 95th percentile and either ≥ 90th percentile or ≥ 120 mm Hg. We defined diastolic pre-hypertension as < 95th percentile and either ≥ 90th percentile or ≥ 80 mm Hg. We defined overall pre-hypertension as (either systolic pre-hypertension or diastolic pre-hypertension) and no overall BP elevation.

Statistics

All analyses were performed separately for boys and girls. Since there were systematic differences among studies even after accounting for age, sex, height and BMI we used study-corrected BPs in the analyses as described previously¹. Since some subjects had BP measured at multiple visits we used generalized estimating equations (GEE) with a logit link based on PROC GENMOD of SAS (Statistical Analysis System) to relate the presence of pre-hypertension or BP elevation at a particular visit to ethnic group with and without adjusting for BMI using the model:

$$\log [p_{ij}/(1 - p_{ij})]=\alpha+\beta_1x_{i1}+\beta_2x_{i2}+\gamma z_{ij}$$

where p_{ij} = prob (BP elevation or pre-hypertension) for the i^{th} child at the j^{th} visit, $x_{i1} = 1$ if subject i is African- American, = 0 otherwise, $x_{i2} = 1$ if subject i is Hispanic, = 0 otherwise, z_{ij} = BMI for the i^{th} subject at the j^{th} visit. To assess effect modification of ethnicity by BMI, we also considered GEE models of BP elevation (or pre-hypertension) on ethnicity, BMI and ethnicity \times BMI given by

$$\log [p_{ij}/(1 - p_{ij})]=\alpha_A+\beta_{1A}x_{i1}+\beta_{2A}x_{i2}+\beta_{3A}v_{ij}+\beta_{4A}x_{i1}v_{ij}+\beta_{5A}x_{i2}v_{ij}+\gamma_Az_{ij}$$

where $v_{ij} = 1$ if the i^{th} subject is overweight at the j^{th} visit, = 0 otherwise. β_{4A} and β_{5A} represent interaction effects of overweight by African-American and Hispanic ethnicity, respectively. To assess effects of ethnicity within (overweight/normal weight) subgroups we fit the model

$$\log [p_{ij}/(1-p_{ij})]=\alpha_B+\beta_0v_{ij}+\beta_{1B}x_{i1}v_{ij}+\beta_{1C}x_{i1}(1-v_{ij})+\beta_{2B}x_{i2}v_{ij}+\beta_{2C}x_{i2}(1-v_{ij})+\gamma_Bz_{ij}$$

The coefficients (β_{1B} , β_{2B}) and (β_{1C} , β_{2C}) represent effects of African-American and Hispanic ethnicity vs. Caucasian for overweight and normal weight children, respectively.

To assess differences in overweight prevalence by ethnic group we fit the model

$$\log [p_{ij}^*/(1 - p_{ij}^*)]=\alpha_C+\delta_1x_{i1}+\delta_2x_{i2}$$

Where p_{ij}^* = prob (overweight) for the i^{th} subject at the j^{th} visit.

To assess the effect of overweight status on the prevalence of BP elevation or pre-hypertension within specific ethnic groups we fit the model

$$\log [p_{ij}/(1 - p_{ij})]=\alpha_D+\beta_{1D}x_{i1}+\beta_{2D}x_{i2}+\gamma_{1D}v_{ij}(1 - x_{i1})(1 - x_{i2})+\gamma_{2D}v_{ij}x_{i1}+\gamma_{3D}v_{ij}x_{i2}$$

Results

The demographic data for the database used in this study⁶⁻²⁰ are presented in Table 1. A total of 58,698 children ages 1–17 provided data at 78,556 visits over 11 studies of whom 29,868 (51%) were boys and 28,830 (49%) were girls. 34,396 (59%) of the children were Caucasian, 18,016 (31%) were African- American and 6,288 (11%) were Hispanic. Diastolic BP was available for 43,152 (74%) of the children at 53,626 visits. Prevalence of BP elevation and pre-hypertension for systolic blood pressure (SBP) are presented by ethnic

group, gender and BMI group (normal weight < 85th percentile for BMI/overweight \geq 85th percentile for BMI) in Table 2.

The data in table 2 demonstrate that for SBP, the odds of BP elevation is 2.9–3.6 times higher and the odds of pre-hypertension is 1.8–2.2 times higher among overweight children vs. normal weight children for all ethnic and gender groups. The odds ratio for BP elevation is slightly higher among overweight adolescents (age 13–17, OR = 3.1–3.5) than among overweight children (age 1–12, OR = 2.4–3.2). The odds ratio for prehypertension was similar for children and adolescents (data not shown). Also, overweight prevalence is significantly higher among Hispanic boys (OR = 1.60, 95% CI = 1.47–1.75, $p < 0.001$) and girls (OR = 1.80, 95% CI = 1.65–1.96, $p < 0.001$) than their Caucasian peers (data not shown). Results for African-Americans differed by gender with a lower overweight prevalence for African-American boys (OR = 0.83, 95% CI = 0.78–0.88, $p < 0.001$) and a higher prevalence for African-American girls (OR = 1.30, 95% CI = 1.23–1.39, $p < 0.001$) than their Caucasian peers. Prevalence of SBP elevation ranges from 7–10% among boys and 7–8% among girls. Prevalence of systolic pre-hypertension ranges from 13–16% among boys and 8–9% among girls.

There are some differences in prevalence of systolic pre-hypertension and BP elevation by ethnic group. For boys, the crude prevalence of SBP elevation is not significantly different between African- American and Caucasian boys (OR= 0.96, $p = 0.39$). However, Hispanic boys have significantly higher prevalent SBP elevation rates than Caucasian boys (OR= 1.49, $p < 0.001$). Both African- American and Hispanic girls have a significantly higher crude prevalence of SBP elevation than Caucasian girls ($p \leq 0.003$). After adjusting for BMI, Hispanic boys continue to have a significantly higher prevalence of SBP elevation (OR= 1.29, 95% CI = 1.14–1.47, $p < 0.001$) while African-American boys have a slightly lower prevalence of SBP elevation (OR= 0.91, 95% CI = 0.83–1.00, $p = 0.06$) than Caucasian boys. For systolic pre-hypertension, significant BMI-adjusted differences were found between African-American boys vs. Caucasian boys (OR= 1.21, 95% CI = 1.13–1.30, $p < 0.001$) but not between Hispanic and Caucasian boys. For girls, no significant differences in SBP elevation or pre-hypertension prevalence among ethnic groups remain after adjusting for BMI. Results for DBP are presented in Table 3.

For DBP, the BMI-adjusted prevalence of BP elevation is significantly higher for both African-American boys (OR= 1.13, 95% CI= 1.01–1.26, $p = 0.04$) and Hispanic boys (OR = 1.19, 95% CI = 1.01–1.40, $p = 0.04$) compared with Caucasian boys. For girls, no significant difference between ethnic-specific prevalence of DBP elevation is found after adjusting for BMI. For diastolic pre-hypertension, significant BMI- adjusted differences were found for African-American vs. Caucasian boys (OR= 1.15, 95% CI = 1.03–1.29, $p = 0.01$), but not between Hispanic and Caucasian boys. Hispanic girls had a slightly lower BMI- adjusted prevalence of diastolic pre-hypertension than Caucasian girls (OR= 0.82, 95% CI = 0.68–0.99, $p = 0.04$). Results for overall BP elevation and pre-hypertension are given in Table 4.

For boys, the crude prevalence of BP elevation is significantly higher for Hispanics vs. Caucasians (OR= 1.41, 95% CI = 1.25–1.59, $p < 0.001$). After adjusting for BMI, Hispanic boys still have a higher prevalence of BP elevation (OR= 1.21, 95% CI = 1.07–1.37, $p = 0.002$). The BMI- adjusted ethnic differences persisted when children (age 1–12) (OR Hispanic vs. Caucasian boys = 1.39, 95% CI = 1.13–1.72, $p = 0.002$) and adolescents (age 13–17) (OR Hispanic vs. Caucasian boys = 1.16, 95% CI = 1.00–1.35, $p = 0.06$) were analyzed separately (data not shown). No significant differences are seen between African-American and Caucasian boys either before or after adjusting for BMI. For girls, African-American girls have a significantly higher prevalence of BP elevation than Caucasian girls (OR=1.17, 95% CI= 1.08–1.27, $p < 0.001$) which becomes non-significant after adjusting for BMI (OR=

1.02, 95% CI= 0.94–1.11, $p=0.61$). No significant differences are seen between the prevalence of BP elevation for Hispanic vs. Caucasian girls either with or without adjusting for BMI. For overall pre-hypertension there were significant BMI-adjusted differences between African-American vs. Caucasian boys (OR = 1.32, 95% CI = 1.22–1.43, $p<0.001$) and girls (OR = 1.23, 95% CI = 1.11–1.37, $p<0.001$). No significant differences were found between Hispanic and Caucasian boys but a slightly decreased risk of pre-hypertension was found for Hispanic vs. Caucasian girls (OR = 0.80, 95% CI = 0.67–0.95, $p=0.01$).

An assumption made in Tables 2–4 is that the differences between the prevalence of BP elevation and pre-hypertension by ethnic group are the same for all levels of BMI. In Table 5, we assess effect modification of ethnicity \times overweight status as well as estimate effects of ethnicity separately for normal weight and overweight children (see Statistical Methods for details of modelling).

For boys, there was significant effect modification of African- American ethnicity by BMI for both BP elevation ($p=0.01$) and pre-hypertension ($p=0.05$). No significant effect modification was found for Hispanic ethnicity by BMI. For normal weight boys (BMI $<85^{\text{th}}$ percentile), the prevalence of BP elevation was significantly elevated for both African-American boys (OR=1.14, 95% CI=1.03–1.27, $p=0.01$) and Hispanic boys (OR= 1.18, 95% CI= 1.00–1.39, $p = 0.05$). For overweight boys (BMI $\geq 85^{\text{th}}$ percentile), significant effects are seen for Hispanic boys (OR=1.23, 95% CI= 1.02–1.48, $p=0.03$), but not for African-American boys (OR = 0.90, 95% CI= 0.78–1.05, $p=0.20$). Similar results are seen for pre-hypertension. For girls, no significant effect modification of ethnicity by BMI was found for BP elevation; however, for pre-hypertension significant effects are seen for normal weight African-American girls vs. Caucasian girls (OR = 1.32, 95% CI = 1.17–1.49, $p <0.001$), but not for overweight girls (OR = 0.99, 95% CI = 0.82–1.21, $p=0.93$, p -interaction =0.01).

Discussion

For overweight children (BMI $\geq 85^{\text{th}}$ percentile) the odds of pre-hypertension increases about 50% and the odds of BP elevation increases two to three-fold in all race/ethnic groups compared with normal weight children. Ethnic differences in the prevalence of both BP elevation and pre-hypertension were identified even after controlling for BMI. Hispanic boys, both normal weight and overweight, have a significantly higher prevalence of BP elevation (SBP and/or DBP $\geq 95^{\text{th}}$ percentile) compared to Caucasian boys. Hispanic boys also had a significantly higher prevalence of BP elevation when SBP and DBP were considered separately. The prevalence of BP elevation was significantly higher in normal weight African-American boys than their Caucasian counterparts, but was similar in overweight African-American and Caucasian boys. These results persisted when children (age 1–12) and adolescents (age 13–17) were considered separately. Results for pre-hypertension differed somewhat, with a higher prevalence observed for African- American boys, (but not Hispanic boys) as compared with Caucasian boys, especially among normal weight boys. The race/ethnic disparity in BP is much less apparent among girls. Because BMI is higher on average in both African American and Hispanic girls, after adjusting for BMI there is no difference in the prevalence of BP elevation among the three race/ethnic groups.

These results on the prevalence of BP elevation among race/ethnic groups in childhood are different than the data on prevalence of hypertension across race/ethnic groups in adults. The prevalence of obesity among patients with hypertension is much higher than the population prevalence of obesity. In addition to the obesity-hypertension relationship in adults, there appears to be an added effect of race or ethnicity. Similarly, fat patterning as characterized by waist-to-hip ratio does not explain the racial differences in hypertension

among adults²¹. A limitation of the current study is that waist/hip ratio was not available for the Task Force database. Data on adults from the National Health and Nutrition Examination Survey³ show that African Americans have the highest prevalence of hypertension at 37.8% in men and 40.3% in women; the prevalence of hypertension in Hispanic men (22.1%) is somewhat lower than Caucasian men at 26.0%. The prevalence of hypertension is nearly equivalent in Caucasian (21%) and Hispanic (21.6%) adult women.

While adult African Americans, both men and women, have the highest prevalence of hypertension, our data show that in children, Hispanic boys have the highest prevalence of elevated BP, although African-American boys have the highest rate of pre-hypertension. Overweight prevalence is highest among Hispanic boys and girls compared to the other race/ethnic groups. But even among the normal weight children the rates of BP elevation are highest among Hispanic boys compared to other race/ethnicity (and sex) groups. When the rates of BP elevation are compared in boys the rates are only slightly higher in African American boys, and this is due to somewhat greater rates of DBP elevation. While the explanation for this race/ethnicity difference between childhood and adulthood is uncertain, these findings could indicate an emerging trend toward increasing risk for hypertension and subsequent cardiovascular disease among Hispanic children as they age into adulthood.

Because the 95th percentile of the BP distribution is used to define BP elevation, the prevalence of high BP is expected to be approximately 5% among normal weight children on the basis of a single measurement in this group^{1, 2}. Our results on the prevalence of both SBP and DBP elevation in normal weight children are close to the expected 5%. The prevalence of both BP elevation and pre-hypertension clearly increase among the overweight groups in all three ethnic groups, both males and females. One limitation of our study is that the data were drawn from several epidemiologic surveys on healthy children mostly from the 1970's and 1980's. Thus the data used in this analysis were obtained prior to the current childhood obesity epidemic, that is now well established²². Considering the increasing overall prevalence of obesity in the childhood population and the evidence that the prevalence of BP elevation is higher in obese children, it would be expected that the current prevalence of BP elevation would be higher than the prevalence for the earlier sample that was used in this analysis.

The results reported here are similar to the results of a study to determine the effect of increasing BMI on BP among children in primary care pediatric practices²³. In that study, electronic medical record data were analyzed on over 18,000 children between 2 and 19 years of age. The effect of increasing BMI on both BP level and the prevalence of BP elevation was significant in both males and females, although no analysis by ethnic group was reported. The prevalence of BP elevation among normal weight males and females was also close to 5% with a substantially higher prevalence of BP elevation in the overweight groups. An analysis of the trends in childhood BP from two sequential national cross-sectional studies identified a significant increase in both SBP and DBP. The BP increase was most significant among minority groups, which also have the highest rates of childhood obesity²⁴.

A second limitation of this study is that the ascertainment of pre-hypertension and BP elevation were based on only one BP measurement session. A designation of hypertension or pre-hypertension that uses a single BP measurement generally overestimates the prevalence because BP tends to decrease in subsequent visits due to an accommodation effect and regression to the mean². In clinical practice, an average SBP or DBP $\geq 95^{\text{th}}$ percentile obtained on at least three separate visits is required for the clinical diagnosis of hypertension in childhood. Recent reports have demonstrated that, using these criteria, the prevalence of childhood hypertension is from 3.2 to 3.6%^{25, 26}. Considering a prevalence of

3.2 to 3.6%, hypertension can be considered one of the most common chronic diseases in childhood. Moreover, BP data from other studies indicate that a single BP measurement does provide important information regarding risk of future BP elevation and cardiovascular disease. A recent systematic review and analysis of 50 cohort studies that examined BP tracking documented significant BP tracking correlation coefficients from childhood into adulthood²⁷. The strength of the tracking increased with baseline age and decreased with follow-up length. The analysis concluded that data from diverse populations show that the evidence for BP tracking from childhood into adulthood is strong and that early intervention is important. The population evidence is substantial that BP measured in childhood predicts future BP with a tracking coefficient of approximately 0.4 for SBP²⁸.

Perspective

Racial disparities in the prevalence of hypertension and pre-hypertension have been identified in adults and are also detectable in children. Some of the observed differences appear to be associated with population differences in overweight and obesity between the pediatric and adult populations. Data in this study demonstrate differences in BP elevation by race/ethnicity, particularly for boys after controlling for the effect of BMI, which appear to be different than observed in adults. These differences may portend a different epidemiology of hypertension when these children and adolescents reach adulthood. As the prevalence of childhood obesity increases, the prevalence of high BP in childhood is expected to increase, especially among Hispanics, and contribute to rising rates of premature cardiovascular disease.

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Table 1

Ethnic and Demographic Data By Study Population, Pediatric Task Force Data

Source	Time Period	Age	Gender		Ethnic Group			Persons (visits) SBP Available	Persons (visits) DBP Available	Total No. of Persons (visits)
			Boys	Girls	Caucasian	African-American	Hispanic			
NHANES II ⁶	1976–1980	6–17	1,843	1,720	2,963	600	0	3,563 (3,563)	3,526 (3,526)	3,563 (3,563)
Pittsburgh ⁷	1975–1982	1–5	148	136	176	108	0	284 (890)	0 (0)	284 (890)
Dallas ^{8,9}	1976–1980	13–17	5,915	5,649	4,728	5,266	1,570	11,564 (21,859)	11,564 (21,851)	11,564 (21,859)
Bogalusa ^{10–12}	1973–1982	1–17	3,715	3,607	4,878	2,480	0	7,358 (15,880)	0 (0)	7,358 (15,880)
Houston ¹³	1975–1978	3–17	1,386	1,339	748	636	1,341	2,725 (2,725)	0 (0)	2,725 (2,725)
South Carolina ¹⁴	1982–1983	4–17	3,162	3,261	3,315	3,108	0	6,423 (6,423)	6,362 (6,362)	6,423 (6,423)
Iowa ^{15,16}	1981	5–17	2,098	1,993	4,091	0	0	4,091 (4,091)	0 (0)	4,091 (4,091)
Providence ¹⁷	1985–1987	1–3	229	230	431	24	4	459 (894)	369 (556)	459 (894)
Minnesota ¹⁸ (sodium-potassium blood pressure trial in children)	1986–1987	9–17	7,916	7,367	11,307	3,421	555	15,283 (15,283)	15,127 (15,127)	15,283 (15,283)
NHANES III ¹⁹	1988–1991	5–17	2,405	2,513	1,322	1,768	1,828	4,918 (4,918)	4,202 (4,202)	4,918 (4,918)
NHANES 1999–2000 ²⁰	1999–2000	8–17	1,015	1,015	437	605	988	2,030 (2,030)	2,002 (2,002)	2,030 (2,030)
TOTAL		1–17 (%)	29,868 (51)	28,830 (49)	34,396 (59)	18,016 (31)	6,288 (11)	58,698 (78,556)	43,152 (53,626)	58,698 (78,556)

Table 2

Percent of Pre- Hypertensive and Hypertensive Children for SBP by BMI Percentile, Ethnic Group and Gender*

Ethnic Group	Normal Weight Children †			Overweight Children ‡				Total			Unadjusted		BMI Adjusted	
	Number of Visits	Number Elevated	%	Number of Visits	Number Elevated	%	OR // (95% CI)	Number of Visits	Number Elevated	%	OR (95% CI)	P-value§	OR (95% CI)	P-value§
<i>SBP Hypertension Boys</i>														
Caucasian	18,001	870	4.8	4,784	684	14.3	3.17 (2.84–3.54)	22,785	1,554	6.8	1.0 (ref)		1.0 (ref)	
African-American	10,919	528	4.8	2,328	328	14.1	3.07 (2.63–3.58)	13,247	856	6.5	0.96 (0.87–1.05)	0.39	0.91 (0.83–1.00)	0.06
Hispanic	2,673	174	6.5	1,075	193	18.0	3.13 (2.51–3.90)	3,748	367	9.8	1.49 (1.31–1.68)	<0.001	1.29 (1.14–1.47)	<0.001
<i>SBP Pre-Hypertension Boys</i>														
Caucasian	18,001	2,074	11.5	4,784	891	18.6	2.00 (1.82–2.18)	22,785	2,968	13.0	1.0 (ref)		1.0 (ref)	
African-American	10,919	1,590	14.6	2,328	495	21.3	1.76 (1.56–1.98)	13,247	2,085	15.7	1.26 (1.18–1.34)	<0.001	1.21 (1.13–1.30)	<0.001
Hispanic	2,673	368	13.8	1,075	213	19.8	1.83 (1.51–2.23)	3,748	581	15.5	1.26 (1.14–1.40)	<0.001	1.05 (0.94–1.17)	0.41
<i>SBP Hypertension Girls</i>														
Caucasian	17,691	856	4.8	4,164	556	13.4	2.94 (2.62–3.31)	21,855	1,412	6.5	1.0 (ref)		1.0 (ref)	
African-American	10,174	542	5.3	3,131	452	14.4	2.93 (2.54–3.37)	13,305	994	7.5	1.16 (1.06–1.28)	0.001	1.00 (0.91–1.09)	0.92
Hispanic	2,540	124	4.9	1,076	172	16.0	3.61 (2.78–4.67)	3,616	296	8.2	1.24 (1.08–1.43)	0.003	1.02 (0.88–1.17)	0.82
<i>SBP Pre-Hypertension Girls</i>														
Caucasian	17,691	1,216	6.9	4,164	514	12.3	2.13 (1.90–2.37)	21,855	1,730	7.9	1.0 (ref)		1.0 (ref)	
African-American	10,174	813	8.0	3,131	414	13.2	1.96 (1.72–2.23)	13,305	1,227	9.2	1.20 (1.11–1.30)	<0.001	1.07 (0.98–1.16)	0.11
Hispanic	2,540	175	6.9	1,076	133	12.4	2.18 (1.71–2.79)	3,616	308	8.5	1.10 (0.97–1.26)	0.14	0.94 (0.83–1.08)	0.39

* (Prehypertensive = ≥ 90 th percentile or ≥ 120 mmHg) and < 95 th percentile); hypertensive = ≥ 95 th percentile based on quantile regression methods.

† Normal weight children = BMI < 85 th percentile.

‡ Overweight children = BMI ≥ 85 th percentile.

§ Based on Proc GENMOD of SAS.

// Odds ratio for SBP hypertension (pre-hypertension) for overweight vs. normal weight children.

Table 3

Percent of Pre- Hypertensive and Hypertensive Children for DBP by BMI Percentile, Ethnic Group and Gender *

Ethnic Group	Normal Weight Children †			Overweight Children ‡			OR // (95% CI)	Total			Unadjusted		BMI Adjusted	
	Number of Visits	Number Elevated	%	Number of Visits	Number Elevated	%		Number of Visits	Number Elevated	%	OR (95% CI)	P-value§	OR (95% CI)	P-value§
<i>DBP Hypertension Boys</i>														
Caucasian	11,374	494	4.3	3,116	297	9.5	2.29 (1.96 – 2.67)	14,490	791	5.5	1.0 (ref)		1.0 (ref)	
African-American	7,828	440	5.6	1,804	159	8.8	1.60 (1.32 – 1.94)	9,632	599	6.2	1.16 (1.04–1.30)	0.008	1.13 (1.01–1.26)	0.04
Hispanic	2,011	109	5.4	876	95	10.8	2.10 (1.57 – 2.81)	2,887	204	7.1	1.32 (1.12–1.55)	<0.001	1.19 (1.01–1.40)	0.04
<i>DBP Pre-Hypertension Boys</i>														
Caucasian	11,374	598	5.3	3,116	211	6.8	1.39 (1.18 – 1.64)	14,490	809	5.6	1.0 (ref)		1.0 (ref)	
African-American	7,828	463	5.9	1,804	160	8.9	1.60 (1.32 – 1.95)	9,632	623	6.5	1.18 (1.06–1.32)	0.003	1.15 (1.03–1.29)	0.01
Hispanic	2,011	114	5.7	876	52	5.9	1.11 (0.80–1.55)	2,887	166	5.7	1.05 (0.89–1.25)	0.56	0.97 (0.82–1.15)	0.72
<i>DBP Hypertension Girls</i>														
Caucasian	11,210	544	4.9	2,781	332	11.9	2.62 (2.26–3.02)	13,991	876	6.3	1.0 (ref)		1.0 (ref)	
African-American	7,364	402	5.5	2,410	294	12.2	2.38 (2.03–2.80)	9,774	696	7.1	1.15 (1.04–1.28)	0.008	1.02 (0.92–1.14)	0.72
Hispanic	1,954	89	4.6	898	99	11.0	2.58 (1.89–3.53)	2,852	188	6.6	1.05 (0.88–1.24)	0.59	0.88 (0.74–1.05)	0.15
<i>DBP Pre-Hypertension Girls</i>														
Caucasian	11,210	584	5.2	2,781	212	7.6	1.63 (1.39–1.92)	13,991	796	5.7	1.0 (ref)		1.0 (ref)	
African-American	7,364	389	5.3	2,410	172	7.1	1.49 (1.24–1.80)	9,774	561	5.7	1.02 (0.91–1.14)	0.75	0.96 (0.85–1.07)	0.47
Hispanic	1,954	89	4.6	898	57	6.3	1.53 (1.09–2.15)	2,852	146	5.1	0.90 (0.75–1.08)	0.24	0.82 (0.68–0.99)	0.04

* Prehypertensive = (≥ 90 th percentile or ≥ 80 mmHg) and < 95 th percentile ; hypertensive = ≥ 95 th percentile based on quantile regression methods.

† Normal weight children = .BMI < 85 th percentile;

‡ Overweight children=BMI ≥ 85 th percentile

§ Based on Proc GENMOD of SAS

// Odds ratio for DBP hypertension (pre-hypertension) for overweight vs. normal weight children

Table 4

Percent of Hypertensive and Pre-Hypertensive Children by BMI percentile, Ethnic Group and Gender *

Ethnic Group	Normal Weight Children †			Overweight Children ‡				Total			Unadjusted		BMI Adjusted	
	Number of Visits	Number Elevated	%	Number of Visits	Number Elevated	%	OR // (95% CI)	Number of Visits	Number Elevated	%	OR// (95% CI)	P-value§	OR// (95% CI)	P-value§
<i>Hypertension, Boys</i>														
Caucasian	11,374	977	8.6	3,116	649	20.8	2.72 (2.43–3.04)	14,490	1,626	11.2	1.0 (ref)		1.0 (ref)	
African-American	7,828	764	9.8	1,804	365	20.2	2.25 (1.95–2.59)	9,632	1,129	11.7	1.08 (0.99–1.17)	0.08	1.03 (0.95–1.12)	0.49
Hispanic	2,011	209	10.4	876	222	25.3	2.91 (2.35–3.61)	2,887	431	14.9	1.41 (1.25–1.59)	<0.001	1.21 (1.07–1.37)	0.002
<i>Pre-Hypertension, Boys</i>														
Caucasian	11,374	1,317	11.6	3,116	505	16.2	1.47 (1.31–1.65)	14,490	1,822	12.6	1.0 (ref)		1.0 (ref)	
African-American	7,828	1,206	15.4	1,804	362	20.1	1.35 (1.18–1.54)	9,632	1,568	16.3	1.37 (1.27–1.47)	<0.001	1.32 (1.22–1.43)	<0.001
Hispanic	2,011	273	13.6	876	150	17.1	1.30 (1.04–1.62)	2,887	423	14.7	1.24 (1.10–1.39)	<0.001	1.00 (0.88–1.14)	1.00
<i>Hypertension, Girls</i>														
Caucasian	11,210	988	8.8	2,781	616	22.2	2.88 (2.57–3.22)	13,991	1,604	11.5	1.0 (ref)		1.0 (ref)	
African-American	7,364	720	9.8	2,410	568	23.6	2.80 (2.46–3.18)	9,774	1,288	13.2	1.17 (1.08–1.27)	<0.001	1.02 (0.94–1.11)	0.61
Hispanic	1,954	157	8.0	898	208	23.2	3.40 (2.67–4.32)	2,852	365	12.8	1.10 (0.97–1.25)	0.15	0.91 (0.79–1.03)	0.14
<i>Pre-Hypertension, Girls</i>														
Caucasian	11,210	624	5.6	2,781	261	9.4	1.76 (1.51–2.05)	13,991	885	6.3	1.0 (ref)		1.0 (ref)	
African-American	7,364	563	7.7	2,410	279	11.6	1.56 (1.33–1.82)	9,774	842	8.6	1.39 (1.26–1.54)	<0.001	1.23 (1.11–1.37)	<0.001
Hispanic	1,954	97	5.0	898	75	8.4	1.72 (1.24–2.38)	2,852	172	6.0	0.96 (0.81–1.14)	0.64	0.80 (0.67–0.95)	0.01

* Hypertension = \geq the 95th percentile for either systolic or diastolic BP based on quantile regression methods; pre-hypertension = either systolic or diastolic pre-hypertension and not hypertensive

† Normal weight children = BMI <85th percentile.

‡ Overweight children=BMI \geq 85th percentile

§ Based on Proc GENMOD of SAS

// Odds ratio for hypertension (pre-hypertension) for overweight vs. normal weight children

Table 5

Effect Modification of the Association between Hypertension, Pre-hypertension* and Ethnicity by Body mass Index, Pediatric Task Force Data

Ethnic Group	Boys					Girls				
	Normal Weight †		Overweight †		p, interaction§	Normal Weight †		Overweight †		p, interaction§
OR# (95% CI)	p-value‡	OR# (95% CI)	p-value‡	OR# (95% CI)		p-value‡	OR# (95% CI)	p-value‡		
<i>Hypertension</i>										
Caucasian	1.0 (ref)		1.0 (ref)			1.0 (ref)		1.0 (ref)		
African-American	1.14 (1.03–1.27)	0.01	0.90 (0.78–1.05)	0.20	0.01	1.08 (0.97–1.20)	0.14	0.97 (0.85–1.11)	0.69	0.22
Hispanic	1.18 (1.00–1.39)	0.05	1.23 (1.02–1.48)	0.03	0.74	0.84 (0.70–1.01)	0.06	0.96 (0.79–1.16)	0.67	0.31
<i>Pre-hypertension</i>										
Caucasian	1.0 (ref)		1.0 (ref)			1.0 (ref)		1.0 (ref)		
African-American	1.28 (1.17–1.39)	<0.001	1.02 (0.83–1.25)	0.83	0.05	1.32 (1.17–1.49)	<0.001	0.99 (0.82–1.21)	0.93	0.01
Hispanic	1.06 (0.92–1.23)	0.41	0.83 (0.64–1.08)	0.17	0.11	0.82 (0.66–1.02)	0.08	0.73 (0.55–0.99)	0.04	0.57

* Hypertension = \geq the 95th percentile for either systolic or diastolic BP based on quantile regression methods; pre-hypertension = either systolic or diastolic pre-hypertension and not hypertensive

† Normal weight = < 85th percentile; overweight = \geq 85th percentile

‡ Based on PROC GENMOD of SAS

§ P-value for interaction of ethnicity x Normal weight/overweight

// Odds ratio for hypertension (pre-hypertension) for overweight vs. normal weight children