Epidemiology of Hypertension from Childhood to Young Adulthood in Black, White, and Hispanic Population Samples

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SYNOPSIS

RESEARCHERS RECORDED BLOOD PRESSURE LEVELS of children and adolescents in the Bogalusa Heart Study (black and white populations) and in the Brooks County Study (Hispanic population). Hispanic children had smaller stature, while whites and Hispanics tended to be fatter than blacks in childhood. In Bogalusa, black boys showed higher blood pressure levels. Hispanic girls showed lower systolic blood pressure than the other ethnic groups. In cultures with a high prevalence of hypertension, such as blacks in the United States, it is important to understand the effect of environmental factors like dietary intake and electrolytes and obesity on the control of hypertension.

Hypertension is the second most common form of cardiovascular disease in the United States, involving about 25% of the adult population. Hypertension accelerates atherosclerosis and is commonly associated with diabetes mellitus. Although hypertension is a common clinical entity, it is poorly understood in the early stages. Consequently, the true prevalence of hypertension remains unknown particularly during youth and early adulthood. Although hypertension is a major health risk in virtually all populations, limited information exists on children and adolescents of different ethnic groups especially when studied under comparable conditions.

Unlike atherosclerosis, documentation of early anatomic hypertensive effects on the cardiovascular system is difficult; however, autopsy studies on young individuals have shown that increasing heart weight and microscopic thickening of small renal arteries correlate with increasing blood pressure levels *(1)*. Experimental studies by Folkow and others *(2)* and Mulvany *(3)* have indicated that small renal artery changes do occur as a result of hypertension, particularly with hypertrophy of smooth muscle cells and increased thickness of the media of small renal arteries. Further, Tracy and colleagues *(4)* have shown early renal intimal-media fibroplasia and early atherosclerosis relate to higher blood pressure levels in Bogalusa Heart Study participants.

Fortunately, it is becoming possible to detect subtle evidence of hypertensive cardiovascular disease in children and young adults by non-invasive studies. In childhood, echocardiographic measurements can document

cardiac changes. Increased left ventricular wall thickness and left ventricular mass occurs at higher blood pressure levels in children and adolescents, particularly in those in the uppermost quintiles of the distribution. Hemodynamic increases in cardiac output and increased peripheral resistance are found in children and young adults with levels persisting at the 90th or 95th percentile *(5–7)*. These levels are considerably lower than the conventional cutoff point of 140/90 mmHg used to identify adults with early mild hypertension. Hemodynamic studies indicate an increased left ventricular stroke volume and cardiac output in white males with higher blood pressure, while an increased peripheral resistance occurs in black males *(7)*. Schieken and others also find by Doppler ultrasound measurements a correlation of systolic pressure with aortic stiffness *(8)*. Ultrasonic studies of the carotid arteries of children and young adults indicate that white males with higher systolic blood pressure and higher concentrations of serum cholesterol have diminished arterial elasticity *(9)*. Also, a decreased carotid artery resilience was found in offspring with a parental history of myocardial infarction.

The observations that both coronary atherosclerosis and hypertensive disease begin in childhood *(1)* establish a subtle and early development of heart disease in populations of Westernized cultures. These population studies give credibility to examining children for cardiovascular risk and beginning prevention early for whole populations. Sorting out genetic and environmental factors in early life that are responsible for the production of hypertension and understanding the genetic and environmental interactions that occur in specific populations with high or low incidence of hypertension are important. Understanding ethnic differences in a relatively homogenous culture may give clues to the role of genetic differences in the production of hypertension. In the Bogalusa Heart Study, the effect of ethnic differences has been particularly evident in the study of a young population of blacks and whites in a single community *(10)*. Although there are socioeconomic differences within the population, the biracial population shares some common environmental factors, such as consumption of the same meals as part of the school nutrition program. Yet, there were considerable contrasts between the two racial groups that relate to early hypertension.

Methods

Several populations participated in blood pressure studies. Most information comes from the Bogalusa Heart Study, a 20-year epidemiologic program, which has been described previously *(11,12)*. A biracial population (65% white and 35% black) numbering about 14,000 comprised the study cohort, most of whom were examined from two to six times over the 20-year period. Special subsets of the population, such as children (n=273) with previously documented high or low blood pressure levels, participated in additional blood pressure studies.

The study cohort for the Brooks County Heart Study comprised Hispanic children in Brooks County, a rural county in southern Texas *(13)*, where the population is 95% Mexican American. A 25% random sample of all children enrolled in kindergarten through grade 12 participated in the Brooks County Heart Study from 1984 to 1985. Researchers using the Bogalusa Heart Study protocols examined a total of 401 Hispanic children between the ages of 5 and 17. Bogalusa Heart Study staff conducted training sessions *(11)*.

In both studies, trained observers measured blood pressure following established protocols *(11)*: Two observers recorded three readings each, using the right arm of participants who were seated and relaxed. Measurements included first, fourth, and fifth Korotkoff phases as recorded with a mercury sphygmomanometer. In some studies, observers used an automatic instrument to record additional measurements, for a total of nine readings. Most analyses, however, were based on the average of the six mercury sphygmomanometer recordings.

The study protocols also included anthropometric measurements of height, weight, and triceps and subscapular skinfolds. Since most blood pressure studies

Table 1. Blood pressure and body mass index in Caucasian children

The Bogalusa Heart Study

			Systolic BP		Diastolic BP		BMI	
Sex	Age	n	Mean	s	Mean	s	Mean	s
Males	3–5	126	93.3	7.2	52.2	7.5	15.4	1.2
	6–9	251	96.7	7.6	57.7	7.9	16.6	2.4
	10–12	265	102.3	8.6	60.9	8.0	19.3	3.7
	13–15	285	110.3	9.1	63.3	8.0	21.4	4.2
	16–17	120	115.4	9.4	68.2	7.8	22.2	4.2
Females	3–5	90	93.5	8.2	53.5	9.2	15.8	2.4
	6–9	273	97.1	9.1	59.7	8.2	17.1	3.2
	10–12	248	102.4	8.6	52.6	8.3	19.3	3.9
	13–15	297	107.7	8.5	68.0	7.5	21.8	4.6
	16–17	117	109.3	8.0	69.2	7.0	21.8	3.9

Table 2. Blood pressure and body mass index in black children

The Bogalusa Heart Study

Sex	Age	n	Systolic BP		Diastolic BP		BMI	
			Mean	s	Mean	s	Mean	s
Males	3–5	77	93.6	8.5	53.9	9.3	15.4	1.5
	6–9	154	95.6	8.2	57.7	7.8	16.6	2.4
	10–12	154	102.6	8.7	60.4	7.5	19.0	4.5
	13–15	141	111.3	9.8	62.3	8.8	20.9	3.9
	16–17	76	116.3	10.2	65.6	8.1	22.3	4.2
Females	3–5	71	92.5	8.6	54.3	8.9	15.3	1.7
	6–9	170	97.2	9.7	59.8	8.3	16.6	2.6
	10–12	154	103.2	9.5	63.1	9.2	20.2	4.5
	13–15	159	110.3	9.3	67.0	8.6	22.5	5.4
	16–17	66	112.8	8.9	70.2	8.5	23.4	5.5

Table 3. Blood pressure and body mass index in Hispanic children

The Bogalusa Heart Study

Sex	Age	n	Systolic BP		Diastolic BP		BMI	
			Mean	s	Mean	s	Mean	s
Males	3–5	20	85.5	8.6	49.7	7.4	15.9	1.6
	6–9	77	95.0	10.5	56.7	8.3	18.5	4.1
	10–12	43	101.3	8.7	62.3	7.0	20.6	4.6
	13–15	46	109.9	12.2	66.9	7.9	22.1	5.1
	16–17	22	113.3	7.4	69.8	7.6	25.7	5.4
Females	3–5	22	83.3	8.5	49.2	7.3	16.6	2.5
	6–9	61	92.7	9.5	56.4	8.6	18.1	4.6
	10–12	43	99.2	7.9	62.7	8.0	19.6	4.2
	13–15	43	104.3	9.7	68.4	7.9	21.6	2.8
	16–17	24	108.6	9.6	68.2	7.4	21.8	2.6

were part of a general cardiovascular risk factor screening, observers also obtained parental history and information on lifestyles, including diet.

Results

In the Bogalusa Heart Study observers noted progressive increases in stature for girls to ages 15 or 16, and for boys to age 17 with boys 5 cm taller than girls by adolescence. They noted little difference in height between blacks and whites; however, blacks and whites exhibit differences in body mass index (BMI), a measure of fatness, throughout childhood and early adolescence. In general, girls have more body fatness, and blacks have more lean body mass and are thinner than whites. By late adolescence white boys tend to be considerably heavier than black boys. Black girls tend to have a higher BMI than white girls at most ages. This difference is particularly exaggerated at the extreme percentiles.

Black children at all ages tend to exhibit somewhat higher blood pressure levels. In the early age periods an automatic blood pressure recording instrument detected differences, while higher levels in blacks around adolescent age became more evident with the mercury sphygmomanometer. Black girls had systolic blood pressures about 3 to 4 mmHg higher than those of white girls after age 10, and black boys showed consistently higher levels beginning in adolescence. Blood pressure levels increased until adult stature was reached, around age 18 in males and around age 15 in females. Studies indicate a close correlation of blood pressure levels with height and with the logarithm of weight. The correlation of blood pressure with height or weight does not change with age.

In the Brooks County Study, systolic blood pressure levels for Hispanic boys were remarkably similar to those for white and black boys in the Bogalusa Heart Study (Tables 1 to 3). Systolic blood pressure levels were somewhat lower (5 mmHg) for Hispanic girls over the entire range. Diastolic blood pressure (fourth phase) levels, on the other hand, were slightly higher in Hispanic boys than in the older white or black boys. Observers noted no consistent racial differences in diastolic pressure for girls. Hispanics were smaller in stature, although their BMI was higher than that of blacks or whites.

One or two years later, observers examined a special subset of the Bogalusa population—a cohort of black and white children stratified by diastolic blood pressure—to examine determinants of high or low blood pressure *(10,12)*. They noted a number of physiologic and metabolic black-white contrasts. These included greater obesity in the white children with the higher blood pressure levels. Obesity had a smaller impact on blood pressure levels in black children, and higher post-glucose-load blood glucose was prevalent in white children with higher blood pressure levels. White children also showed higher renin and dopamine beta hydroxylase levels. In addition,

blacks showed a significantly lower potassium excretion in 24-hour urine collections.

In studies using ambulatory blood pressure measurements, observers noted smaller decreases of nighttime blood pressures in blacks. Echocardiographic studies indicated greater cardiac output in whites with higher blood pressure levels, while black males showed higher peripheral resistance associated with higher blood pressure levels.

Discussion

Genetic and environmental factors contribute to the development of hypertension. Ethnicity very likely plays a significant role in the genetic-environmental interaction, which was illustrated by the black-white contrasts in the Bogalusa Heart Study. For example, obesity in young white children influences the development of hypertension more so than in young black males. However, cross-cultural differences likely show greater influences on the prevalence of hypertension in various populations than will the genetic influence in early life. Consequently, understanding those environmental factors that contribute to population or ethnic differences in blood pressure levels over time is imperative, as will be understanding the impact of factors like dietary intake and electrolytes, and obesity and inactivity in the control of hypertension, in cultures with a high prevalence of hypertension. These observations can serve as a guide to future prevention and better management of hypertensive disease.

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