Hypertension: Effects of Social Class and Racial Admixture

The Results of a Cohort Study in the Black Population of Charleston, South Carolina

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Abstract: It has been hypothesized that genetic factors, as manifested by skin color, play an important role in the genesis of hypertension among Blacks. A community-based study was carried out in Charleston County, South Carolina to test this hypothesis. The results of a ten year follow-up study suggest that social class and age were more consistently associated with the incidence of hypertension and levels of blood pressure. The association of hypertension with skin color was minimal and substantially less than that of social class.

The incidence rate of hypertension (≥ 150 and ≥ 90 mm Hg) was three to four times greater when the study participants were of low social class than when they had higher social class scores at the beginning of this study. In contrast, the incidence rate was only 1.5 times higher for dark than for lighter skinned men, and the rates were almost identical when social class was comparable. Similar results emerged when blood pressure was treated as a continuous variable; blood pressure levels and pressure changes over time were consistently and significantly ($p < .01$) higher in those Blacks categorized as low social class, controlling for skin color. (Am. J. Public Health 67:634–639, 1977)

Introduction

It has been known for sometime that within the United States the prevalence of hypertension was substantially lower in Whites than in Blacks although this differential has been more pronounced in studies[1–4] reported from the Southeast. Only one U.S. community-based biracial incidence study has been reported to date, and it, consistent with the prevalence studies, indicated an approximately two times higher incidence rate of hypertension in Blacks than Whites.[5] Boyle not only confirmed a racial differential, but his cross-sectional study showed the first quantitative association between blood pressure and skin color.[6] Using a reflectometer, he demonstrated a positive correlation of skin pigmentation with blood pressure. With each five units of decreasing skin reflectance (or darkening) among Black men, the age adjusted systolic pressure increased 3.1 mm Hg and the diastolic blood pressure increased by 1.3 mm Hg. Other workers have also noted that darker skin color was related to high blood pressure levels independent of residential stress areas.[7]

Studies relating blood pressure and social class among Blacks have been few in number. Howard and Holman found that for both races, Social Class V (the lowest) had the largest mortality ratios for hypertension.[8] Harburg, et al. found blood pressures higher in residents of Black high-stress areas compared with Black low-stress areas, where ecologic stress was assessed by economic deprivation, residential and family instability, crime, and population density.[7] Kotchen, et al. reported that blood pressure was significantly higher in Black students whose fathers worked as laborers than in those whose parents had professional occupations.[9] And, Syme, et al. also found an inverse relation between the prevalence of hypertension and social class in Oakland and San Francisco, California.[10]

In an earlier follow-up of high social class Blacks in the Charleston Heart Study, one of these authors (JEK) was impressed by the lack of hypertension, generally excellent health, and the low mortality of this select group with light skin color when compared with the general Black population in the Charleston, South Carolina area. From these observations and impressions evolved two hypotheses—one of heterosis or hybrid vigor—that these high social class Black subjects, who were obviously the product of several generations of racial admixture, had distinct health advantages over those less racially admixed Blacks as well as the predominant Caucasian. The second hypothesis involved the assumption that skin color was a genetic marker and may, indeed, relate to blood pressure. The first hypothesis will not be considered in this report. The second, however, will be examined in light of social class and selected antecedent variables measured in 1960.

The biracial county of Charleston, South Carolina, with its unique dimensions of extremes of social class as well as a

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spectrum of skin color among Blacks, provided an opportunity to observe over time the joint effects of genetic and environmental factors. Thus, this paper will report the individual and joint effects of ethnicity and life styles on hypertension, a prime risk factor for cardiovascular disease.

Specifically, this paper will report on the incidence of hypertension and blood pressure levels over time in association with social class, skin color, and other variables.

Methods

The study population from Charleston, South Carolina was a random sample of Black males, age 35 years or older in 1960 and also a group of high socioeconomic adult Black males in 1964. This first group is one of the four race-sex groups of the Charleston Heart Study, a cohort study of a random sampling of Charleston County, South Carolina residents 35 years and older in 1960. The respondents were physically, biochemically, and socially examined in 1960; and in 1974–1975 re-examination of survivors of the original cohort was completed. Details of the sample design have been published previously.[4] The initial response rate was 78.3 per cent in the Black male. In 1964, Boyle, noting that this randomly obtained sample of Blacks was predominantly low social class, then recruited, by peer nomination, 103 Black males representing 90 per cent of all identified high social class nominees. Both groups were re-examined in 1974, representing a 14 and 10 year follow-up, respectively.

Follow-up interviews and examinations were done in the offices of the Preventive Medicine Section of the Medical University of South Carolina during 1974.

Recruitment

During the intervening years between initial and re-examination times, a monthly search of death certificates at the local health department was made. Thus, the listing of participants, available during the planning stage of the 1974 re-examination, contained most of the names of survivors and those available for re-examination. Other sources used to locate original study participants included telephone and city directories, former neighbors, employers, and ministers.

Response rates adjusted for death were 80 per cent and 81 per cent, respectively, for the random sample and high social class group and were uniform when viewed by age specific groupings.

Blood Pressure Measurements

About 75 per cent of all follow-up blood pressure measurements were performed by one examiner as compared with 90 per cent of baseline measurements. All examiners were White and had their auditory acuity measured before the 1974 follow-up began. Examiner reproducibility varied from 83 per cent to 100 per cent and comparability of observers' measurements indicated that all obtained similar mean and standard deviations. A comparison of home and office blood pressures showed no significant differences in blood pressures in these settings.

Blood pressure was taken on the left arm with the subject in the seated position. A mercury manometer* with standard cuff was used to take all office pressures.

Skin Color Measurement

Baseline skin pigmentation estimates by light reflectance was measured at the medial aspect of the inner surface of the upper arm, a body area normally shielded from direct sunlight, yet accessible for measurement. The Photoelectric Reflection Meter, Model 610,** using an amber (tristimulus) filter, was used to make all measurements. This instrument, as reported by Lasker, provides quantitative estimation of degree of skin pigmentation.[11] A scale of zero to 45 was used: the higher the number, the more reflectance from skin of lighter color. For example purposes, a lightly suntanned Caucasian would have a reflectance value of 40–45. Figure 1 presents a frequency polygon of skin reflectance values obtained at the initial examination. There is a considerable difference in the frequency distributions of skin color of the random and high social class samples. Although the ranges are similar, the high social class sample is shifted towards lighter skin color than the random sample.

Social Class

The Green Manual for calculating socioeconomic status (SES)[12] was used to score study participants, based on their education and occupation at time of intake into the study in 1960 or 1964. The term SES, as defined by Green, refers to the relative placement of an individual or group in the social status hierarchy. The Green SES scoring, while similar to those obtained from the Hollingshead techniques, is predicated on a composite index of nine types of preventive health behavior regressed on occupation and education. Thus, the Green SES indices are intended to optimize the prediction of family health from socioeconomic information.

As used in this paper, "low social class" generally represented those with occupations categorized as laborers, service workers, operatives or semi-skilled workers and with educational level equal to or less than one year of high school. "High social class" contained mostly craftsmen, foremen, clerical, managerial, and professional workers whose educational levels ranged from high school to advanced degrees. A frequency distribution of social class scores is shown in Figure 2. The almost complete separation of the distribution of SES scores in the random and high social class samples reflects the nature of the sampling scheme used. The small area of overlap of the two distributions reflects the extremely small proportion of the Black population who were upper social class in Charleston County in 1960.

Other Variables

Height and weight, at the initial and re-examination times, were measured with shoes and heavy outer clothing removed. Serum cholesterol was assayed by the Zlatkis, et al. procedure.[13] Heart rate was calculated from electrocardiogram tracings by one individual. Quetelet Index, a

*Baumanometer, W. A. Baum Company, Inc., NY.
**Photovolt Corporation (NYC).

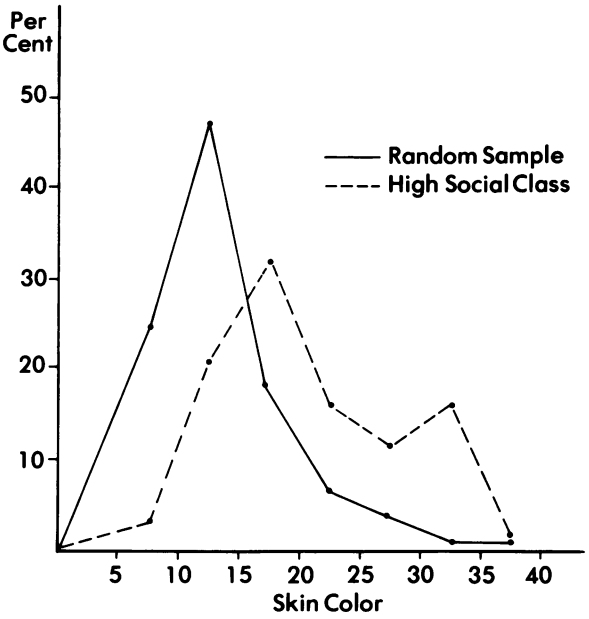


FIGURE 1—Frequency Distribution of Skin Color among Black Males, Charleston County, South Carolina Heart Study.

body mass index considered to be a surrogate measure of obesity, independent of height and shown to be highly correlated with skinfold measurements,[14] was calculated using the formula:

Q.I. = [weight in pounds ÷ (height in inches^2)] × 100.

Statistical Considerations

Categorical and continuous methods were used to assess the role of the independent variables of social class and skin color on the response variables, viz. incidence of hypertension and average blood pressure levels.

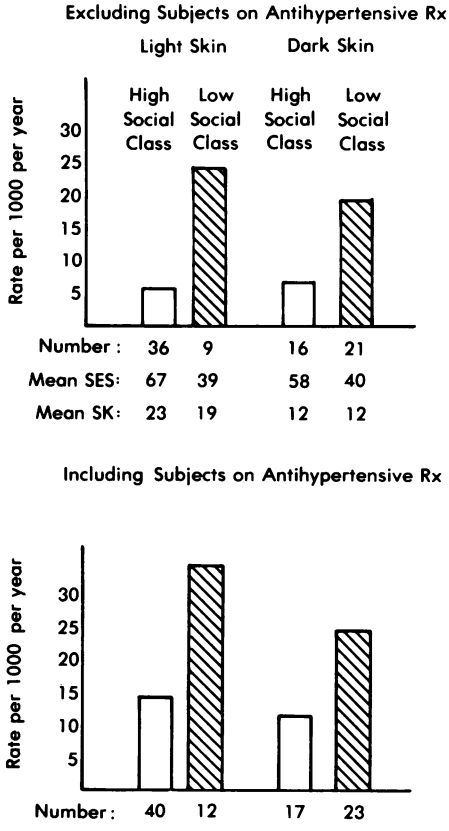
The incidence of hypertension represented a change (in the combined random sample and specially recruited high social class group) from a normotensive status (≤ 139 mm Hg systolic and ≤ 84 mm Hg diastolic) at the first examination period in 1960 to levels of ≥ 150 mm systolic and ≥ 90 diastolic in 1974. With a definite gap between normotension and hypertension, the influences or affects of small changes because of measurement error, blood pressure variability, and regression to the mean were minimized. Use of anti-hypertensive medication was also deemed to be a possible confounding factor and the data were analyzed including and excluding those who, at re-examination in 1974, reported they were on such medication. Incidence rates were age-adjusted by the indirect method and time-adjusted based on the exact interval between initial and follow-up examinations. Discriminant Function and Stepwise Multiple Regression Analyses utilized BMD 07M and BMD 02R Programs, respectively.

Results

The incidence rate of hypertension was considerably higher in those participants characterized as low social class (21.0 per 1,000 per year) than in study participants of higher social class (5.5 per 1,000 per year). As shown in Figure 3, this finding was rather clear cut when skin color and age were controlled. The figure also shows that skin color effects were slight, although complete control of social class was not possible in this categorical analysis. The correlation between skin color and social class is so strong that only partial control of each is possible in this categorical approach. The mean SES score of both dark and light skinned subjects characterized as low social class are almost identical at 40 and 39, respectively, and the incidence rates of hypertension are quite similar for dark and light skinned subjects.

There also is an identical mean skin color of 12 units among low and high social class subjects in the darker groups. In this instance, with control of skin color, the incidence rate of hypertension is 19.6 per 1,000 per year in low social class and 6.1 in high social class subjects.

The general relationships described above excluding in-



Incidence rate of hypertension = No. of cases adjusted for follow up period and indirect age adjusted; expressed as rate per 1000 per year

Normotension = ≤ 139 & ≤84

Hypertension = ≥150 & ≥90

FIGURE 2—Frequency Distribution of Socioeconomic Status among Black Males, Charleston County, South Carolina Heart Study.

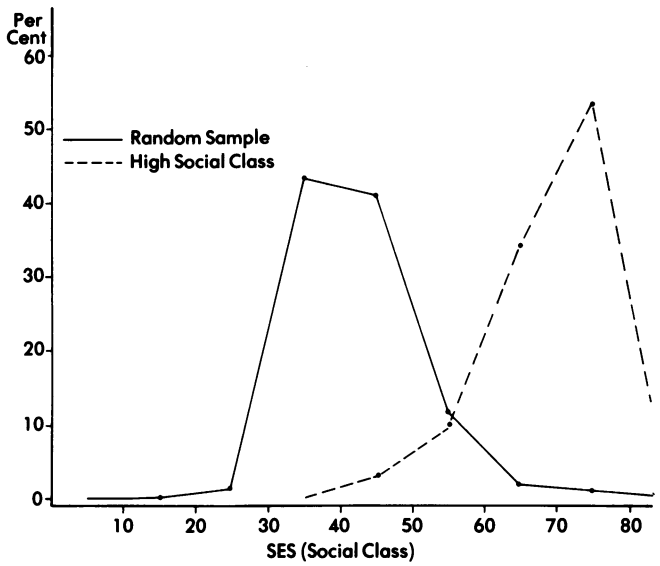


FIGURE 3—Incidence Rate of Hypertension among Black Males by Social Class and Skin Color, Charleston County, South Carolina.

dividuals on anti-hypertensive medication from the analyses remain essentially unchanged when analyses are repeated including those on treatment. Thus, the potential for selective bias due to differential use of therapy in the social classes, while real, does not alter the relationship of incidence to social class, controlling for skin color.

Quantification of the association of social class and skin color with the incidence of hypertension was estimated by calculating rate ratios (Table 1). Excluding subjects on anti-hypertensive treatment, the incidence of hypertension was 3.8 times higher in lower than upper social class Blacks and the rate ratio was little different in dark and light skinned low social class Blacks. The incidence rate of hypertension was only 1.5 times higher in all dark skinned, contrasted with all light skinned Blacks which was not statistically significant. Repeating these analyses to include those on anti-hypertensive treatment reduces the magnitude of the rate ratio but does not change the finding of a stronger association of hypertension incidence with social class than skin color.

Average blood pressure levels were significantly elevated in the low social class individual as compared to those of higher social class. As seen in Table 2, systolic pressure averaged 8 mm Hg and diastolic pressure 5 mm Hg higher in the low social class. Blood pressures were slightly higher (1.5–3.5 mm Hg systolic and $\leq$ 1 mm Hg diastolic) in the darker than in the lighter skinned subjects. Controlling for social class appeared to remove most of the skin color effects, although some of the strong social class effects in this bivariate analysis may be due to the high correlation of skin color with social class.

Analysis of variance (ANOVA) results, shown in Table 3, confirms the statistical significance of the social class effects on blood pressure when controlling for skin color and age.

When subjected to discriminant function analysis, diastolic blood pressure, age, and social class, in that rank order, predicted 67 per cent of the incident cases of hypertension. Skin color contributed no predictability.

TABLE 1—Social Class and Skin Color Effects, Expressed as Rate Ratios Comparison of Incidence of Hypertension in Analyses Including and Excluding Subjects on Anti-Hypertensive Medication

	Excluding Anti-Hyper. Rx	Including Anti-Hyper. Rx
Social Class Effects	3.8**	2.1*
Ratio of Incidence in low to high social class:		
within Dark Skin	3.2**	2.2
with Light Skin	4.5**	2.3*
Skin Color Effects	1.5	1.0
Ratio of Incidence in dark to light skinned subjects:		
within Low Social Class	.8	.7
within High Social Class	1.1	.8

*Significantly different from 1 with $p < .1$
**Significantly different from 1 with $p < .05$

In the Stepwise Multiple Regression Analyses, "age" was forced first into the equation for average systolic and diastolic blood pressures as a method for controlling for this factor. All other variables were allowed to freely enter the equation and in the order dictated by their F value after the previous variable or combination of variables had been considered.

For the random sample (Table 4), the variables with their contribution expressed as a percentage of the variation in average systolic blood pressure (i.e., that proportion of the total sum of squares attributable to a variable) were, in order of importance: age, socioeconomic status, heart rate, weight in 1974, Quetelet Index, and weight in 1960 or 1964. In the high social class group, age accounted for the greatest variation in average systolic blood pressure, followed by weight in 1960 or 1964, cholesterol, and weight in 1974.

For average diastolic blood pressure, it shows that, for the random sample, heart rate had the most influence, followed by socioeconomic status and height respectively. For the high social class, skin color was the only significant variable.

Discussion

The data do not support the hypothesis that skin color is related to the incidence of hypertension. The results obtained in this study of Black males strongly suggest that social class, together with earlier life levels of diastolic blood pressure, may be among the primary determinants of hypertension. The strong association of age with systolic blood pressure may be a function of the aging process, per se, or reflective of the social and environmental experiences over a period of time. Indeed, other factors, such as heart rate and weight-related variables associated with higher blood pressure levels in this study may reflect social class experiences.

Skin color effects were hardly detectable in the popu-

TABLE 2—Age Adjusted Average Blood Pressure by Social Class and Skin Color

		Social Class		
		Low (33.9-47.1)	High (47.2-73.5)	All
SYSTOLIC (mm Hg)				
	Dark	147.4	138.6	144.7
	≤ 14	N = 64	N = 29	N = 93
Skin Color	Light	143.9	137.2	139.4
	≥ 15	N = 34	N = 73	N = 107
	All	146.2	137.6	141.9
		N = 98	N = 102	N = 200
DIASTOLIC (mm Hg)				
	Dark	88.5	83.4	86.9
	≤ 14	N = 64	N = 29	N = 93
Skin Color	Light	88.6	82.5	84.4
	≥ 15	N = 34	N = 73	N = 107
	All	88.5	82.7	85.6
		N = 98	N = 102	N = 200

lation when social class was controlled. Conversely, the risk of becoming hypertensive was three to four times greater when the study participants were low social class compared to being higher social class.

Yet, as shown by multiple regression analyses, skin color was significantly related to diastolic blood pressure level in the specially selected high social class group. This group was uniformly high social class (and, thus, this variable was controlled). Why such an association between skin color is shown with diastolic pressure and not systolic may be a chance occurrence. Or it may suggest more genetic control over diastolic than systolic pressure, operating only in the lighter skinned uniformly high social class group. But the quandary is not resolved because it may be a skin color effect operating through social class. The complex interaction of social class and skin color can only be resolved through a larger population. Further, there were other factors associated with blood pressure, such as heart rate, that were equal to or greater than the association of blood pressure with social class. The variation in blood pressure, yet to be explained by variables not considered in the study, varied from 60 per cent in the random sample to 80 per cent in the high social class group.

Social class membership summarizes an aggregate of life styles, diet, mobility, and preventive health behavior, all of which may be relevant to hypertension. Each, or the constellation of all, may index currently unknown physical and chemical causes of hypertension.

If there were inverse relationships between social class and blood pressure in the Black population of Charleston in the past several decades, what then are the specifics of life styles that are associated with social status? These may include the physical environment—including exposure to infectious diseases, pollutants, climatic factors, diet, stresses generated by concern for personal safety, crowding, lack of life's necessities, or even sudden affluence. Finally, one must consider the social and psychological restraints imposed on Blacks.

TABLE 3—Statistical Evaluation of Social Class and Skin Color Effects

	Systolic B. P. Effects	From ANOVA F	P	Diastolic B. P. Effects	From ANOVA F	P
Social Class Main Effects	8.6 mm Hg	6.08	<.01	5.8 mm Hg	10.45	<.001
within Dark Skin	8.8 mm Hg			5.1 mm Hg		
within Light Skin	6.7 mm Hg			6.1 mm Hg		
Skin Color Main Effects	5.3 mm Hg	.62	nsd	2.5 mm Hg	.05	nsd
within Low Social Class	3.5 mm Hg			-.1 mm Hg		
within High Social Class	1.4 mm Hg			.9 mm Hg		
Interaction of Social Class and Skin Color		.12	nsd		.09	nsd
Age Effects, adjusted by Covariance		20.30	<.001		2.51	nsd

TABLE 4—Blood Pressure Variation[1] Associated with Selected Variables in Random (R) and High Social Class (H) Samplings

Variable	Systolic Pressure R = 115	Systolic Pressure H = 60	Diastolic Pressure R = 115	Diastolic Pressure H = 60
Age (forced)	6.6	21.1	—	—
Socioeconomic Status	5.4	—	5.7	—
Skin Color	—	—	—	8.6
Heart Rate	5.3	—	7.2	—
Cholesterol	—	3.7	—	—
Height	—	—	1.9	—
Initial Weight	1.8	6.7	—	—
Weight, 1974	4.9	3.6	—	—
Quetelet Index	2.4	—	—	—
Non-Significant Variables	3.1	4.5	4.8	17.0
Total R^2	29.5	39.6	19.6	25.6

[1]Values are in % but are not shown unless the regression coefficient was significantly different from zero.

These findings of the association of hypertension with social class, thus, are not unexpected. They do suggest the starting points for more detailed studies into the etiology and eventually the primary prevention of hypertension.

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