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# Racial/Ethnic Disparities in Coronary Heart Disease Risk Factors among WISEWOMAN Enrollees

ERIC A. FINKELSTEIN, Ph.D., M.H.A.,[1] OLGA A. KHAVJOU, M.A.,[1]
LEE R. MOBLEY, Ph.D.,[1] DAWN M. HANEY, B.S.,[2,3] and JULIE C. WILL, Ph.D., M.P.H.[2]

## ABSTRACT

***Background*: We used the baseline data collected for the Well-integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN) participants to provide a snapshot of cardiovascular disease (CVD) risk on enrollment and to address racial/ethnic disparities in the following CVD risk factors: body mass index (BMI), systolic and diastolic blood pressure, high-density lipoprotein (HDL) and total cholesterol, diabetes and smoking prevalence, 10-year coronary heart disease (CHD) risk, and treatment and awareness of high cholesterol, hypertension, and diabetes.**

***Methods*: We used linear regression analysis to (1) assess the presence of racial/ethnic disparities and test whether existing disparities can be explained by (2) differences in individual characteristics or by (3) differences in individual and community characteristics.**

***Results*: Our results reveal a high degree of CVD risk among the WISEWOMAN participants and statistically significant racial/ethnic disparities in risk factors. Black participants were at the greatest risk of CVD, and Hispanic and Alaska Native participants were healthier in terms of CVD risk than white participants. Some racial/ethnic disparities were explained by differences in individual and community characteristics, but other disparities persisted even after controlling for these factors.**

***Conclusions*: Because differences in community characteristics explain many of the racial/ethnic disparities in CVD risk factors, eliminating disparities may require community-wide interventions. Successful WISEWOMAN projects are likely to not only reduce CVD risk factors overall but also to lessen racial/ethnic disparities in these risk factors.**

## INTRODUCTION

CARDIOVASCULAR DISEASE (CVD), which includes heart disease, infarctions, and stroke, is the leading cause of death of women in the United States.[1,2] It is also a primary contributor to morbidity and decreased quality of life, especially among older women. Women in lower income brackets with lower levels of education and without health insurance have an increased risk of CVD morbidity and mortality,[3] as do women from some racial and ethnic minority groups.[4] Low-income, less educated, uninsured, and minority women have limited access to health ser-

[1]RTI International, Health, Social and Economics Research, Research Triangle Park, North Carolina.
[2]Centers for Disease Control and Prevention, Division of Nutrition and Physical Activity, Atlanta, Georgia.
[3]Department of Health Promotion and Behavior, University of Georgia, Athens, Georgia.
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vices and are more likely to smoke cigarettes, to engage in limited physical activity, and to have poor nutrition.[5]

In 1995, the Centers for Disease Control and Prevention (CDC) began funding the Well-Integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN) demonstration projects. WISEWOMAN provides CVD screening and intervention services for low-income women aged 40–64 who participate in the National Breast and Cervical Cancer Early Detection Program (NBCCEDP), a cancer screening program for underinsured and uninsured women.

To increase the likelihood of a successful intervention, it is important to consider the influence of community characteristics on CVD risk behaviors and the degree to which community characteristics vary by racial/ethnic group. Community characteristics include measures of racial segregation, community-level education and income characteristics, employment opportunities, and neighborhood safety. These characteristics are strongly associated with race/ethnicity and may cause disparities in CVD risk factors by differentially influencing behaviors, such as diet, physical activity, and smoking.[6–8] As summarized by Wallerstein, "Living in an environment of physical and social disadvantage—being poor, low in the hierarchy, under poor working conditions or being unemployed, subject to discrimination, living in a neighborhood of concentrated disadvantage, lacking social capital, and at relative inequity to others—is a major risk factor for poor health."[9(p73)]

As Wallerstein suggests, community characteristics affect health status, even after controlling for individual characteristics. Robert[10] found that community-level socioeconomic status (SES) remained a statistically significant predictor of health even after including individual and family measures of SES. Community-level income inequality has also been shown to be a statistically significant independent predictor of health outcomes.[11,12] Diez-Roux et al.[13] found that living in deprived neighborhoods and community-level income inequality were associated with increased prevalence of coronary heart disease (CHD) and increased levels of CVD risk factors even after adjusting for individual-level variables. Several studies have found that residential segregation contributes to racial disparities in health status.[14–18] Community-level variables, such as median home value, percentage of the population that owns a home, proportion of single-family homes, population density, and racial/ethnic mix, have also been shown to statistically significantly influence the availability of healthy foods.[19]

The purpose of this paper is to use the baseline data collected for the WISEWOMAN participants to provide a snapshot of CVD risk on enrollment and, because a statistically significant fraction of participants are minorities, to address racial/ethnic disparities in CVD risk factors. When present, we attempt to explain the disparities through differences in individual and community characteristics that vary along racial/ethnic dimensions. Analyses of this type can provide useful information for designing interventions that take community characteristics into account.

## MATERIALS AND METHODS

### *Data*

Baseline CVD risk factor data for this analysis came from all the WISEWOMAN participants enrolled in 1 of 8 locations between January 2001 and December 2002 ($n = 5596$): Connecticut, Massachusetts, Michigan, Nebraska, North Carolina, South Dakota, Southeast Alaska Regional Health Consortium (SEARHC), and the Southcentral Foundation (SCF), also in Alaska. Although each project is unique and tailored to meet the needs of the women enrolled, all collected similar data on CVD risk factors.

Risk factor data included body mass index (BMI), systolic and diastolic blood pressure, and total and high-density lipoprotein (HDL) cholesterol. In addition, participants were asked whether they had ever been told by a health professional that they had diabetes, high cholesterol, or high blood pressure; whether they were currently taking medication to treat these conditions; and whether they smoked cigarettes. Using this information, each participant was assigned a summary measure of CHD risk, namely, the 10-year probability of CHD (including angina pectoris, myocardial infarction [MI], coronary insufficiency, and CHD death). We computed 10-year CHD risk using a scoring methodology[20] that assigns points to certain risk factors, including age, total and HDL cholesterol, hypertension (systolic and diastolic blood pressure), smoking status, and diabetes status.

Other data collected from participants included ZIP code and county of residence, age, race, Hispanic or Latina origin, and education. Using the county and ZIP code of residence, we merged in additional data from the 2000 Census, the 2002 Area Resource File, and the 2000 National Archive of Criminal Justice Data.

Based on our review of the literature and on data availability, we included six ZIP code-level variables and six county-level variables in our analysis (see Appendix for variable definitions). The six ZIP code-level variables were (1) median earnings of females, (2) ratio of median earnings of females to median earnings of males, (3) index of racial isolation, (4) proportion of population that is urban, (5) proportion of the adult (≥25 years) female population with a high school diploma as highest educational attainment, and (6) proportion of families with all adults working. The six county-level variables were (1) income inequality, (2) index of dissimilarity, (3) proportion of the work force in manufacturing jobs, (4) proportion of families in poverty, (5) robbery arrests per 100,000 county residents, and (6) population density per square mile of land.

### *Analyses*

We ran a series of regressions to (1) assess the presence of racial/ethnic disparities and test whether they could be explained by (2) differences in observable characteristics that vary across individuals or by (3) differences that vary across individuals and communities. The dependent variable in each regression was the CHD risk factor.

In model 1, the independent variables were limited to dichotomous variables identifying the race/ethnicity of each participant. White non-Hispanic (white) was the omitted reference category in all regressions, and other categories included African American non-Hispanic women (black), Hispanic women (Hispanic), and Alaska Native women (Alaska Native). Model 2 included participants' age and educational attainment (less than high school, some high school, and high school graduate). We included BMI as an independent variable in blood pressure, cholesterol, and diabetes regressions because racial/ethnic differences in BMI may explain the racial/ethnic differences in these CVD risk factors. Model 3 included the same variables as in the first two models and additional community-level variables.

Because white was the omitted reference category, the Student's $t$ statistic associated with each of the race/ethnicity dummy variables tested whether the mean value for the risk factor among the minority population was statistically different from the mean value for white participants. In model 1, a statistically significant Student's $t$ statistic identified racial/ethnic disparities. The $t$ statistics in models 2 and 3 tested whether the racial/ethnic disparities remained statistically significant after accounting for the individual (model 2) and individual and community (model 3) characteristics. In the next section, we show a figure for each risk factor, illustrating the average risk factor value among all the WISEWOMAN participants and the average value for white, black, Hispanic, and Alaska Native women. The figures identify whether the differences are statistically significant both before and after controlling for (1) individual and (2) individual and community characteristics.

## RESULTS

### *Sample characteristics*

Summary statistics detailing individual-level and community-level variables are shown in Table 1. The average age of all the participants was 51.7 years. Black participants were slightly older (53.2) than white (52.1) participants, and Hispanic (49.6) and Alaska Native (50.2) participants were slightly younger. Overall, 10% of the participants had less than a ninth grade education, and 37% had some college experience. Only 4% of the white participants had less than a ninth grade education vs. 12% and 38% of the black and Hispanic participants, respectively. Of the four groups, Alaska Natives were the most likely to have attended some college (64%), and Hispanic women were the least likely (17%).

The WISEWOMAN participants of different races/ethnicities live in communities that differ along several dimensions (Table 1). On average, white participants lived in communities that had lower levels of income inequality but were much more segregated than communities where minority participants lived. Hispanic ($19,137) and Alaska Native ($21,847) participants lived in communities with the highest average median earnings for females. The average ratio of median earnings of females to median earnings of males was the lowest in communities of white participants. Black participants (18%) lived in commu-

TABLE 1. INDIVIDUAL-LEVEL AND COMMUNITY-LEVEL CHARACTERISTICS OF WISEWOMAN ENROLLEES BY RACE/ETHNICITY (MEANS)

| *Variable* | *All (n = 5596)* | *White non-Hispanic (n = 3348)* | *Black non-Hispanic (n = 895)* | *Hispanic (n = 727)* | *Alaska Native (n = 626)* |
|---|---|---|---|---|---|
| Age (years) | 51.7 | 52.1 | 53.2* | 49.6* | 50.2* |
| Education | | | | | |
| Less than 9th grade | 10% | 4% | 12%* | 38%* | 5%* |
| Some high school | 10% | 10% | 20%* | 12%* | 5%* |
| High school diploma | 43% | 48% | 47% | 32%* | 26%* |
| Some college | 37% | 39% | 22%* | 17%* | 64%* |
| Body mass index | 30.0 | 29.2 | 32.5* | 29.1 | 31.6* |
| ZIP code level data | | | | | |
| Median earnings of females ($1000s) | 18.6 | 18.1 | 17.8* | 19.1* | 21.8* |
| Ratio of median earnings of females to males | 0.7 | 0.6 | 0.7* | 0.7* | 0.7* |
| Index of racial isolation | 61% | 87% | 33%* | 19%* | 15%* |
| Proportion of urban population | 66% | 59% | 69%* | 88%* | 78%* |
| Proportion of female population (≥25 years) with high school diploma as highest education | 31% | 32% | 31%* | 30%* | 26%* |
| Proportion of families with all adults working | 53% | 53% | 54%* | 53% | 58%* |
| County level data | | | | | |
| Income equality ($1000s) | 28.6 | 28.1 | 28.4* | 29.5* | 30.2* |
| Index of dissimilarity | 29% | 30% | 30% | 36%* | 19%* |
| Proportion of work force in manufacturing jobs | 13% | 13% | 18%* | 12%* | 3%* |
| Proportion of families in poverty | 11% | 11% | 13%* | 9%* | 8%* |
| No. of robbery arrests per 100,000 residents | 26.9 | 20.3 | 52.4* | 28.8* | 23.6* |
| Population density per square mile | 586 | 466 | 533 | 1626* | 93* |
| Location | | | | | |
| Connecticut | 5% | 4% | 10%* | 6%* | 0%* |
| Massachusetts | 32% | 37% | 8%* | 66%* | 0%* |
| Michigan | 3% | 4% | 3%* | 0%* | 0%* |
| Nebraska | 16% | 24% | 3%* | 9%* | 0%* |
| North Carolina | 29% | 25% | 76%* | 16%* | 0%* |
| South Dakota | 3% | 5% | 0%* | 1%* | 0%* |
| SCF[a] (Alaska) | 7% | 0% | 0% | 0% | 66%* |
| SEARHC[b] (Alaska) | 4% | 0% | 0% | 1%* | 34% |

*Significantly different from white non-Hispanics ($p \leq 0.05$).
[a]Southcentral Foundation.
[b]Southeast Alaska Regional Health Consortium.

nities with a higher proportion of the work force in manufacturing jobs compared with white (13%), Hispanic (12%), and Alaska Native (3%) participants. Black participants also lived in communities with a higher proportion of families in poverty (13% vs. 8%–11%) and a substantially higher rate of robberies (52% vs. 20%–29%).

More than three fourths of all the WISEWOMAN participants were from Massachusetts (32%), North Carolina (29%), and Nebraska (16%), with substantial racial/ethnic clustering by state (Table 1). For example, 86% of the white participants and more than 90% of the Hispanic participants were from these three states, and more than three fourths (76%) of the black participants were from North Carolina alone. By design, only Alaska Natives participated in the SCF and SEARHC WISEWOMAN projects.

*CHD risk factors*

The average BMI at baseline was 30.2 overall and 29.2 for whites (Fig. 1). Unadjusted for individual and community characteristics, the average BMI was in the obese range (BMI > 30) among blacks (32.5) and Alaska Natives (31.7). Controlling for individual characteristics alone and individual and community characteristics together did not change this result. No statistical differences in BMI were present between white and Hispanic participants.

The average systolic blood pressure at baseline was 123.1 overall (Fig. 2). The unadjusted results showed that blacks had higher average systolic blood pressure (127.4) than whites (123.5) and that Alaska Natives (120.5) and Hispanics (120.2) had lower average systolic blood pressure than whites. After controlling for individual characteristics, the difference in systolic blood pressure between blacks and whites became insignificant. After controlling for individual and community characteristics, the difference in systolic blood pressure between whites and Hispanics and between whites and Alaska Natives also became insignificant.

As with systolic blood pressure, the average diastolic blood pressure among black women (79.9) was significantly higher than among white women (76.4) but was statistically significantly lower among Hispanic women (74.2) (Fig. 3). There were no statistically significant differences between Alaska Native women and white women. After controlling for individual characteristics, blacks continued to have higher, and Hispanics lower, average diastolic blood pressure than whites. After controlling for individual and community characteristics, the difference between whites and blacks became insignificant, although Hispanics continued to have lower diastolic blood pressure than whites.

Total cholesterol was the highest for white women (217.2) (Fig. 4). Hispanics had the lowest total cholesterol levels (203.5), followed by blacks (208.6) and Alaska Natives (209.3). After controlling for individual-level and community-level variables, the total cholesterol remained higher for whites than for women of all other racial/ethnic backgrounds. For HDL cholesterol (Fig. 5), there were no statistically significant differences in the unadjusted values for whites (56.9) and blacks (56.7), but Alaska Natives (60.0) had higher (better) HDL cholesterol levels. Even though Hispanics had lower levels of total cholesterol than

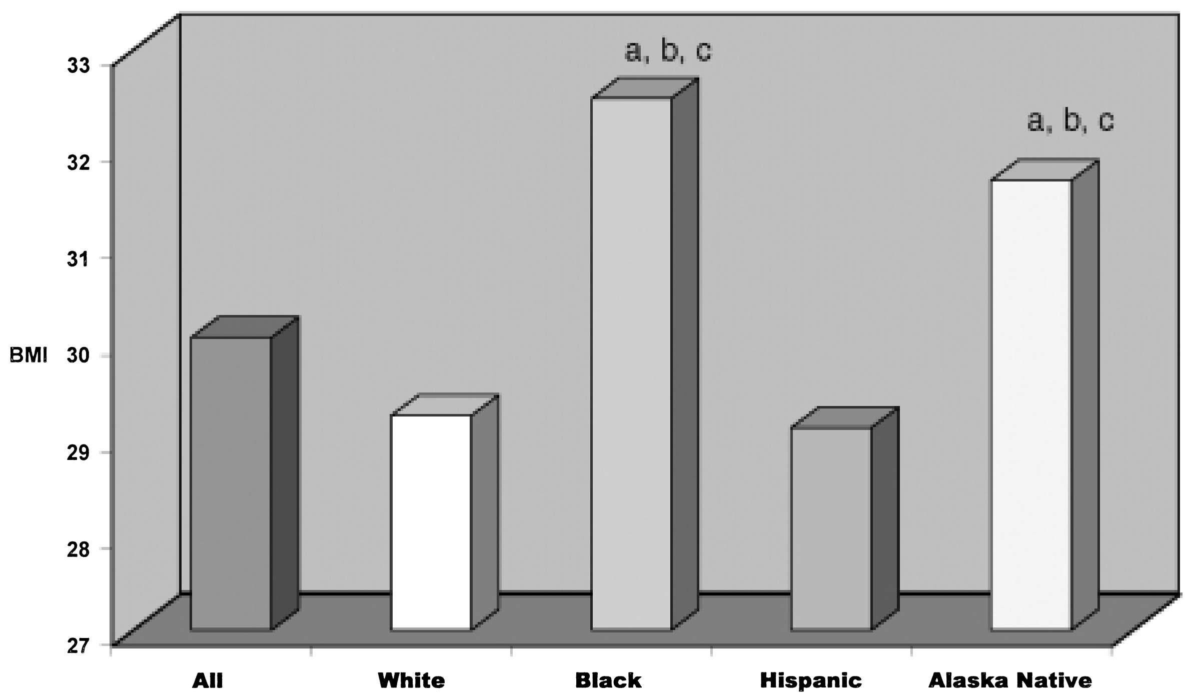


**FIG. 1.** Average body mass index (BMI) of WISEWOMAN participants. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics.

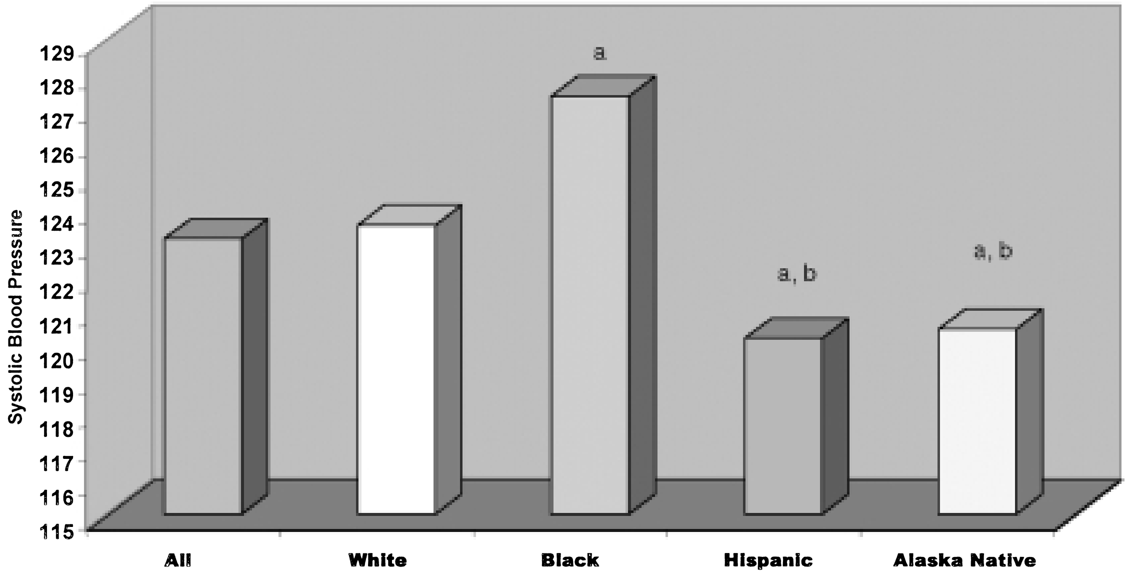


**FIG. 2.** Average systolic blood pressure of WISEWOMAN participants. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. *Note:* Sample restriction: Women not taking medication for high blood pressure.

whites, their HDL cholesterol was also statistically significantly lower (52.6). After controlling for individual and community characteristics, blacks and Alaska Natives had a higher average HDL cholesterol level than whites, but the difference in HDL cholesterol between whites and Hispanics became insignificant.

Blacks (17%) and Alaska Natives (10%) were statistically significantly more likely to have diabetes than whites (6%) (Fig. 6). After controlling

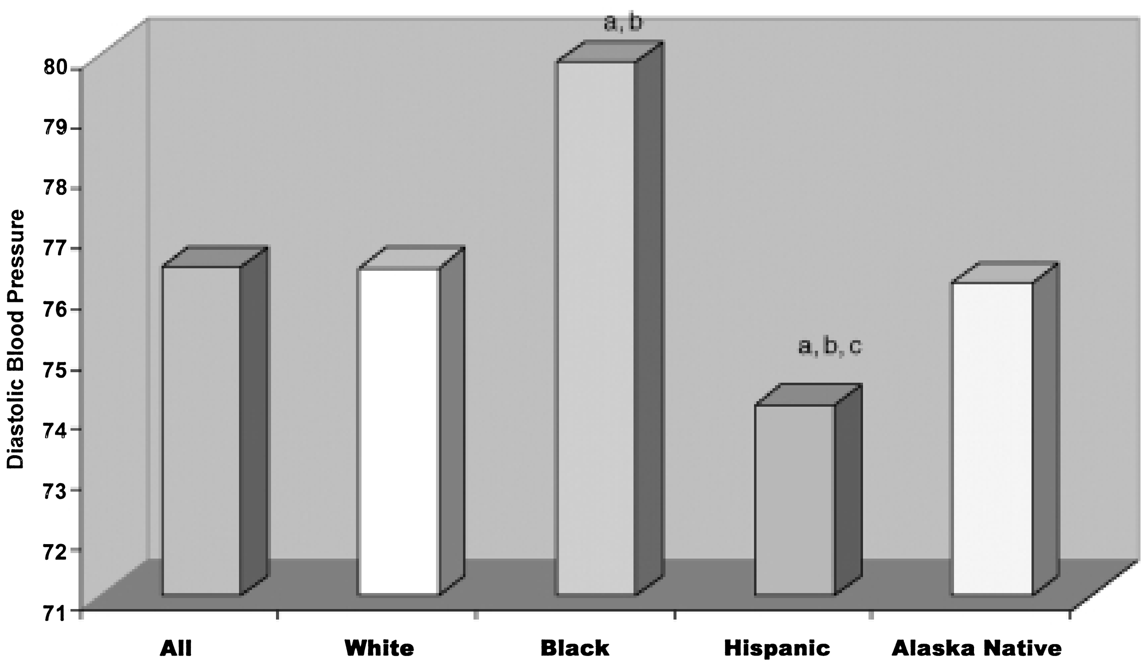


**FIG. 3.** Average diastolic blood pressure of WISEWOMAN participants. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics. *Note*: Sample restriction: Women not taking medication for high blood pressure.

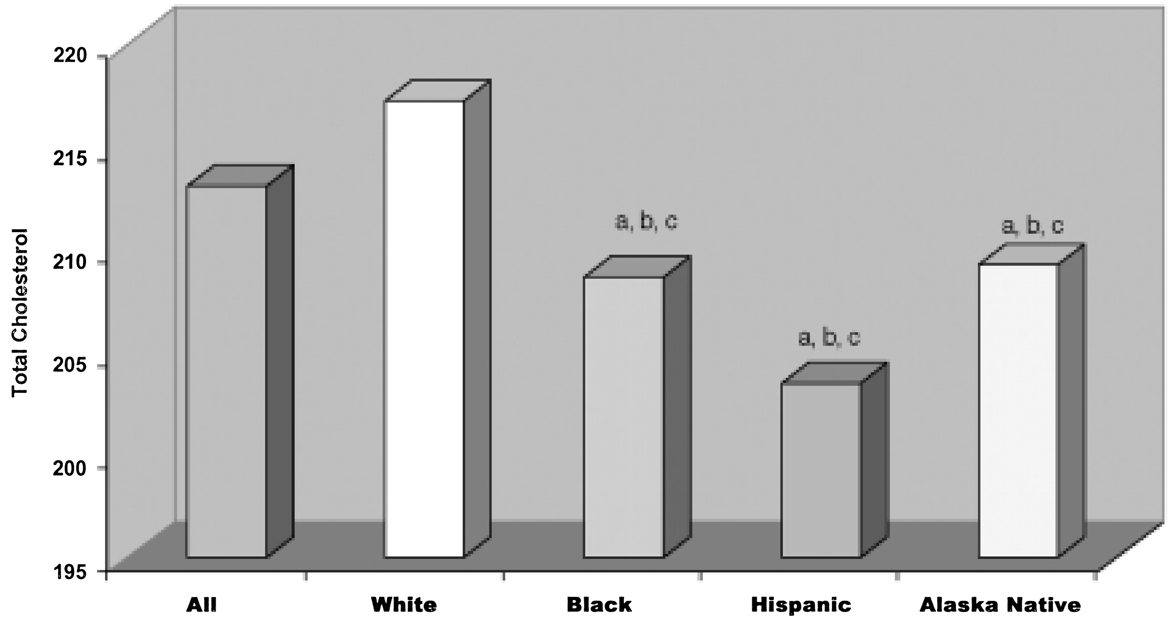


**FIG. 4.** Average total cholesterol (mg/dl) of WISEWOMAN participants. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics. *Note*: Sample restriction: Women not taking medication for high blood pressure.

for individual and community characteristics, the diabetes prevalence rate among blacks remained higher than among whites, but the difference between whites and Alaska Natives became insignificant.

One fourth (26%) all of the WISEWOMAN enrollees reported smoking cigarettes (Fig. 7). Both before and after controlling for individual and community characteristics, Hispanic women (12%) were statistically significantly less likely to smoke

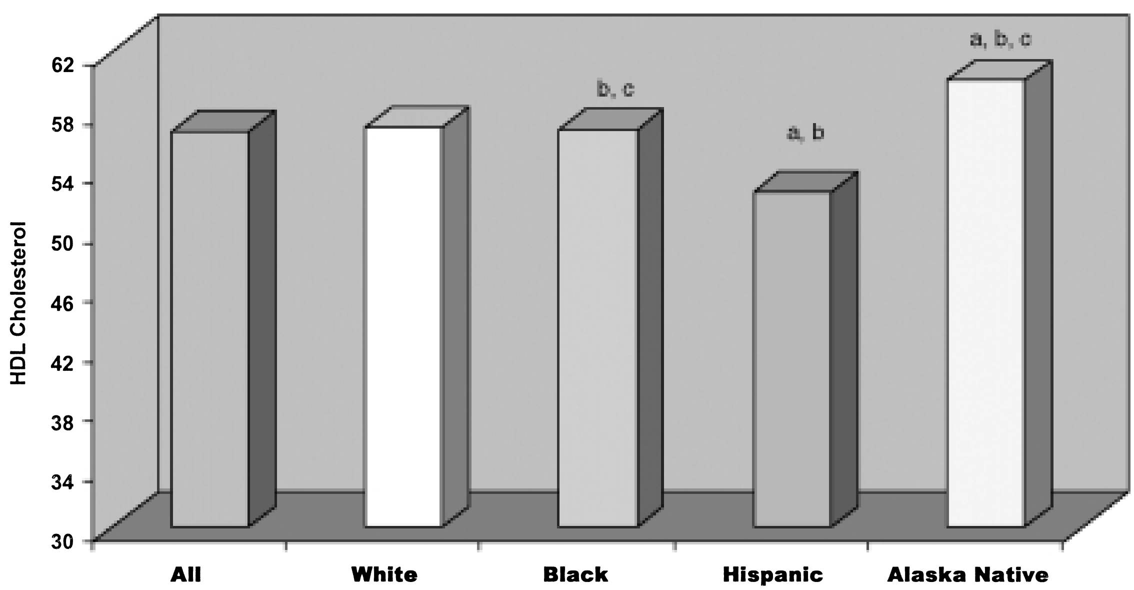


**FIG. 5.** Average HDL cholesterol (mg/dl) of WISEWOMAN participants. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics. *Note*: Sample restriction: Women not taking medication for high blood pressure.

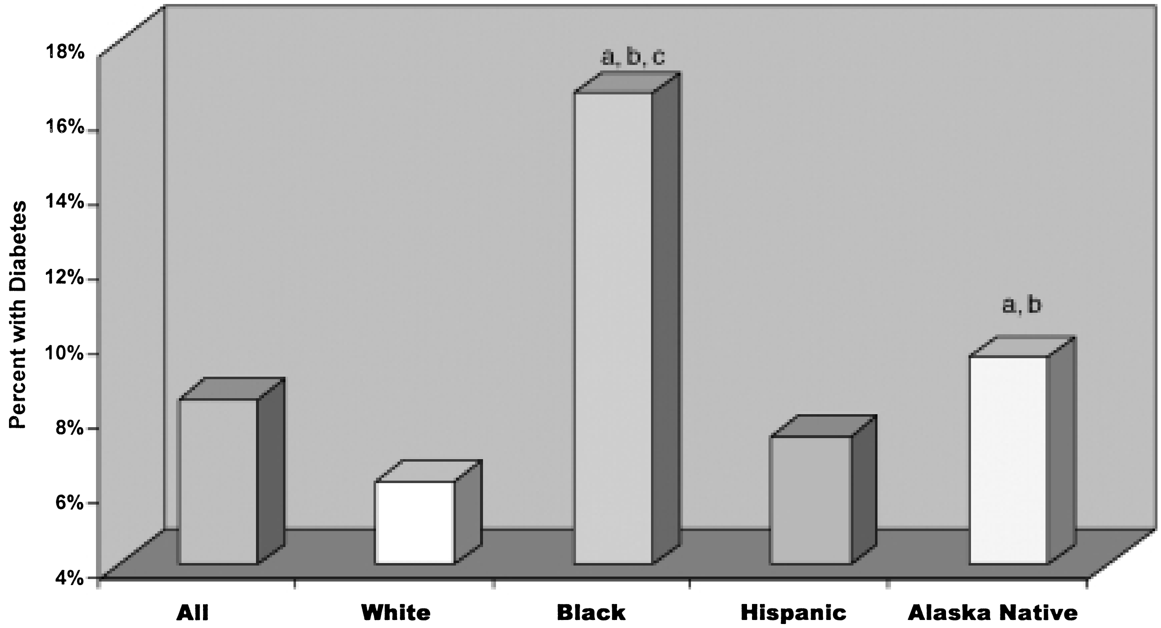


**FIG. 6.** Percentage of WISEWOMAN participants with known diabetes. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics.

than white women (28%). After controlling for these characteristics, blacks were statistically significantly less likely to smoke than whites.

Hispanics (5.3%) and Alaska Natives (5.0%) had statistically significantly lower 10-year CHD risk scores than whites (6.6%) (Fig. 8). Unadjusted, blacks (7.5%) had statistically significantly higher CHD risk scores than whites. Controlling for individual characteristics revealed no statistical difference between whites and Hispanics or

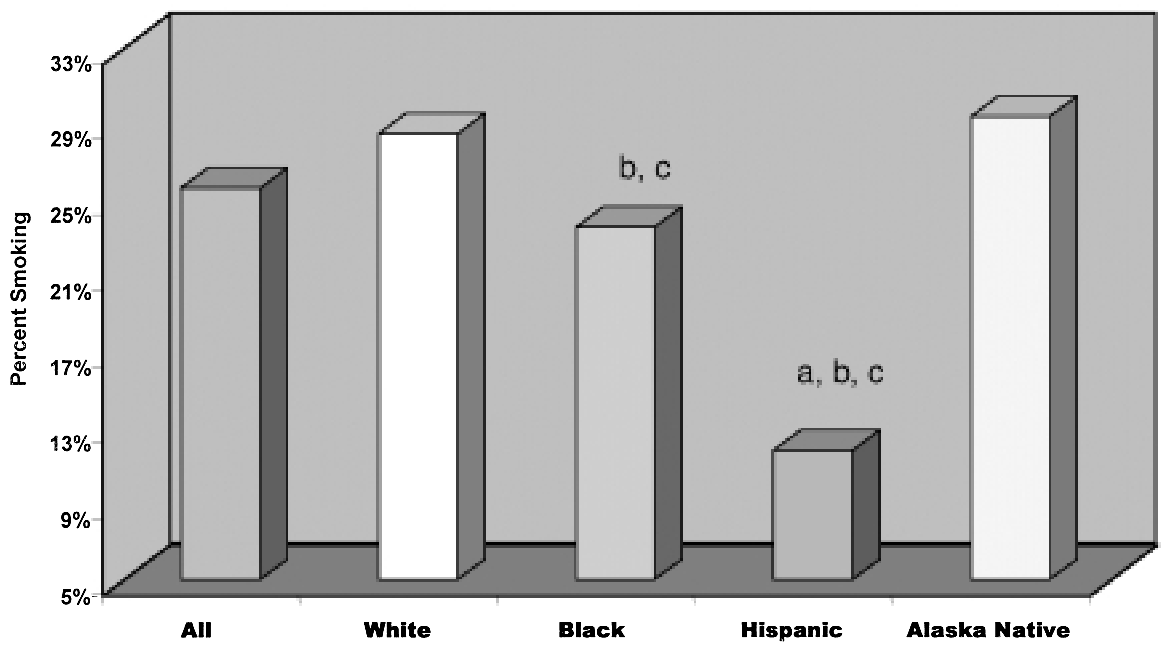


**FIG. 7.** Percentage of WISEWOMAN participants who smoke. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics.

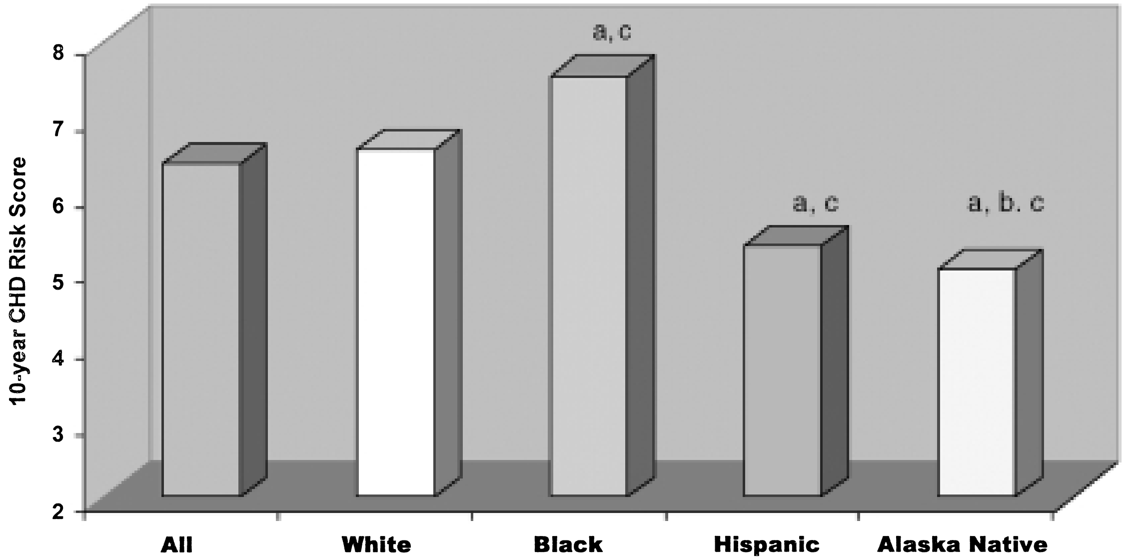


**FIG. 8.** Ten-year CHD risk score (Wilson et al.[20] guidelines). [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics.

between whites and blacks. However, after controlling for individual and community characteristics, blacks, Hispanics, and Alaska Natives had statistically significantly lower average CHD risk scores than whites.

*Risk factor awareness*

In addition to measuring CHD risk factors, baseline data collection assessed whether women with hypertension and high cholesterol were aware of their condition on enrollment in WISEWOMAN. Hypertension is defined by an average of two blood pressure readings at the initial screening where either the systolic blood pressure is ≥140 mm Hg or the diastolic blood pressure is ≥90 mm Hg. High cholesterol is defined as a total cholesterol value of ≥240 mg/dl.

Overall, 41% of the women with hypertension were previously unaware of their condition (Fig. 9). Black and Alaska Native women were more likely to be aware of their hypertension than white women (24% of blacks and 28% of Alaska Natives reported being unaware vs. 48% of whites). This difference persisted after adjusting for individual and community characteristics.

More than one half (53%) all of the enrollees were unaware of their high cholesterol on enrollment (Fig. 10). Compared with white women (55%), Hispanic women (66%) were substantially more likely to be unaware of their high cholesterol, and Alaska Native women (35%) were much less likely to be unaware of their condition. The difference in high cholesterol awareness rates between whites and Hispanics became insignificant after accounting for individual characteristics, whereas Alaska Natives continued to have higher awareness rates. After adjusting for both individual and community characteristics, however, awareness rates between Alaska Natives and whites also became insignificant.

*Treatment*

A history of hypertension, high cholesterol, or diabetes and the use of specific medications for those conditions were based on self-reported responses from the participants on enrollment. Overall, 74% of the WISEWOMAN participants with hypertension reported currently being treated for their condition (Fig. 11). Before adjusting for individual and community characteristics, blacks (88%) were statistically significantly more likely than whites (71%) and Alaska Natives (55%) were statistically significantly less likely to take medication for hypertension. After adjusting for these characteristics, there were no statistically significant differences in hypertension treatment rates between whites and Alaska Natives, but blacks remained more likely than whites to have their hypertension treated with medication.

Approximately one fourth (24%) of all the par-

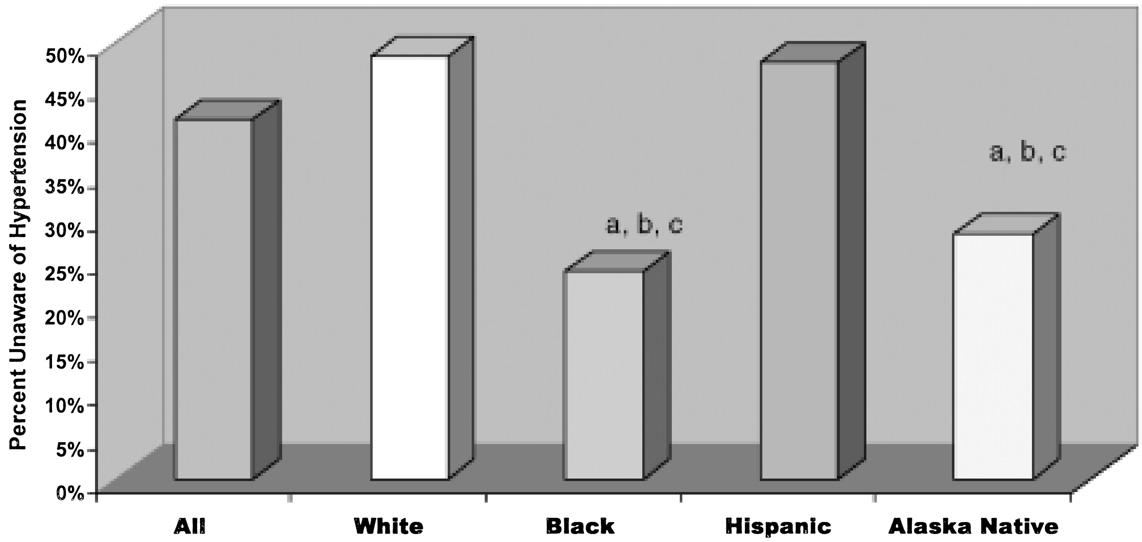


**FIG. 9.** Percentage of WISEWOMAN participants with hypertension who are unaware of their condition. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics. *Note*: Sample restriction: BP $\geq$ 140/90.

ticipants reported taking medication to treat high cholesterol (Fig. 12). Both adjusted and unadjusted results revealed no statistically significant differences in high cholesterol treatment rates between whites and women of other races/ethnicities.

Among participants who reported a history of diabetes, almost three fourths (73%) reported taking medication to treat their condition (Fig. 13). Before adjusting for individual and community characteristics, Alaska Natives (55%) were less likely

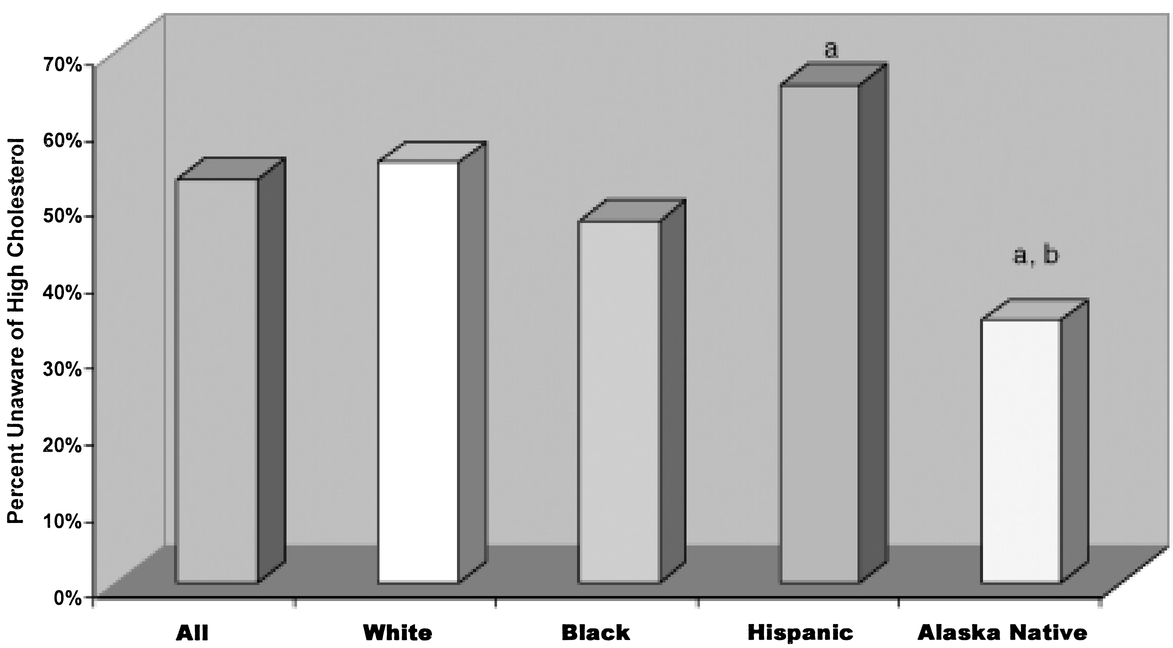


**FIG. 10.** Percentage of WISEWOMAN participants with high cholesterol who are unaware of their condition. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. *Note*: Sample restriction: Total cholesterol $\geq$ 240.

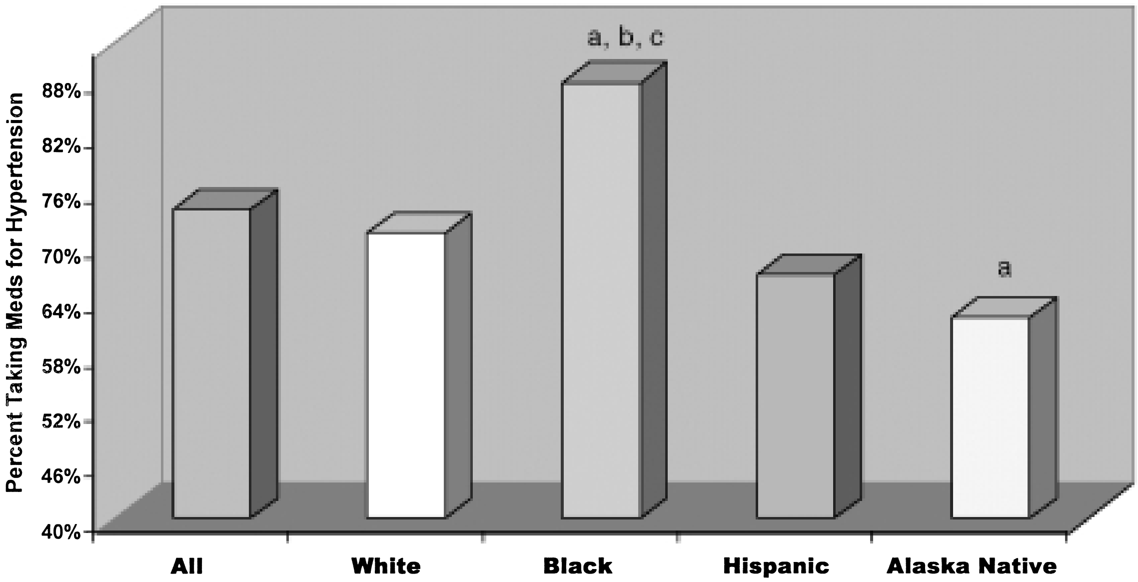


**FIG. 11.** Percentage of WISEWOMAN participants with a history of hypertension taking medication to treat their condition. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. [c]Statistically different from white ($p < 0.05$) after controlling for age, education, BMI, and community characteristics. *Note*: Sample restriction: History of hypertension $\geq 240$.

to take diabetes medication than whites (71%), but this difference became insignificant after accounting for both individual and community characteristics. Controlling only for individual characteristics, blacks had statistically significantly higher diabetes treatment rates than whites. This difference became insignificant after controlling for individual and community characteristics.

## DISCUSSION

Our analysis of data collected from women as they enrolled in the WISEWOMAN projects in seven geographically diverse states reveals a high degree of CVD risk and statistically significant racial/ethnic disparities in CVD risk factors. In general, before adjusting for individual and com-

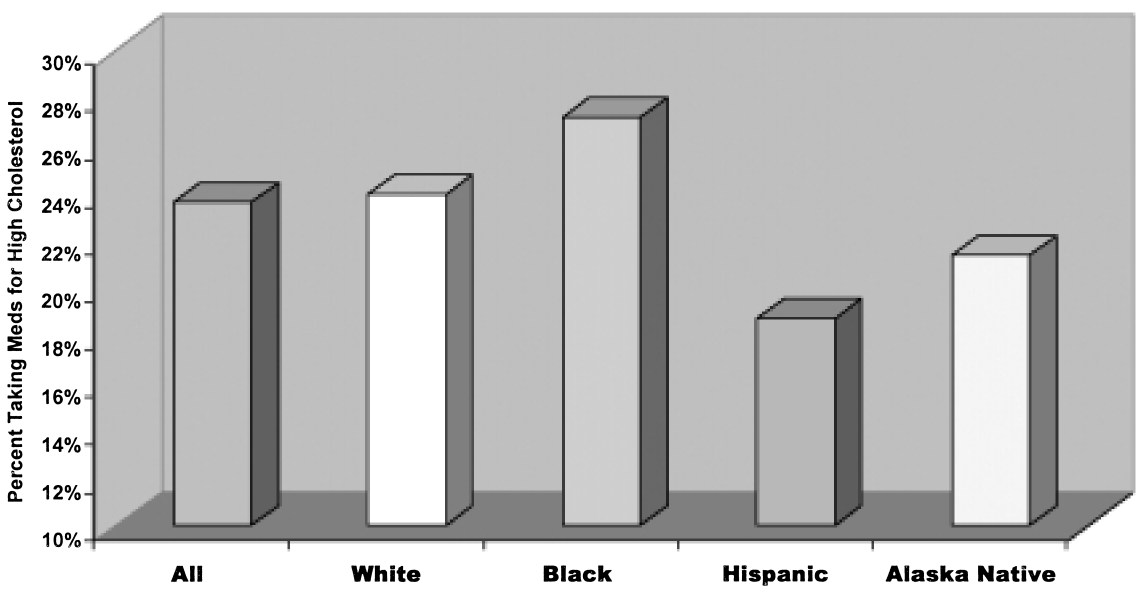


**FIG. 12.** Percentage of WISEWOMAN participants with a history of high cholesterol taking medication to treat their condition. *Note*: Sample restriction: History of high cholesterol.

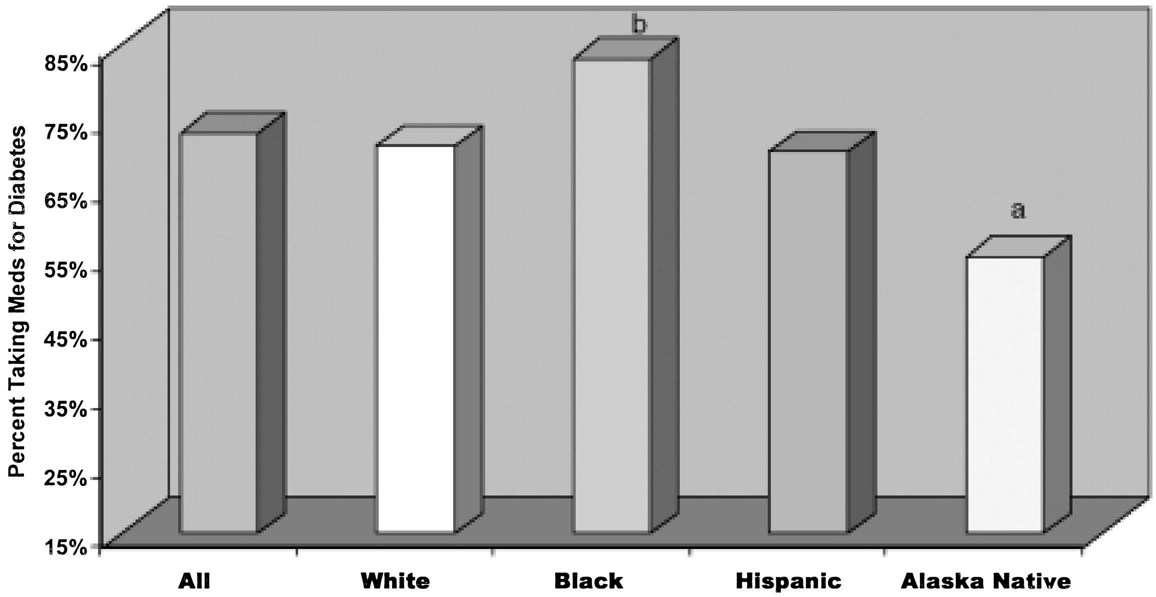


**FIG. 13.** Percentage of WISEWOMAN participants with diabetes taking medication to treat their condition. [a]Statistically different from white ($p < 0.05$). [b]Statistically different from white ($p < 0.05$) after controlling for age, education, and BMI. *Note*: Sample restriction: Diabetes patients.

munity characteristics, black participants were at the greatest risk of CVD. Compared with white participants, black women had, on average, more obesity, higher blood pressure, higher diabetes prevalence rates, and a higher 10-year CHD risk score. In terms of unadjusted CVD risk, Hispanic and Alaska Native participants were healthier than white participants, with lower average blood pressure, total cholesterol, and 10-year CHD risk scores.

We also found that blacks with hypertension and Alaska Natives with hypertension or high cholesterol were more likely than whites to be aware of these conditions, and blacks were more likely to be receiving treatment. These unadjusted differences in awareness and access to medications may be due to differences in preventive care or treatment patterns that vary along racial/ethnic dimensions. Several studies[21–25] provide evidence that white and minority patients with similar symptoms receive different levels of medical care. For example, Psaty et al.[21] found that hypertension awareness and treatment rates were higher among blacks than among whites, and another study[25] found that black patients with access to primary care received equal or better preventive care than white patients. It is likely that the pervasive problem of high blood pressure is well recognized in African American communities,[26] therefore, and clinicians may be more aggressive in treating this condition among blacks.

We were able to explain several of the racial/ethnic disparities in CVD risk factors by the differences in individual characteristics that varied along racial/ethnic dimensions. For example, the higher BMI among black women accounted for the difference in blood pressure between white and black participants. Controlling for differences in individual characteristics also revealed some differences in CVD risk that were masked in the unadjusted results. After controlling for age and education, black participants had a lower smoking rate than whites. The differences in community characteristics (after controlling for individual differences) explained several racial/ethnic disparities in CVD risk. For example, controlling for individual differences, Alaska Natives had higher rates of diabetes than whites, but these differences disappeared after taking community characteristics into account. Similarly, the differences in individual and community characteristics explained the differences in diastolic blood pressure between whites and blacks, the differences in systolic blood pressure and HDL cholesterol between whites and Hispanics, and the differences in systolic blood pressure, diabetes prevalence, and high cholesterol awareness rates between whites and Alaska Natives. Moreover, whereas our unadjusted results showed that blacks had higher 10-year CHD risk scores, on average, than whites, after adjusting for individual and community characteristics, blacks had lower scores than whites. This result clearly illustrates the impact of community characteristics on individual health.

In some instances, racial/ethnic disparities persisted even after controlling for individual-level and community-level factors. Our analyses were unable to explain why white participants had higher levels of total cholesterol or why black participants had higher diabetes prevalence rates than whites. Other factors that we were unable to incorporate into our regressions might explain these remaining disparities. These factors include genetic predisposition for CVD risk and other unobservable characteristics that are associated with CVD risk that vary along racial/ethnic dimensions. For example, although all the WISEWOMAN participants were underinsured or uninsured, racial/ethnic disparities in healthcare access might persist because of past experiences with healthcare providers, language barriers, or cultural beliefs about the need for treatment.[6] Hogue[16] argues that a lifetime accumulation of the acute stress caused by prejudice and discrimination can also degrade health among minority populations. This theory is consistent with our finding of greater CVD risk among black participants but does not explain the generally better health status of Hispanic and Alaska Native participants compared with white participants.

Other community characteristics might further explain racial/ethnic disparities in CVD risk factors but were not included in our analyses because such data were not available. Community characteristics, such as the availability of affordable healthy foods and safe locations for physical activity, are associated with CVD risk and vary systematically with race/ethnicity.[19] However, these variables are likely to be highly associated with the community variables that were included in our analysis and, therefore, may not have an independent effect. Future analyses should focus on determining which variables serve as the best proxies for measuring community characteristics and seek to identify the community variables that have the greatest impact on CVD risk.

Our findings have implications for the success of WISEWOMAN and similar interventions in reducing disparities in health risk factors. Specifically, because our findings suggest that the differences in community characteristics account for many racial/ethnic disparities in CVD risk factors, efforts to eliminate the disparities are likely to require community-wide interventions that seek to even the playing field. To be effective, interventions should address community-level factors that may inhibit an individual's ability to undertake specific activities and be tailored to ensure that individuals are able to engage in and fully benefit from the activities promoted by the intervention. For example, we found that the black WISEWOMAN participants lived in communities with substantially higher crime rates (as measured by robbery arrests) than white, Hispanic, or Alaska Native participants. Interventions that do not address community-level factors, such as crime rates (and fail to acknowledge that women may not be able to safely engage in physical activity), are unlikely to be successful. The WISEWOMAN projects, which seek to identify and reduce CVD risk factors by implementing interventions that are tailored to meet the unique needs of the participants, will be more likely to succeed and to reduce racial/ethnic disparities in risk factors if they attend to community-level influences on individual behavior.

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Address reprint requests to:
*Eric A. Finkelstein, Ph.D.*
*RTI International*
*Health, Social and Economics Research*
*3040 Cornwallis Road*
*P.O. Box 12194*
*Research Triangle Park, NC 27709*

*E-mail:* finkelse@rti.org

## APPENDIX: DETAILS ON VARIABLE CONSTRUCTION

In this Appendix, we provide a definition for each community-level variable used in the analysis. Specifically, we describe how the variable was created, the dataset from which it was obtained, and our rationale for including the variable as a potential determinant of racial/ethnic disparities in health outcomes.

### *Zip code-level variables*

Our analysis included data from 1021 ZIP codes in seven states.

*Median earnings*. The two median earnings variables (median earnings of females and the ratio of the median earnings of females to the median earnings of males) were created using the 2000 Census data on the median earnings of males and females. We included median female earnings because it is a sex-specific variable that measures wealth at the local (ZIP code) level. We expected that women from ZIP codes with higher median earnings would have better access to healthcare and, as a result, better health outcomes than women from ZIP codes with lower median earnings.

*Ratio of median earnings*. The ratio of median earnings of females to the median earnings of males is a measure of sex inequality. Women from ZIP codes where the ratio of earnings of females to the earnings of males is >1 are (on average) economically better off than men and may have a greater role in the community. In our data, we found 10 ZIP codes with the ratio of earnings of females to the earnings of males >1—1 in Massachusetts, 1 in Connecticut, 3 in Nebraska, and 5 in Alaska (representing <1% of the total ZIP codes included in our analysis). These ZIP codes are located in the communities with higher average unemployment and poverty rates and lower average incomes.

*Index of isolation*. Racial isolation is one of the dimensions of residential segregation, defined as the degree to which two or more racial/ethnic groups live separately from one another. Racial isolation is the degree to which members of each racial/ethnic group in the community are exposed only to one another, rather than to members of other racial/ethnic groups.[27] We used the 2000 Census data (i.e., the number of people from each racial/ethnic group living in the ZIP code) to calculate an index of racial isolation that represents the proportion of the woman's ZIP code that was the same race/ethnicity as the participant. The index values range from 0 to 1, with a value of 1 representing a community where everyone is of the same race/ethnicity. Because residential segregation is a fundamental contributor to disparities in health, we expected that a minority woman living in a more isolated ZIP code (i.e., index value closer to 1) would be at a greater disadvantage in obtaining access to healthcare than a minority woman living in a less isolated ZIP code (i.e., index value closer to 0).[14–18]

*Urban population, adult female population with high school only, and families with all adults working*. We used the 2000 Census data to create ZIP code-level variables for the proportion of the population that was urban, the proportion of the adult (≥25 years) female population with a high school diploma as their highest level of educational attainment, and the proportion of the families with all of the adults working, which is a measure of local area employment.

### *County-level variables*

We included 223 counties in our analysis.

*Income inequality*. Income inequality measures dispersion in median household income among residents in the county. We used the 2000 Census data on the distribution of median household income by income class to construct this variable. The Census income distribution can be used to calculate the number of families with a median income in classes determined by increments of $25,000 (e.g., $1–$24,999 and $25,000–$49,999). The highest income class is the open-ended class for ≥$150,000. We calculated the mean and standard deviation (SD) for this frequency distribution using the number of families in each county in each class as frequency weights. Income inequality was defined as the SD of median household income across the income classes. Given the considerable evidence that neighborhood income inequality has a statistically significant effect on health outcomes of minorities, we expected this county-level variable to be a statistically significant predictor, even after including the ZIP code-level measures of median earnings.[11,12]

*Index of dissimilarity*. The index of dissimilarity is another measure of residential segregation that has been used extensively in previous research.[14,15,27] In our analysis, the index measures how whites and nonwhites are distributed across the ZIP codes that make up each county. We used the 2000 Census data to create this variable. The index values range between 0 and 1 and are calculated as follows:

$$D = 0.50 \sum_{z=1}^{Z} \left| \frac{Pzw}{Pw} - \frac{Pznw}{Pnw} \right|$$

where $Pzw$ is the number of white people in the ZIP code, $Pw$ is the number of white people in the county, $Pznw$ is the number of nonwhite people in the ZIP code, $Pnw$ is the number of nonwhite people in the county, and $Z$ is the number of ZIP codes in the county.

For example, a value of 0.80 for the dissimilarity index can be interpreted as follows: 80% of the whites in the county would have to move from some ZIP codes to others to produce a completely even distribution of whites and nonwhites across all ZIP codes in the county. A value of 0 would mean that each ZIP code had the same ratio of whites to nonwhites as the county ratio; a value of 1 would mean that no whites share their ZIP code with nonwhites, and *vice versa*.

Because residential segregation has been found to be a fundamental cause of racial disparities in health,[14–18] we would expect minority women living in highly segregated communities (i.e., dissimilarity index closer to 1) to have worse access to healthcare than minority women who share their communities with white populations (i.e., dissimilarity index closer to 0). In other words, we expect lower values of the dissimilarity index to be associated with better health outcomes for nonwhite women.

Although the indices of dissimilarity and isolation are highly correlated, they are conceptually distinct because the isolation measure (ZIP code level) depends on the relative size of the groups being compared, and the dissimilarity measure (county level) does not.[27] For example, if African Americans are evenly distributed among the ZIP codes of a county, the index of dissimilarity would suggest little or no segregation. However, if African Americans make up the majority of the county's population, they will have little exposure to residents of other races, which would be reflected by the index of isolation. Therefore, we include both the index of dissimilarity and the index of racial isolation in our analyses.

*Manufacturing jobs, families in poverty, and population density*. We used the 2002 Area Resource File to create variables for the proportion of the county's work force in manufacturing jobs, the proportion of families in poverty, and population density per square mile of land. We used the proportion of the county's work force in manufacturing jobs as a measure of level of industry in the community. The proportion of families in poverty is a measure of economic conditions and community income levels. Population density is a measure of urbanization in the county.

*Robbery arrests*. We obtained data on the number of robbery arrests per 100,000 county residents from the 2000 National Archive of Criminal Justice Data. We assumed that the women living in high crime areas would feel unsafe and be less likely to be physically active outside of their homes, resulting in worse health outcomes.