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RACIAL DIFFERENCES IN HYPERTENSION AND CORONARY HEART DISEASE IN THE U.S. NAVY

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RACIAL DIFFERENCES IN HYPERTENSION AND CORONARY HEART DISEASE
IN THE U.S. NAVY

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SUMMARY

Problem

Hypertension affects a large percentage of the adult population in the United States and has been implicated in the etiology of stroke and coronary heart disease. The risk of hypertension in blacks is approximately twice as great as it is in whites. This risk is presumed to be due to a combination of genetic and socioenvironmental factors, but the contribution of each set of factors is unknown.

Objective

The objective of this study was to determine if blacks in the U.S. Navy are at significant risk of hospitalization for hypertension and coronary heart disease. The relationship between disease risk and socioeconomic status, measured by education and occupation, was examined.

Approach

Data were collected from two separate studies. The first was a cross-sectional study of all enlisted males on active duty between 1974 and 1979. Total hospital admission rates for diagnoses of essential benign hypertension, myocardial infarction, angina pectoris, chronic ischemic heart disease, and coronary insufficiency were computed on the basis of age, race, education and occupation. The second study was a longitudinal study of a cohort of enlisted personnel who entered the Navy in 1974. First hospitalization rates were computed on the basis of age, race, education, and occupation.

Results

The results indicated that blacks have elevated rates of hypertension and whites have elevated rates of coronary heart disease. Both diseases also were found to be associated with socioeconomic status. The racial group differences were not found to be statistically significant, however, after adjusting for age differences.

Conclusions

Despite the elevated rates of hypertension, blacks in the navy do not appear to have higher total or first hospitalization rates for the cardiovascular diseases studied than whites. Moreover, there was no association between the risk for hypertension and coronary heart disease for blacks.

Recommendations

The divergence in association between hypertension and coronary heart disease suggests the need for further research on the etiology of the two diseases and their presumed association.

Racial Differences in Hypertension and Coronary Heart Disease
in the U.S. Navy

INTRODUCTION

In the past decade, cardiovascular diseases have accounted for only 3% of all hospital admissions and 10% of all deaths among enlisted personnel in the U.S. Navy (1). Nevertheless, these diseases remain a subject of concern. Despite the decline in mortality rates in the past ten to fifteen years, cardiovascular diseases in general and coronary heart disease in particular still account for a major portion of deaths in males 25 years and older in the United States. Coronary heart disease has a tremendous impact in terms of disruption of families and loss of earning power during the most productive years of life (2), and may adversely affect performance in the Navy as well.

The most common form of cardiovascular disease is hypertension, affecting almost 18% of the adult population of the United States (3-6). Hypertension is an important risk factor for coronary heart disease and stroke (7-9). The effects of chronic elevated blood pressure are numerous and include changes in the kidneys, brain, heart and other major organs. At least three major types of vascular pathology are known to be related to hypertension: atherosclerosis, fibrinoid arteriolar necrosis of accelerated malignant hypertension, and the Charcot-Bouchard aneurysms associated with intracranial hemorrhage (10).

One of the most consistent findings of epidemiologic studies of hypertension is its high risk of development among blacks. Blacks of both sexes have widely been reported to have higher rates of incidence and prevalence than whites (2, 11-13). The excess prevalence in black males is almost two to one in every age group. Moreover, in black males, hypertension occurring at a relatively young age carries an extremely high mortality risk (11). This risk may be due to several factors but two major sets of etiological factors have been investigated. The first set of etiologic factors is genetic. Blacks are believed to be genetically predisposed to hypertension and some research (14) has indicated the inheritance of a single hypertensive gene in Blacks is responsible for the observed morbidity.

The second set of etiological factors is social. Several investigators have hypothesized that differences in socioeconomic status place blacks at greater risk of hypertension. Syme et al (15), for example, observed a gradient of blood pressure along a social class dimension in both Blacks and whites, with lower-class members of both racial groups displaying the highest levels. This suggests a socioenvironmental influence on blood pressure. Other studies have demonstrated similar findings (12, 16), although the results are by no means consistent. Factors related to socioeconomic status which may be important in the etiology of hypertension include obesity (17), sodium intake (18) and cholesterol levels (11), access to adequate health care facilities and services (19), and psychosocial stress associated with occupation (20-21), discrimination (22), social change (17, 23), and residence (24).

If blacks are at elevated risk of hypertension, does this affect the performance of black military personnel? Blacks today comprise 12 percent of all personnel in the Navy and account for roughly 18 percent of all current enlistments. The effect of the risk of hypertension on the health and performance of these individuals, therefore, has implications for Navy policymakers and health care providers. Previous research has shown differences in occupation between blacks and whites in the Navy (25). Studies of hospitalization rates in black and white enlisted men demonstrated that socioeconomic status, measured by education and occupation, accounted for much of the excess risk for hospital admissions among blacks (1).

This paper is a descriptive account of selected patterns of hypertension and coronary heart disease in black and white enlisted males in the Navy between 1974 and 1979. The data presented here were collected from two separate studies--a cross-sectional study of all enlisted males on active duty between 1974 and 1979 and a longitudinal study of a cohort of enlisted personnel who entered the Navy in 1974. This paper examines racial differences in total and first hospitalization rates in terms of age and socioeconomic status as measured by education and occupation. Hospitalization rates are an indication of burden on medical services and not a direct indication of risk of development of disease. Such risk is best observed by first hospitalization rates, which were obtained for a cohort of men who enlisted in 1974, and are also shown in this report.

METHODS

Data for both studies were derived from individual hospitalization histories compiled for research purposes at the Naval Health Research Center, San Diego. The patient population included all active duty Navy black and white enlisted males hospitalized in naval medical facilities throughout the world during 1974-1979.

In the cross-sectional study, hospital admission rates were computed for black and white enlisted males in the Navy over the period January 1, 1974 through December 31, 1979. Variables examined in this study included age, sex, race, education, and occupation. Diagnoses were in accordance with the Eighth Revision, International Classification of Disease Adapted for Use in the United States (ICDA-8) (26). Five diagnoses were selected for examination: Essential Benign Hypertension (ICDA-8 Code 401), Myocardial Infarction (Code 410), Coronary Insufficiency (Code 411), Chronic Ischemic Heart Disease (Code 412), and Angina Pectoris (Code 413). Hospital admission rates were expressed as number of hospital admissions per 100,000 person-years.

Population data for the total Navy and for the two racial groups under investigation were compiled from data files located at the Naval Health Research Center, San Diego. As this data base contains the records of over two and one half million enlisted personnel on active duty during the study period, a 10 percent sample, selected at random on the basis of the last digit of the social security number, was taken to derive estimates of average population size per year for the characteristics of interest.

Age-adjusted rates for the specific diagnoses were calculated using the direct method.

The standard population consisted of the total of all active-duty enlisted black and white males in the U.S. Navy during the study period. Hospitalization rates were reported for subgroups within the two racial groups according to age, education and occupation. Education and occupation were selected because they are indicators of socioeconomic status prior to enlistment and within the Navy respectively. Income or pay grade was not used as an index because of its high correlation with age. The rates for groups and subgroups of blacks and whites were compared to obtain an estimate of relative risk by taking the ratio of rates for Blacks to rates for whites. Levels of significance of these associations were obtained using 95 percent confidence intervals (27).

In the longitudinal study, the cohort consisted of all black and white males who entered regular service for the first time during 1974. The cohort was followed for a six year period. First hospitalizations for essential benign hypertension, myocardial infarctions, coronary insufficiency, angina pectoris, and chronic ischemic heart disease were selected for examination. Subjects who were discharged from the Navy during the 1974-1979 period were defined as withdrawals. Incidence rates were calculated using person-years at risk.

RESULTS

The average annual hospitalization rates among black and white enlisted men for essential benign hypertension, myocardial infarction, coronary insufficiency, chronic ischemic heart disease, and angina pectoris are shown in Table 1. Black males were hospitalized for

Table 1
Average Annual Hospitalization Rates per 100,000 Person-Years for
Hypertension and Coronary Heart Disease (ICDA-8 Codes 410-413)
by Race and Age, Active Duty Enlisted Males, 1974-1979

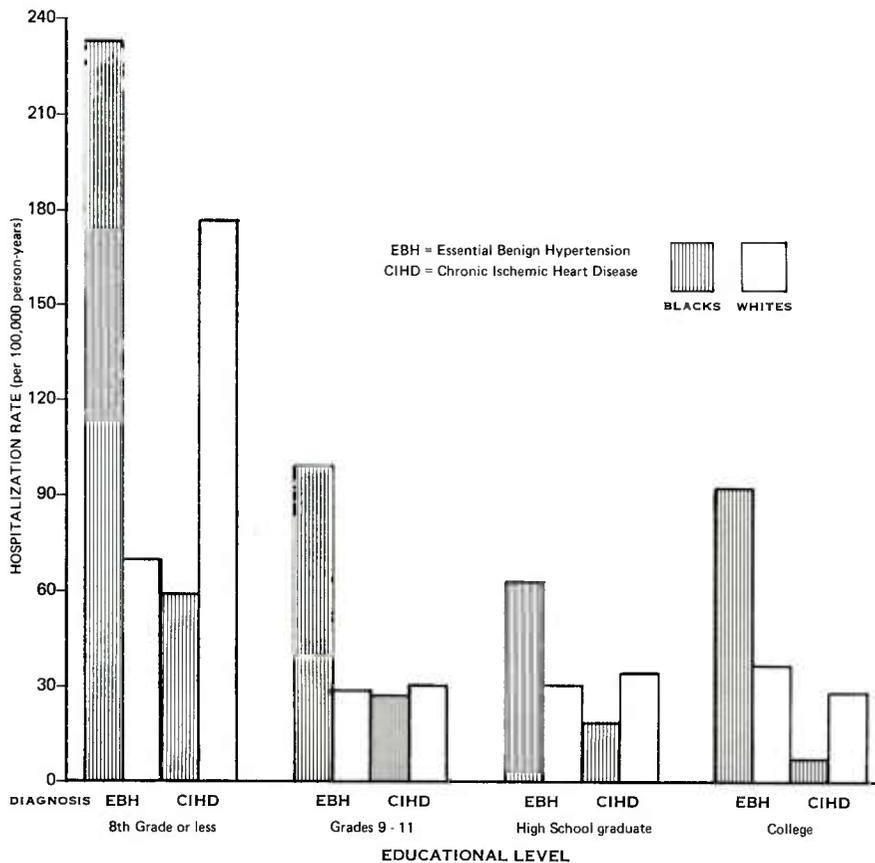
Age in years	DIAGNOSTIC CATEGORY											
	Essential Benign Hypertension (Code 401)		Myocardial Infarction (Code 410)		Coronary Insufficiency (Code 411)		Chronic Ischemic Heart Disease (Code 412)		Angina Pectoris (Code 413)		Total Coronary Heart Disease	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
<u>Whites</u>												
< 20	53	11.5	1	0.2	0	-	1	0.2	1	0.2	3	0.7
20 - 29	296	21.7	29	2.2	2	0.1	24	1.8	4	1.8	59	4.4
30 - 39	230	56.1	264	66.1	23	5.8	506	126.7	138	34.6	931	233.1
40 - 49	107	212.6	127	259.0	9	18.4	227	463.2	56	114.3	419	855.1
50 - 59	14	394.8	15	434.0	1	28.9	40	1157.0	4	115.7	60	1736.1
60 - 69	1	537.6	0	-	0	-	4	2222.0	0	-	4	2222.2
TOTAL*	701	31.6	436	20.3	35	1.6	802	37.3	203	9.5	1476	68.8
Confidence		42.6		31.3		4.6		54.1		16.1		95.9
Limits		20.6		9.3		0		20.6		2.8		41.7
<u>Blacks</u>												
< 20	8	16.5	2	4.2	1	2.1	0	-	0	-	3	6.3
20 - 29	57	38.3	1	0.7	1	0.7	4	2.7	6	4.1	12	8.2
30 - 39	87	283.0	9	29.7	1	3.3	26	85.7	6	19.8	42	138.5
40 - 49	20	480.3	6	146.2	0	-	14	341.1	2	48.7	22	536.1
50 - 59	2	1190.5	2	1234.6	0	-	0	-	0	-	2	1234.6
60 - 69	0	-	0	-	0	-	0	-	0	-	0	-
TOTAL*	174	93.7	20	11.9	3	1.4	44	25.9	14	7.2	81	46.6
Confidence		163.8		70.0		4.8		57.0		20.0		118.6
Limits		23.6		0		0		0		0		0

* Totals are age-adjusted.

hypertension almost three times more often than white males. This excess risk occurred in all age groups, with those in the 30-39 year age group displaying the highest risk for hospital admission. Blacks, however, were hospitalized less frequently than whites for the other diagnoses, with the exception of those less than 20 years of age. Whites appeared to have the greatest risk of hospitalization, relative to blacks, for myocardial infarction and chronic ischemic heart disease. None of the observed differences between the two racial groups were found to be statistically significant, however, when age was taken into consideration.

Figure 1 shows racial differences in age-adjusted hospitalization rates for two diagnoses, essential benign hypertension (ICDA-8 Code 401) and chronic ischemic heart disease (ICDA-8 Code 412), by educational level. CIHD was selected for examination because this diagnosis accounted for the highest number of hospitalizations for coronary heart disease among the two racial groups during the study period. Also, blood pressure has been identified as a powerful predictor for the occurrence of ischemic heart disease (28). As the figure suggests, an inverse linear relationship existed between hospitalization for hypertension

FIGURE 1
 Age-Adjusted Hospitalization Rates
 for Hypertension and Chronic Ischemic Heart Disease
 by Race and Education
 ACTIVE DUTY ENLISTED MALES, 1974-1979

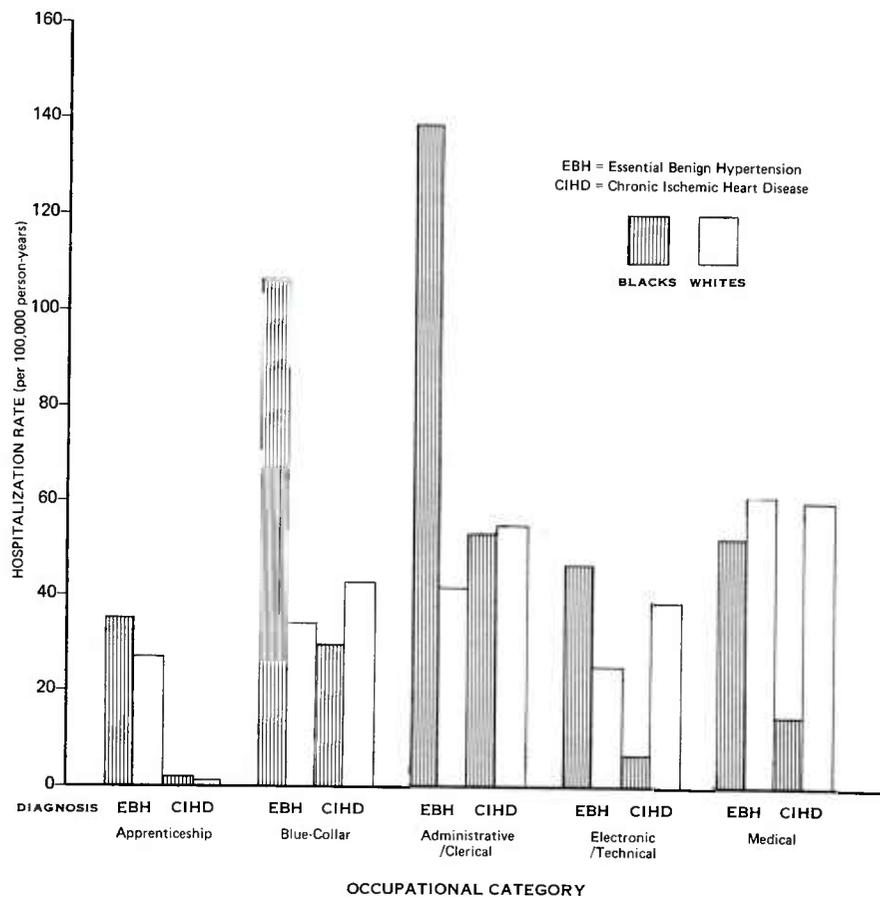


and educational level, among both racial groups with one important exception: college-educated black males exhibited a higher rate than black high school graduates. Blacks with less than a high school degree were at a greater risk of hospitalization than whites with the same level of education. When age-adjusted, however, none of the differences among educational groups were found to be statistically significant.

With respect to chronic ischemic heart disease, an inverse linear relationship between hospitalization rate and educational level existed for both racial groups. Whites with eight years or less or one or more years of college appear to be at greatest risk of hospital admission, relative to blacks with the same levels of education.

Figure 2 provides a comparison of hospitalization rates by occupational category. Occupations were grouped into five categories: unspecialized apprenticeship positions such as seaman, airman, fireman, and constructionman; blue-collar positions such as boatswain's mate, gunners mate, and boiler technician; administrative and clerical occupations such as mess management specialist, yeoman, and disbursing clerk; electronic and technical

FIGURE 2
 Age-Adjusted Hospitalization Rates
 for Hypertension and Chronic Ischemic Heart Disease
 by Race and Occupation
 ACTIVE DUTY ENLISTED MALES, 1974-1979



occupations such as electronics technician and sonar technician; and medical occupations which include hospital corpsmen and dental technicians. As the figure indicates, blacks in the administrative and clerical rates displayed the highest rates of hospital admission for both hypertension and chronic ischemic heart disease. Blacks in these occupations also were at highest risk for hospitalization relative to whites in the same occupational category. The highest rates for both hypertension and chronic ischemic heart disease among whites, however, were displayed by those in the medical category. These individuals also were at greatest risk for both diagnoses, relative to blacks in the same occupational category. When age-adjusted, however, none of these occupational differences were found to be statistically significant. A rank ordering of the hospitalization rates for blacks and whites in the remaining occupational categories reveals a similar pattern for the two racial groups.

First Hospitalization Rates

First hospitalization rates of essential benign hypertension and chronic ischemic heart disease in black and white enlisted males are shown in Table 2. Blacks 17-35 years of age had higher rates of first hospitalization for hypertension than whites in the same age group. With the exception of one case of myocardial infarction, however, there were no observed cases of coronary heart disease among blacks. Chronic ischemic heart disease was the most frequent form of coronary heart disease among whites. When age-adjusted, however, none of the observed racial differences were found to be statistically significant.

Table 2

First Hospitalization Rates per 100,000 Person-Years for Hypertension and Coronary Heart Disease (ICDA-8 Codes 410-413) by Race and Age, 1974 Cohort of Active Duty Enlisted Males

Age in years	DIAGNOSTIC CATEGORY											
	Essential Benign Hypertension (Code 401)		Myocardial Infarction (Code 410)		Coronary Insufficiency (Code 411)		Chronic Ischemic Heart Disease (Code 412)		Angina Pectoris (Code 413)		Total Coronary Heart Disease	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
<u>Whites</u>												
< 20	14	13.2	0	-	0	-	2	1.9	0	-	2	1.9
20 - 24	49	25.8	2	1.0	0	-	0	-	0	-	2	1.0
25 - 29	10	37.0	0	-	0	-	3	11.1	1	3.7	4	14.8
30 - 34	3	67.6	1	22.5	0	-	2	45.1	0	-	3	6.8
35 - 39	1	130.1	2	260.2	0	-	2	260.2	1	130.1	6	780.7
40+	1	687.3	1	687.3	0	-	2	1374.5	0	-	4	2749.1
TOTAL*	78	23.9	6	1.8	0	-	11	3.4	2	0.6	19	6.4
Confidence Limits		56.4		16.6		-		46.1		13.2		31.7
		8.5		0		-		0		0		0
<u>Blacks</u>												
< 20	3	29.4	0	-	0	-	0	-	0	-	0	-
20 - 24	15	61.6	1	4.1	0	-	0	-	0	-	1	4.1
25 - 29	4	73.1	0	-	0	-	0	-	0	-	0	-
30 - 34	1	124.6	0	-	0	-	0	-	0	-	0	-
35 - 39	0	-	0	-	0	-	0	-	0	-	0	-
40+	0	-	0	-	0	-	0	-	0	-	0	-
TOTAL*	23	53.2	1	2.4	0	-	0	-	0	-	1	2.4
Confidence Limits		100.3		3.1		-		-		-		3.1
		6.2		0		-		-		-		0

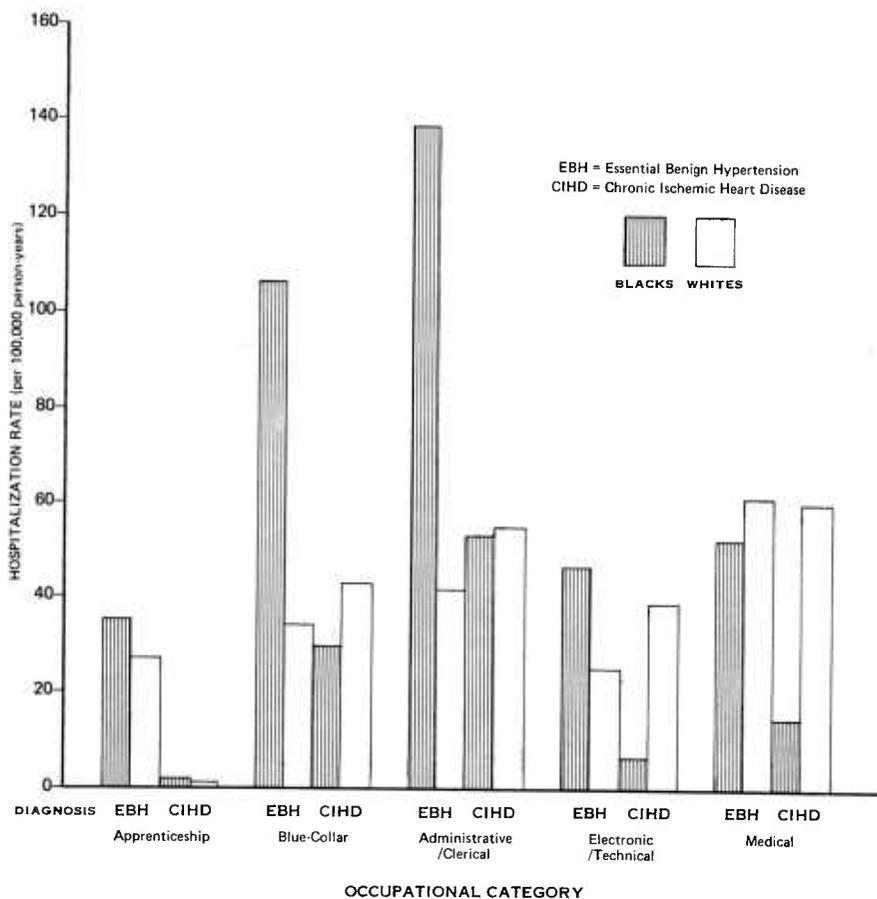
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With respect to chronic ischemic heart disease, an inverse linear relationship between hospitalization rate and educational level existed for both racial groups. Whites with eight years or less or one or more years of college appear to be at greatest risk of hospital admission, relative to blacks with the same levels of education.

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	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
<u>Whites</u>												
< 20	14	13.2	0	-	0	-	2	1.9	0	-	2	1.9
20 - 24	49	25.8	2	1.0	0	-	0	-	0	-	2	1.0
25 - 29	10	37.0	0	-	0	-	3	11.1	1	3.7	4	14.8
30 - 34	3	67.6	1	22.5	0	-	2	45.1	0	-	3	6.8
35 - 39	1	130.1	2	260.2	0	-	2	260.2	1	130.1	6	780.7
40+	1	687.3	1	687.3	0	-	2	1374.5	0	-	4	2749.1
TOTAL*	78	23.9	6	1.8	0	-	11	3.4	2	0.6	19	6.4
Confidence Limits		56.4		16.6		-		46.1		13.2		31.7
		8.5		0		-		0		0		0
<u>Blacks</u>												
< 20	3	29.4	0	-	0	-	0	-	0	-	0	-
20 - 24	15	61.6	1	4.1	0	-	0	-	0	-	1	4.1
25 - 29	4	73.1	0	-	0	-	0	-	0	-	0	-
30 - 34	1	124.6	0	-	0	-	0	-	0	-	0	-
35 - 39	0	-	0	-	0	-	0	-	0	-	0	-
40+	0	-	0	-	0	-	0	-	0	-	0	-
TOTAL*	23	53.2	1	2.4	0	-	0	-	0	-	1	2.4
Confidence Limits		100.3		3.1		-		-		-		3.1
		6.2		0		-		-		-		0

* Totals are age-adjusted.

DISCUSSION

Despite the elevated rates of hypertension, Blacks in the Navy do not appear to have higher total or first hospitalization rates for the cardiovascular diseases studied than whites. No significant differences in hospital admissions rates were found after adjustment for age. This, however, may be due to the small sample size of blacks in the 30 year and older age groups. Moreover, the elevated rates for hypertension are not accompanied by similarly elevated rates for coronary heart disease.

An interesting finding, however, was the divergence in trends for hypertension and coronary heart disease between the two racial groups. Blacks in the general population have been found to have higher risk of mortality due to coronary heart disease, lending support to the association between hypertension and coronary heart disease (2). In the Navy, however, the risk in blacks for myocardial infarctions, angina, and chronic ischemic heart disease, as well as other cardiovascular disorders, is less than or equal to the risk in whites even though blacks have higher rates of hypertension. These patterns remain even after socioeconomic status has been taken into consideration, with some exceptions. This pattern was also found in a study by Stamler et al (29) which suggested that hypertension and coronary heart disease were different in their etiology and pathology. It was hypothesized that blacks may be victimized more by infections and other pathologic processes in the genitourinary tract, processes which may lead to hypertensive disease. Other research (1) has found that blacks in the Navy are at greater risk for hospitalizations for diseases of the genitourinary system. Most of these hospitalizations are for circumcisions but Blacks also are at higher risk for orchitis and epididytitis, nephritis, and kidney infections. The association between hypertension and diseases of the genitourinary system in blacks, therefore, merits further investigation.

There is also a possibility that because Blacks are more frequently diagnosed as hypertensive, the medication they take to reduce high blood pressure also reduces their risk for coronary heart disease. There is no evidence to support this, however. A study of Veterans' Administration hospital patients found that treatment of hypertension was associated with a significant decrease in strokes, congestive heart failure, accelerated hypertension and renal failure but not of myocardial infarction or other forms of coronary heart disease (30).

Although the pattern of association between hypertension and coronary heart disease diverges between the two racial groups, the pattern within groups is consistent. Blacks consistently are at higher risk for hypertension and lower risk for chronic ischemic heart disease. This pattern remains even after accounting for age, education and occupation. This suggests a genetic factor in hypertension and calls into question the relationship between elevated blood pressure and coronary heart disease. The rate of decline in relative risk by education, however, suggests that socioeconomic status plays some role in the etiology of both types of cardiovascular disorder. Further research employing multivariate models to determine the contribution of selected features of socioeconomic status such as diet, occupation and stress, is required.

19. Kitagawa EM, Hauser P. Differential mortality in the United States: a study in socioeconomic epidemiology. Cambridge: Harvard University Press, 1973.
20. Howard J, Holman BL. The effects of race and occupation on hypertension mortality. *Milbank Mem Fund Q* 1970;43:263-296.
21. McQueen DV, Siegrist J. Social factors in the etiology of chronic disease: an overview. *Soc Sci Med* 1982;16:353-367.
22. Tyroler HA, James SA. Blood pressure and skin color. *Am J Public Health* 1978;68:1170-1172.
23. Henry JP, Cassel JC. Psychosocial factors in essential hypertension: recent epidemiologic and animal experimental evidence. *Am J Epidemiol* 1969;90:171-200.
24. Harburg E, Gleibermann L, Roeper P, Schork MA, Schull WJ. Skin color, ethnicity, and blood pressure I: Detroit blacks. *Am J Public Health* 1978; 68:1177-1183.
25. Hoiberg A, Berard S, Ernst J. Racial differences in hospitalization rates among Navy enlisted men. *Public Health Rep* 1981;96:121-127.
26. U.S. Department of Health, Education and Welfare, Division of Public Health Statistics. International classification of diseases adapted for use in the United States, eighth revision. Washington, DC: U.S. Government Printing Office, 1968.
27. Lilienfeld AM, Lilienfeld DE. Foundations of epidemiology. 2nd ed. New York: Oxford University Press, 1980.
28. Rabkin SW, Mathewson FA, Tate RB. Predicting risk of ischemic heart disease and cerebrovascular disease from systolic and diastolic blood pressures. *Ann Intern Med* 1978;88:342-345.
29. Stamler J, Kjelsberg M, Hall Y. Epidemiologic studies on cardiovascular-renal diseases: I. analysis of mortality by age-race-sex-occupation. *J Chronic Dis* 1960;12:440-455.
30. Veterans Administration Cooperative Study Group on Antihypertensive Agents. Effects of treatment on morbidity in hypertension II. results in patients with diastolic blood pressure averaging 90 through 114 mm Hg. *JAMA* 1970;213:1143-1152.

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LIST OF REFERENCES

1. Palinkas LA, Colcord CL. Health risks among enlisted males in U.S. Navy: race and ethnicity as correlates of hospital admissions. San Diego, CA: Naval Health Research Center Technical Report No. 83-31.
2. Moriyama I, Krueger DE, Stamler J. Cardiovascular diseases in the United States. Cambridge: Harvard University Press, 1971.
3. Marx JL, Kolata GB. Combatting the no. 1 killer: the science report on heart research. Washington DC: American Association for the Advancement of Science, 1978.
4. Roberts J, Maurer K. Blood pressure levels of persons 6-74 years, United States, 1971-1974. Washington DC: U.S. Government Printing Office, 1978; DHEW publication no (HRA) 78-1648.
5. U.S. Department of Health, Education, and Welfare. Blood pressure of persons 18-74 years, United States, 1971-1972. National Health Survey, National Center for Health Statistics, Series 11, No. 150, April 1975.
6. McQueen DV, Celentano DD. Social factors in the etiology of multiple outcomes: the case of blood pressure and alcohol consumption patterns. *Soc Sci Med* 1982;16:397-418.
7. Kannel WB. Importance of hypertension as a major risk factor in cardiovascular disease. In: Genest J, Koiw E, Kuchel O, eds. *Hypertension physiopathology and treatment*. New York: McGraw Hill, 1977:888-910.
8. Paul O. A survey of the epidemiology of hypertension: 1964-1974. *Mod Concepts Cardiovasc Dis* 1974;43:99-102.
9. Mathisen HS, Loken H, Brox D, Stenback O. The prognosis in long term and untreated essential hypertension. *Acta Med Scand* 1969;185:253.
10. Tyroler HA. Hypertension. In: Last JM, ed. *Maxcy-Rosenau public health and preventative medicine*. 11th ed. New York: Appleton-Century-Crofts, 1980:1202.
11. Freis ED. Age, race, sex and other indices of risk in hypertension. In: Laragh JH, ed. *Hypertension manual*. New York: Dun-Donnelley, 1973:31-41.
12. Hypertension Detection and Follow-up Program Collaborative Group. Race, education and prevalence of hypertension. *Am J Epidemiol* 1977;106:351-361.
13. Boyle E. Biological patterns in hypertension by race, sex, body weight, and skin color. *JAMA* 1970;213:1637-1643.
14. McDonough JR, Garrison GE, Hames CG. Blood pressure and hypertensive disease among Negroes and whites: a study in Evans County, Georgia. *Ann Intern Med* 1964;61:208-228.
15. Syme SL, Oakes TW, Friedman GD, Feldman R, Sieglaub AB, Collen M. Social class and racial differences in blood pressure. *Am J Public Health*;1974:619-620.
16. Keil JE, Tyroler HA, Sandifer SH, Boyle E. Hypertension: effects of social class and racial admixture. *Am J Public Health* 1977;67:634-639.
17. Waldron I, Nowotarski M, Freimer M, Henry JP, Post N, Witten C. Cross-cultural variation in blood pressure: a quantitative analysis of the relationships of blood pressure to cultural characteristics, salt consumption and body weight. *Soc Sci Med* 1982;16:419-430.
18. Freis ED. Salt, volume and prevention of hypertension. *Circulation* 1976;589-595.

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entered the Navy in 1974. Racial differences were examined in terms of age and socioeconomic status. The results indicated that blacks have elevated rates of hypertension and whites have elevated rates of coronary heart disease. Both diseases also were found to be associated with socioeconomic status. The racial group differences were not found to be statistically significant, however, after adjusting for age differences. Nevertheless, the divergence in association between hypertension and coronary heart disease suggests the need for further research on the etiology of the two diseases and their presumed association.

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