

ORIGINAL REPORT: CARDIOVASCULAR HEALTH

RACIAL, ETHNIC AND SOCIOECONOMIC DISPARITIES IN THE CLUSTERING OF CARDIOVASCULAR DISEASE RISK FACTORS

Objective: To evaluate racial and ethnic differences in the clustering of cardiovascular disease (CVD) risk factors in the United States and to determine whether these differences vary by socioeconomic status (SES).

Methods: Data from the Third National Health and Nutrition Examination Survey (1988–1994), a cross-sectional survey of the US population, were used to examine these relationships among 486 non-Hispanic Blacks, 469 Mexican Americans, and 772 non-Hispanic Whites, aged 25 to 99 years. Risk factors included hypertension, abnormal cholesterol, diabetes mellitus, overweight, and cigarette smoking. Educational level was used as a proxy for SES.

Results: Twenty percent of non-Hispanic Whites had zero CVD risk factors vs 18% of Mexican Americans and 13% of non-Hispanic Blacks. Non-Hispanic Blacks were twice as likely as the other groups to have 4 or 5 risk factors. Across all groups, the prevalence of having zero risk factors increased with education (from 6%–14% among those with <12 years to 22%–29% among those with >12 years). After adjustment for age and gender, among those with <12 years of education, Mexican Americans were 60% more likely and non-Hispanic Blacks were 30% less likely to have zero risk factors than non-Hispanic Whites. Among persons with >12 years of education, Mexican Americans and non-Hispanic Blacks were 50%–60% less likely to have zero risk factors than non-Hispanic Whites.

Conclusions: Increased CVD risk factor clustering exists among Americans with low SES, particularly among non-Hispanic Blacks. Among persons with high SES, Mexican Americans and non-Hispanic Blacks have a higher risk of CVD than non-Hispanic Whites. These disparities may be reduced through policy changes that promote heart-healthy environments throughout society. (*Ethn Dis.* 2004;14: 43–48)

Key Words: Cardiovascular Disease, Race, Ethnicity, Socioeconomic Status

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INTRODUCTION

Heart disease and stroke, the first and third leading causes of death in the United States, are the primary components of cardiovascular disease (CVD).¹ More than 61 million Americans have one or more types of CVD and, in 1999, 958,000 persons died from CVD.² While mortality rates from CVD have decreased over the last 40 years, disparities in CVD by race, ethnicity, and socioeconomic status (SES) have escalated.³

The inverse association between SES and CVD has been well documented^{4–8} and the ever widening gap between high and low socioeconomic groups is particularly disturbing.^{3,9} Higher rates of CVD mortality are also observed in some racial and ethnic groups.^{1,10} Important disparities also exist in CVD risk factors, with racial and ethnic minority groups (eg, Blacks and Hispanics) having higher rates of overweight, hypertension, diabetes mellitus, physical inactivity, and high blood cholesterol

than Whites.^{11,12} Genetics may partly explain some of these differences. However, behavioral, social, cultural, and economic factors explain these problems to a greater extent.^{5,13–15}

Previous studies have shown that risk factors for CVD tend to cluster and that the risk for CVD increases substantially with each additional risk factor.^{16,17} Although some studies have examined the association between SES and individual CVD risk factors, few have studied the clustering of CVD risk factors within racial and ethnic groups.¹⁸ Furthermore, SES has generally not been considered as a co-factor in explaining the observed racial and ethnic differences in the clustering of risk factors.^{16,17} In addition, studies that have examined these relationships have typically included only 1 or 2 racial groups, usually non-Hispanic Blacks and Whites. Mexican Americans, the fastest growing racial group in the United States, have not been well studied.^{19,20}

The objectives of this analysis were to use data from the Third National Health and Nutrition Examination Survey (NHANES III), a nationally representative sample of non-Hispanic Black, non-Hispanic White, and Mexican American adults, to determine whether there was an inverse association between the clustering of CVD risk factors and educational attainment within each racial group. A second objective, after adjusting for age and gender, was to determine whether within each level of educational attainment, non-Hispanic Black and Mexican-American adults were less likely to have zero CVD risk factors than non-Hispanic Whites.

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METHODS

The NHANES III was designed to assess the health and nutritional status of the non-institutionalized US population. The NHANES III was a stratified, multistage probability survey conducted during two 3-year phases. Phase 1 was conducted from 1988 to 1991 and phase 2 was conducted from 1991 to 1994. Persons included in the sample ranged in age from 2 months to 99 years. NHANES III differed from the previous NHANES studies in that it oversampled non-Hispanic Blacks and Mexican Americans to obtain reliable data on these 2 largest racial and ethnic minority groups in the United States.

Interviews were performed in the subjects' homes to obtain information regarding important sociodemographic factors, such as age, gender, ethnicity, smoking status, and number of years of education. Staff members in Mobile Examination Centers (MEC) conducted the medical examinations, performed phlebotomy, and took anthropometric measurements. Physicians and health technicians measured the subjects' systolic and diastolic blood pressure, height and weight (used to calculate body mass index [BMI]), and obtained blood sam-

ples for biochemical measurements, including serum glucose and lipids.

The present analysis was limited to non-Hispanic Blacks ($N=486$), Mexican Americans ($N=469$), and non-Hispanic Whites ($N=772$) over the age of 25 years with complete information regarding their level of cardiovascular risk factors and SES. Other racial and ethnic groups were excluded because of their small numbers. For this analysis, SES was defined by a participant's level of education. Educational attainment is closely correlated with SES,⁴ is relatively stable over time, and is not as easily influenced by recall bias as some other measures.^{4,21} Education was grouped into 3 categories: less than 12 years (not completing high school), 12 years (having a high school education), and greater than 12 years (at least some college). Risk factors for CVD included hypertension, current smoking, BMI, diabetes, and abnormal cholesterol. Physical activity was excluded as a risk factor because NHANES III did not measure its duration or intensity. To define hypertension status, the average of the second and third blood pressure determinations taken in the MEC were used. Hypertension was defined as either having a systolic blood pressure ≥ 140 mm Hg, a diastolic pressure ≥ 90 mm Hg, or current use of anti-hypertensive medication. Cigarette smoking was defined as having smoked at least 100 cigarettes during one's lifetime and currently smoking cigarettes. Overweight as a risk factor was defined as a BMI (weight [kg]/height [m²]) ≥ 25 for both women and men. Participants were classified as having diabetes mellitus if their fasting plasma glucose values were ≥ 126 mg/dl or if they used insulin or oral hypoglycemic medication (ie, if they met current diagnostic criteria from the American Diabetes Association).²²

Total cholesterol and high-density lipoprotein (HDL) were determined by analysis of the blood samples. The lipoprotein analytical laboratory at Johns Hopkins University, Baltimore, Mary-

land, analyzed the blood samples using a Hitachi 737 analyser (Boehringer-Mannheim Diagnostics, Indianapolis, Indiana). This laboratory participates in the Centers for Disease Control and Prevention-National Heart Lung and Blood Institute Lipid Standardization Program, ensuring the long-term quality of its lipid measurements, which were conducted in accordance with the manual of operations of the Lipid Research Clinics Program. Abnormal cholesterol was defined as an HDL cholesterol value ≤ 35 mg/dl or total blood cholesterol ≥ 240 mg/dl, values indicating significantly greater risk of developing CVD.²³ CVD was defined as having had a self-reported history of myocardial infarction, heart failure, or a stroke. This combined measure was used because the number of strokes and heart attacks within each of the 3 racial groups was very small, particularly for Mexican Americans.

To measure the clustering of risk factors, the number of risk factors for each participant was summed (range: zero to 5). Because few participants had 5 risk factors, persons with either 4 or 5 were combined for analysis.

Data Analysis

SAS (Version 6.12, SAS Institute Inc, Cary, NC) was used for all statistical analyses. A chi-squared test was used to compare the distribution of categorical variables and a *t* test was utilized to compare means across levels of SES and the racial and ethnic groups. Separate logistic regression models were constructed for each racial and ethnic group to determine whether the likelihood of having CVD differed by number of risk factors after adjusting for age, gender, and educational attainment. In addition, separate logistic regression models for each level of SES were used to determine whether the likelihood of having zero CVD risk factors differed between the 3 racial and ethnic groups. We used SUDAAN (version 7.11, Research Triangle Institute, Research Tri-

Table 1. Demographic characteristics and CVD risk factors by racial and ethnic group: Third National Health and Nutritional Examination Survey 1988-1994*

Characteristic	Non-Hispanic Blacks	Mexican Americans	Non-Hispanic Whites	P value†
Mean age (yrs)	44.1	40.9	48.5	<.05
Males (%)	41.7	55.1	52.8	<.01
Mean education (yrs)	11.7	8.8	12.8	<.01
Mean systolic BP (mm Hg)	124.9	120.5	122.9	<.01
Mean diastolic BP (mm Hg)	76.3	74.1	74.1	<.01
Hypertension‡ (%)	35.2	19.0	27.6	<.001
Mean total cholesterol (mg/dL)	202.5	201.7	207.6	<.01
Mean HDL (mg/dL)	55.2	48.8	50.3	<.001
Abnormal blood cholesterol§ (%)	22.1	24.3	30.4	<.001
Mean BMI (kg/m ²)	28.2	28.0	26.5	<.05
Overweight (%)	64.9	68.8	54.7	<.001
Diabetes¶ (%)	7.2	7.7	5.2	<.001
Smokers# (%)	33.4	21.9	26.6	<.001

* Estimates are weighted to the US population.

† P values are calculated from t tests for means and chi-squared tests for proportions.

‡ Hypertension was defined as SBP \geq 140 mm Hg or DBP \geq 90 mm Hg or use of current anti-hypertensive medication.

§ Abnormal blood cholesterol was defined as blood cholesterol \geq 240 mg/dL or HDL <35 mg/dL.

|| Overweight was defined as BMI \geq 25 (kg/m²).

¶ Diabetes was defined as fasting plasma glucose \geq 126 mg/dL or currently taking insulin or oral hypoglycemic medication.

A smoker was defined as smoking at at least 100 cigarettes lifetime and currently smoking cigarettes.

angle Park, NC), to account for the complex sample design and to calculate variance estimates. All the analyses included sampling weights that adjusted for the unequal probabilities of selection, making the results generalizable to the US population.

RESULTS

Mexican Americans tended to be younger and less educated than non-Hispanic Whites and non-Hispanic Blacks, while non-Hispanic Blacks had a lower proportion of men than the other groups (Table 1). Non-Hispanic Blacks had the highest mean systolic and diastolic blood pressure levels and the highest prevalence of hypertension. Non-Hispanic Whites had the highest mean levels of total cholesterol and the highest prevalence of abnormal blood cholesterol. Non-Hispanic Whites had a lower mean BMI than the other 2 groups and the lowest prevalence of individuals who were overweight. The

majority of individuals in each racial and ethnic group were classified as being overweight (from 54.7% of non-Hispanic Whites to 68.8% of Mexican Americans). Mexican Americans had the highest prevalence of diabetes followed by non-Hispanic Blacks and non-Hispanic Whites. Finally, the prevalence of smoking was highest among non-Hispanic Blacks followed by non-Hispanic Whites and Mexican Americans.

In the crude analysis, non-Hispanic Whites were the most likely to have zero risk factors followed by Mexican Americans and non-Hispanic Blacks. Non-Hispanic Blacks were almost half as likely to have zero CVD risk factors as non-Hispanic Whites (12.8% and 20.2%, respectively). Mexican Americans had the highest prevalence of 1 or 2 risk factors and non-Hispanic Blacks the highest prevalence of 3 or more risk factors (almost 1 in 5 non-Hispanic Blacks had 3 or more risk factors). Non-Hispanic Blacks were almost twice as likely as non-Hispanic Whites and Mexican Americans to have 4 or 5 risk factors

Table 2. Odds ratios and 95% confidence intervals for prevalent CVD by number of CVD risk factors and racial and ethnic group*

Number of Risk Factors	Odds Ratio	Confidence Interval		P value†
		Lower	Upper	
Non-Hispanic Whites				
0	1.0			
1	2.0	1.0	3.8	<.05
2	2.7	1.5	4.8	<.01
3	3.7	1.9	7.1	<.001
4-5	6.1	3.3	11.5	<.001
Non-Hispanic Blacks				
0	1.0			
1	1.3	0.3	6.4	<.07
2	2.5	0.5	12.6	<.06
3	3.3	0.5	20.9	<.06
4-5	8.2	1.5	44.9	<.05
Mexican Americans				
0	1.0			
1	1.2	0.3	4.1	<.07
2	2.7	0.7	9.7	<.06
3	3.8	1.0	15.2	<.06
4-5	7.0	1.4	35.0	<.05

* Model is adjusted for age, gender, and education; CVD is defined as a self-reported history of myocardial infarction, heart failure, or stroke; risk factors for cardiovascular disease are hypertension, cigarette smoking, abnormal blood cholesterol, diabetes mellitus, and overweight.

† Wald statistic.

(5.5% vs 2.8% and 2.7%, respectively). Among those with one risk factor, overweight was the most common across all 3 groups and ranged from 47.6% among non-Hispanic Whites to 74.2% among Mexican Americans. Among those with 2 risk factors, overweight and abnormal cholesterol were the most common among non-Hispanic Whites and Mexican Americans, and overweight and hypertension were the most common among non-Hispanic Blacks. Among those with 2 risk factors, the prevalence of overweight ranged from 79.1% among non-Hispanic Whites to 91.5% among Mexican Americans.

In each of the 3 racial/ethnic groups, as the number of CVD risk factors increased, the likelihood of having CVD also increased (Table 2). After adjustment for age, gender, and education,

Table 3. Distribution of CVD risk factors* by race/ethnicity and level of education

Years of Education	Number of Risk Factors				
	0	1	2	3	4-5
Non-Hispanic Whites					
<12	8.7	31.2	32.1	22.0	5.9
12	15.9	37.2	26.1	18.1	2.7
>12	28.6	36.1	25.3	8.6	1.5
Non-Hispanic Blacks†					
<12	6.6	31.3	33.4	20.3	8.4
12	9.8	39.3	33.8	13.6	3.4
>12	22.1	41.4	22.1	9.6	4.9
Mexican Americans‡					
<12	14.2	38.2	31.7	13.2	2.8
12	22.8	36.8	30.6	6.9	2.9
>12	24.3	42.4	24.5	6.4	2.3

* Risk factors for CVD are hypertension, cigarette smoking, increased blood cholesterol, diabetes mellitus, and overweight.

† $P < .001$ for overall chi-square tests within each ethnic group.

persons with 4 or 5 risk factors were 6 to 8 times as likely to have CVD as persons with zero risk factors (odds ratio [OR] 6.1; 95% confidence interval [CI], 3.3–11.5 for non-Hispanic Whites; OR=8.2, 95% CI, 1.5–44.9 for non-Hispanic Blacks; and OR=7.0; 95% CI, 1.4–35.0 for Mexican Americans).

As expected, the prevalence of having zero risk factors increased with additional educational attainment (<12, 12, >12 years) for all 3 racial and ethnic groups (Table 3). Mexican Americans had the smallest increase across the educational groups (almost a doubling, from 14.2% in the lowest group to 24.3% in the highest). For non-Hispanic Whites and non-Hispanic Blacks, the increase was nearly 4 times (8.7% to 28.6% and 6.6% to 22.1%, respectively). Conversely, the prevalence of having 4 or 5 risk factors decreased with advancing educational attainment across all 3 groups. The largest such decrease occurred among non-Hispanic Whites (from 5.9% to 1.5%), the smallest de-

Table 4. Odds ratios and 95% confidence intervals for having zero CVD risk factors by education and racial and ethnic group*

Racial and Ethnic Group	Odds Ratio	95% Confidence Interval		P value†
		Lower	Upper	
<12 Years of Education				
Non-Hispanic White	1.0			
Non-Hispanic Black	0.7	0.4	1.5	.36
Mexican American	1.6	0.9	2.9	.09
12 Years of Education				
Non-Hispanic White	1.0			
Non-Hispanic Black	0.5	0.3	0.7	<.001
Mexican American	1.2	0.8	1.9	.31
>12 Years of Education				
Non-Hispanic White	1.0			
Non-Hispanic Black	0.5	0.4	0.8	<.01
Mexican American	0.6	0.4	1.1	.09

* Model is adjusted for age and gender; risk factors for cardiovascular disease are hypertension, cigarette smoking, increased blood cholesterol, diabetes mellitus, and overweight.

† Wald statistics.

crease among Mexican Americans (from 2.8% to 2.3%).

The relationship between race and ethnicity and the prevalence of having zero CVD risk factors varied within the 3 levels of education (Table 4). Among persons with less than 12 years of education, after adjustment for differences in age and gender, Mexican Americans were 60% more likely (OR=1.6) to have zero risk factors than were non-Hispanic Whites (95% CI, 0.9–2.9). In contrast, non-Hispanic Blacks with less than 12 years education were 30% less likely (OR=0.7) than Whites to have zero risk factors (95% CI, 0.4–1.5). Among persons with 12 years of education, non-Hispanic Blacks were 50% less likely (OR=0.5) than Whites to have zero risk factors (95% CI, 0.3–0.7)

Regardless of race or ethnicity, we observed an inverse relationship between the clustering of risk factors and educational attainment.

and Mexican Americans were slightly more likely to have zero risk factors (OR=1.2; 95% CI, 0.8–1.9). Finally, among persons with more than 12 years of education, both Mexican Americans and non-Hispanic Blacks were less likely to have zero risk factors than non-Hispanic Whites (OR=0.6, 95% CI, 0.4–1.1 for Mexican Americans; OR=0.5, 95% CI, 0.4–0.8 for non-Hispanic Blacks).

DISCUSSION

Our study is among the first studies to examine the clustering of risk factors for CVD by SES using a nationally representative sample of the 3 major racial and ethnic groups in the United States. Regardless of race or ethnicity, we observed an inverse relationship between the clustering of risk factors and educational attainment. The findings also show that regardless of educational level, non-Hispanic Black individuals were less likely to have no CVD risk factors than non-Hispanic Whites or Mexican Americans.

Within each of the 3 racial and ethnic groups, the majority of adults were

overweight, with Mexican Americans having the highest proportion (68.8%). These findings are consistent with Balcazar et al,²⁴ who also showed a high prevalence of overweight among Hispanics corresponding with the national trend showing a dramatic increase in overweight and obesity.²⁵ Ethnic and racial differences in prevalence of overweight may reflect cultural differences in perception of desirable body weight.^{26,27} In addition, the higher rates of overweight in Mexican Americans are associated with a higher prevalence of diabetes in this group.^{28,29} Hypertension was another common risk factor across all groups, but the highest prevalence was noted in non-Hispanic Blacks, a finding consistent with other national surveys.¹²

Our finding that the likelihood of CVD increased as the number of risk factors for this disorder increased is consistent with Yusuf et al¹⁶ and the Framingham heart study.³⁰ Clearly, it is desirable for everyone to have zero risk factors for CVD, but our analysis indicates that the US population is far from achieving this objective. Our findings show that even among those with more than 12 years of education (the best risk factor profile), only one-third of non-Hispanic Whites and one quarter of non-Hispanic Blacks and Mexican Americans had zero risk factors.

Our findings also suggest that race and ethnicity are important determinants of CVD risk apart from their relationship with SES as non-Hispanic Blacks had a greater clustering of risk factors for CVD than non-Hispanic Whites within each level of education. Mexican Americans also were more likely to have multiple CVD risk factors than Whites among those with ≥ 12 years of education. However, in the lowest-SES group, in comparison with non-Hispanic Whites, Mexican Americans were more likely to have zero risk factors. This observation may be due to the "healthy migrant effect" identified by Stern and Wei³¹ in the San Antonio

Heart Study where immigrants from Mexico had very low CVD mortality despite their low socioeconomic status. In addition, the effect of low SES on CVD risk might not be as strong among Mexican Americans as in other racial and ethnic groups. For example, a study of neighborhood deprivation using NHANES III data found that adverse neighborhoods were not as strongly related to the presence of adverse CVD risk factors among Mexican Americans as among Blacks.³² Additional factors that are responsible for these disparities need to be identified and addressed including access to and use of preventive health care, racism, social inequality and other psychosocial factors. Other lifestyle factors, adverse conditions in childhood, and environmental conditions (ie, availability of fresh fruits and vegetables, safe places to exercise) also need to be identified and addressed.^{5,33}

Our results had several potential limitations. First, because NHANES III is a cross-sectional survey we cannot make causal inferences about the association between risk factors for CVD, SES, and CVD. Second, the CVD data in NHANES III is self-reported. Misclassification, however, would most likely result in our underestimating the magnitude of the association between the clustering of risk factors and CVD. In addition, self-reported data on CVD have been shown to have relatively good validity.³⁴ Third, we were unable to include other high-risk but understudied racial groups in our analysis.¹² Future studies should examine risk factor clustering among these groups. Fourth, we used education as a proxy for SES. Because there are differences by birth cohort in educational levels, the value of education as a measure of SES may differ between racial and ethnic groups.^{4,35} Studies have shown that education is the strongest predictor of CVD mortality.^{35,36} Unlike income and employment, education is relatively stable over time.

The majority of persons in the United States have one and 2 CVD risk fac-

tors. For all 3 racial and ethnic groups, overweight was the most common risk factor among those who had just one. The combinations of overweight and abnormal cholesterol and overweight and hypertension were the most common for persons with 2 risk factors. Clearly, more effective prevention efforts targeting overweight, abnormal cholesterol, and hypertension through increased physical activity and heart-healthy diets are needed.

Inequalities in CVD mortality reflect underlying inequalities in CVD risk factors.⁶ Feedback from recent focus groups conducted among low SES women indicates that they would prefer heart disease prevention programs that address multiple CVD risk factors.³⁷ Few successful prevention programs that target these disparities have been developed to date. Future public health interventions need to take into account the needs and resources of disadvantaged communities (where long term health risks seem insignificant in the face of more pressing social and financial demands) if they are to be successful.^{38,39} Eliminating racial, ethnic, and socioeconomic disparities is essential for reducing CVD mortality in the United States.⁴⁰ Society-wide implementation of heart-healthy environments and policies may help decrease these disparities.⁴¹ Unquestionably, targeted primary and secondary prevention efforts will be needed for persons with low SES and for non-Hispanic Blacks.

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