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The Socioeconomic Gradient of Diabetes Prevalence, Awareness, Treatment and Control Among African Americans in the Jackson Heart Study

Mario Sims, PhD^{1,2}, Ana V. Diez Roux, PhD, MD³, Shawn Boykin, PhD³, Daniel Sarpong, PhD⁴, Samson Y. Gebreab, PhD³, Sharon B. Wyatt, PhD⁵, DeMarc Hickson, PhD^{1,4}, Marinelle Payton, PhD, MD⁶, Lynette Ekunwe, MPH⁴, and Herman A. Taylor, MD, MPH^{1,4,7,8}

¹ Jackson Heart Study, University of Mississippi Medical Center, Jackson, MS

² Division of Hypertension, Department of Internal Medicine, University of Mississippi Medical Center, Jackson, MS

³ Department of Epidemiology, School of Public Health, University of Michigan, Ann Arbor, MI

⁴ Jackson Heart Study, Jackson State University, Jackson, MS

⁵ School of Nursing, University of Mississippi Medical Center, Jackson, MS

⁶ School of Public Health, Jackson State University, Jackson, MS

⁷ Division of Cardiovascular Diseases and Internal Medicine, University of Mississippi Medical Center, Jackson, MS

⁸ Jackson Heart Study, Tougaloo College, Tougaloo, MS

Abstract

PURPOSE—Little research has focused on the social patterning of diabetes among African Americans. We examined the relationship between socioeconomic status (SES) and the prevalence, awareness, treatment and control of diabetes among African Americans.

METHODS—Education, income and occupation were examined among 4,303 participants (women=2,726; men=1,577). Poisson regression estimated relative probabilities (RP) of diabetes outcomes by SES.

RESULTS—The prevalence of diabetes was 19.6% in women and 15.9% in men. Diabetes awareness, treatment and control were 90.0%, 86.8%, and 39.2% in women, respectively, and 88.2%, 84.4%, and 35.9% in men, respectively. In adjusted models, low-income men and women had greater probabilities of diabetes than high-income men and women (RP 1.94, 95%CI: 1.28–2.92; RP 1.35, 95%CI: 1.04–1.74, respectively). Lack of awareness was associated with low education and low occupation in women (RP 2.28, 95%CI 1.01–5.18, and RP 2.62, 95%CI 1.08–

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Address correspondence to: Mario Sims, PhD, Associate Professor, Department of Medicine, Jackson Heart Study, Jackson Medical Mall Suite #701, 350 W. Woodrow Wilson Drive, Jackson, MS 39213; Telephone: 601-979-8771; Fax: 601-979-8701; msims2@umc.edu.

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6.33, respectively) but not in men. Lack of treatment was associated with low education in women. Diabetes control was not patterned by SES.

CONCLUSIONS—Diabetes prevalence is patterned by SES, and awareness and treatment are patterned by SES in women but not men. Efforts to prevent diabetes in African Americans need to address the factors that place those of low SES at higher risk.

Keywords

diabetes prevalence; socioeconomic status; Jackson Heart Study; African Americans; disparities

Diabetes ranks as the sixth leading cause of death for Americans and results in increased morbidity and economic costs, and reduced quality of life (1–4). Individuals with diabetes are at increased risk for micro-vascular complications (e.g., retinopathy, nephropathy), macro-vascular complications (e.g., heart disease, stroke) and neuropathy (5). Understanding the risk factors for diabetes remains an important public health question for both primary prevention and targeting of interventions.

Diabetes prevalence has been shown to be nearly twice as high in African Americans than whites (6). There is also evidence that diabetes is patterned by socioeconomic status (SES) with persons of lower SES having higher prevalence and incidence of diabetes (7–11). SES may also affect awareness, treatment and control of diabetes through differential resource and information allocation and through socioeconomically patterned differences in access to care and quality of care (10).

Despite the importance of diabetes in African Americans, the vast majority of work on the social patterning of diabetes has focused on white populations. It has been suggested that differences in diabetes prevalence between African Americans and White Americans may partly reflect differences in SES (12,13), but very little work has examined social patterning among African-Americans, despite some evidence to suggest that the patterning of diabetes is not invariant across racial/ethnic groups (14). Understanding the social patterning of diabetes in African Americans is important for elucidating the etiology of diabetes in this population, for better understanding the causes of racial differences in diabetes, and for the development of more effective prevention efforts. We used data from the Jackson Heart Study (JHS), the largest population based cohort study of cardiovascular disease (CVD) in African Americans, to examine the relation between SES and the prevalence, awareness, treatment, and control of diabetes among African Americans. We hypothesized that lower SES would be associated with higher prevalence of diabetes, and with lower awareness, treatment, and control of diabetes.

Methods

Data were drawn from examination 1 of the JHS collected from 2000–2004. The JHS cohort includes 5,301 men and women between the ages of 21 and 94 at the baseline examination (2000–2004) living in the tri-county area (Hinds, Madison and Rankin counties) of the Jackson, MS metropolitan area. The sample was drawn from different sources: participants in the population-based Atherosclerosis Risk in Communities (ARIC) Study (22%) (15), a community sample (47%) randomly selected from a commercially available list of residents subsequently supplemented using volunteers to be representative in age, sex and socioeconomic characteristics of the population of the tri-county Jackson City area; and relatives of Jackson participants (31%) who lived in the tri-county area included to permit future studies of genetic contributions to CVD. The final study sample for JHS encompasses nearly 7% of age-eligible African-American men and women in the tri-county area of Jackson. Details regarding the design of the JHS have been published elsewhere (16). The

study was approved by the institutional review boards of the participating institutions: University of Mississippi Medical Center, Jackson State University, and Tougaloo College. All participants provided informed consent.

Of the 5,301 JHS participants who completed the baseline clinic examination, 957 were excluded due to missing information on diabetes status, education, income or occupation, and 41 were excluded because they belonged to an occupational group with a very small sample size (e.g. farmers, military, students, homemakers) and therefore could not be reliably analyzed separately. Analyses were based on 4,303 participants with complete data. SES measures included education, family income, and occupation. Education was self-reported and classified as less than high school; high school graduate to some college; college graduate and above. Income was classified as low, middle and high based on the ratio of family income to the census poverty level (adjusted for family size and number of children). Low-income was defined as at or below the poverty level, middle-income was defined as above the poverty level but ≤ 4 times the poverty level, and high-income was defined as more than four times the poverty level. Occupation was derived from participant self-reports of the jobs in which they were currently employed. Retired and unemployed participants reported the last job they spent the majority of their time employed. Jobs, coded based on the US census Standard Occupation Classification, were grouped into three categories: production, service, and management/professional.

Type II diabetes was determined by fasting blood-glucose levels, self-report and anti-diabetic medication status. Fasting blood samples were taken at the examination and blood glucose was analyzed at a central laboratory. Participants were asked “has your doctor... ever said you have... type II diabetes?” Medication use was determined through a standardized medication inventory. Type II diabetes was defined according to American Diabetes Association (ADA) 2004 criteria as fasting glucose ≥ 126 mg/dl, or confirmed medication usage from the medication inventory, or self-reported use of anti-diabetic medications within the past two weeks of the examination, or self-reported diabetes diagnosis. Individuals with diabetes were considered aware of their diabetes if they reported having diabetes, or reported taking anti-diabetic medication within the two-weeks prior to the examination. Individuals with diabetes were classified as treated if they reported taking anti-diabetic medication within the two-weeks prior to the examination, or if inventory and classification of their medications at the exam documented use of anti-diabetic medication. Among study participants who had been treated for diabetes, diabetes was considered to be controlled if HbA1c levels were $<7.0\%$ in accord with ADA recommendations.

Body mass index (BMI) was derived from in-clinic weight and height measurements (kg/m^2), and waist circumference measured in centimeters at the upper hip bone. Dietary intake was assessed using a validated 158-item food frequency questionnaire (17). Intakes of total energy, total dietary fiber, percentage of calories from fat, and percentage of calories from carbohydrates were considered as covariates. Physical activity was measured as a sum of the four index scores (Active Living, Work/Occupational, Home Life, and Sport) from the JHS physical activity instrument (JPAC) (18). Health care access was measured using an item taken from the JHS Health Care Access and Utilization instrument, which asked participants how hard it has been to get health services with responses ranging from not hard at all to very hard.

Statistical Analysis

In descriptive analyses we examined the age-adjusted socioeconomic patterning of diabetes outcomes by sex and computed p-values for the significance of any trends across SES categories using logistic regression. Sex-stratified, Poisson regression (19) with robust standard errors was utilized to estimate the relative probability (RP 95% CI) of diabetes

associated with each SES variable in separate models. Model 1 adjusted for age. Model 2 adjusted for age plus BMI and waist circumference. Model 3 adjusted for model 2 plus diet and total physical activity. Awareness, treatment, and control (among the treated) were examined using similar methods. Two sets of models were fit for awareness, treatment and control outcomes: model 1 adjusted for age, BMI, waist circumference and physical activity and model 2 added health care access. Since prior work has shown important differences in the socioeconomic patterning of diabetes risk factors like BMI by sex, all analyses were stratified by sex (20) All statistical analyses were performed using SAS version 9.1 (SAS Institute Inc, Cary, North Carolina).

Results

The analysis sample included 4,303 African Americans of the JHS cohort. Sixty-three percent of the sample was female. The median age was 54 years in men and 55 years in women. Men were more likely than women to have high income (37.7% vs. 25.5%, respectively), although women were more likely to work in management occupations than men (40.4% vs. 32.7%, respectively) (Table 1). Thirty four percent of men and women had a college education or above. Women had a higher prevalence of diabetes than men (19.6% vs. 15.9%), but greater awareness (90.0% vs. 88.2%), treatment (86.8% vs. 84.4%), and control (39.2% vs. 35.8%). Because the percentages of awareness and treatment were very high (>84%), subsequent analyses modeled the probability of NOT being aware and NOT being treated to minimize ceiling effects.

Table 2 shows age-adjusted proportions of diabetes prevalence, lack of awareness, lack of treatment and control (among persons with diabetes) by SES in men and women. Diabetes prevalence was inversely and significantly associated with income in both men and women and with education in women. SES was also inversely associated with diabetes prevalence for education and occupation in men, although trends were only marginally statistically significant. Awareness, treatment and control were not consistently patterned by SES except for a marginally significant trend for awareness by occupation in women, by which the lower occupational categories were more likely not to be aware of their diabetes (P for trend=0.06).

Table 3 shows relative probabilities (RPs) of diabetes prevalence before and after covariate adjustment. Age adjusted RPs of diabetes prevalence among men and women were higher in the lower compared to the highest income and education groups, although associations with education were not statistically significant in men. Associations were more pronounced for income than for education. Being in the lower occupational categories was associated with higher prevalence of diabetes in men but not in women, although the association in men was not statistically significant. Associations of low income with diabetes prevalence persisted and remained statistically significant after risk factor adjustment in both men and women [RP for lowest vs. highest income category: 1.94 95% CI: 1.28–2.92) in men and 1.35 (95% CI: 1.04–1.74) in women (model 3)]. Associations with education and occupation became statistically significant in men after risk factor adjustment [RP for lowest vs. highest categories: 1.56 (95% CI: 1.11–2.20) for education and 1.59 (95% CI: 1.05–1.85) for occupation], but no statistically significant associations of education or occupation with diabetes prevalence were observed in women after risk factor adjustment. In general, adjustment for risk factors strengthened the SES patterning in men but weakened the SES patterning in women.

Lack of awareness was strongly associated with less education and production jobs in women (Table 4): fully adjusted RP for high school vs. college and above: 2.28 (95% CI 1.01–5.18), and production vs. management: 2.62 (95% CI 1.08–6.33). In contrast, lack of

awareness of diabetes was not consistently patterned by SES in men except for a non-statistically significant greater lack of awareness in the lower than in the higher occupational categories (RP 1.32 95%CI: 0.57–3.07) (data not shown). Among women, those with only a high school education had a significantly higher probability of not being treated than women with college education and above (RP 2.52 95%CI 1.19–5.34, model 2). Men in production jobs had a higher (though nonsignificant) probability of being untreated than men in management jobs (RP 1.57 95%CI 0.71–3.44) (data not shown). There were no consistent socioeconomic differences in the control of diabetes among treated diabetics.

Discussion

We examined the social patterning of diabetes prevalence, awareness, treatment, and control in a large African American cohort. Diabetes prevalence was significantly higher in lower than in higher SES groups with associations persisting after risk factor adjustment. The social patterning was stronger and more consistent for men than for women and for income than for education or occupation. Lack of awareness of having diabetes was associated with low education and low occupation in women and lack of treatment was associated with low education in women, but no statistically significant association of SES with awareness or treatment was observed in men. The control of diabetes was not clearly patterned by socioeconomic factors.

Previous studies of SES and diabetes have reported inverse associations of SES with diabetes mainly among Whites (9). We documented a strong inverse socioeconomic gradient in diabetes in a large African American population sample. Our results are consistent with prior work showing a gradient in diabetes prevalence among African Americans in NHANES, in which persons with less than a high school education were twice as likely to have diabetes than those who have attended college (21). Although sex differences in the social patterning were not statistically significant, point estimates suggested stronger associations in men than in women. In addition, the SES patterning of diabetes prevalence was consistent across all three SES indicators after risk factor adjustment in men but not in women. This gender difference is in contrast to most work in white samples which has generally reported stronger inverse socioeconomic patterning of diabetes in women than in men (9). The reasons for the differential gender patterning of SES differences in whites and blacks deserve further exploration.

We found that associations of SES with diabetes persisted after adjustment for risk factors. Although measurement error in the risk factors is a strong possibility, our results suggest that other processes perhaps involving the stress pathway could be involved in the association between SES and diabetes (22). In addition, for men the association remained significant and became stronger after adjustments for risk factors, while associations for women became weaker. This is consistent with prior work showing positive associations of SES with BMI in black men but inverse associations in black women (23).

Very little research has examined the social patterning of diabetes awareness or treatment among African Americans. We found evidence of less awareness and less treatment in lower SES compared to higher SES women, although the patterning was not as consistent as it was for diabetes prevalence. There was less evidence of social patterning of awareness and treatment among men. Our results for treatment in women are consistent with other studies that showed that lower SES persons have higher rates of being untreated (21), but few studies have used large African American samples. At least one study reported no association between education and treatment among African American men and women in a large multiethnic sample (24).

Access to care could contribute to the SES patterning of awareness and treatment. Our results however were robust to access to care adjustment although the measure we used was limited. Higher SES may help to increase patients' ability to adhere to complex diabetes treatments, which often require diligent patient self-management on a daily basis (21,25). It is plausible that African American women are better able to translate economic resources into more awareness and treatment than African American men.

We found little evidence of social patterning of diabetes control. Although low-income and less educated men had lower probabilities of control than high-income and more educated men, and women in production jobs had lower control than women in management jobs, these differences were not statistically significant. Using a national sample, Ong et al.(3) found that being White and more educated was associated with better control, but analyses were not stratified by race or sex. Another study found that years of education was associated with better control among African American men and women but differences were not statistically significant (24). Our results suggest that clinicians are failing to help control diabetes among African Americans in all social classes, and that high SES does not protect them from having uncontrolled diabetes.

Although the JHS is among the largest population-based cohorts of African Americans, it is restricted to a single site in the southeastern United States, which limits its generalizability. In general diabetes prevalence, and awareness/treatment/control were comparable to those observed in national samples: the prevalence of diabetes in the JHS was slightly higher than the 2001–2004 national average for African Americans (18.8% vs. 14.5%) (4), and overall awareness was slightly higher than in national samples (nearly 90% in JHS vs., 80% and 73% in NHANES III men and women respectively). Diabetes treatment for men in the JHS was higher than that for African American men in the nation (84% vs. 57%), while treatment rates for women were lower than national rates (87% vs. 95%) (24). Diabetes control for men and women in our sample was lower than the national total for African Americans in the US as of 2004 (3) (35.8% and 39.0% vs. 44%, respectively). Importantly, we were unable to determine from these data whether participants who controlled their diabetes achieved this through behavioral modification or use of medications.

Our sample is a relatively high SES sample drawn from a moderately racially segregated metropolitan area. Results regarding social patterning could be different in areas with different demographic and environmental features. We used a cross-sectional design which limits our ability to draw causal inferences. In addition, although we investigated three measures of SES, a more complete profile of socioeconomic position (e.g., wealth measures) could show stronger patterning in awareness, treatment and control.

In summary, we found that diabetes prevalence was strongly patterned by SES in African American men and women. However, less social patterning was observed for diabetes awareness and treatment (only in women) and no consistent patterning was observed for diabetes control. These results show that effects to prevent diabetes should focus on the factors that lead to greater risks in low SES African Americans. Our results reveal important disparities in diabetes between African Americans of different social classes. Addressing the underlying causes of these disparities is important for reducing disease burden in African Americans (26) and will also contribute to the reduction of race differences in diabetes.

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Acronyms

SES	socioeconomic status
CVD	cardiovascular disease
NHANES	National Health and Nutrition Examination Survey
JHS	Jackson Heart Study
BMI	body mass index
MSA	metropolitan statistical area
ARIC	Atherosclerosis Risk in Communities Study
ADA	American Diabetes Association
JPAC	JHS physical activity
RP	relative probabilities
CI	confidence interval

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Table 1

Sociodemographic characteristics and diabetes status by sex, Jackson Heart Study 2000–2004.

	Men	Women
	N=1577	N=2726
Family Income (%)		
Low	10.34	17.94
Middle	51.93	56.53
High	37.73	25.53
Education (%)		
Less than HS	18.14	16.25
HS graduate – some college	48.19	49.45
College graduate and above	33.67	34.30
Occupation (%)		
Production	37.86	10.01
Service	29.49	49.60
Management/professional	32.66	40.39
Diabetes Prevalence (%)		
No	84.15	80.41
Diabetes	15.85	19.59
Diabetes Awareness (among diabetics) (%)	88.21	89.98
Diabetes Treatment (among diabetics) (%)	84.35	86.80
Diabetes Control (among treated) (%)	35.83	39.20
	Mean (SD)	Mean (SD)
Age	54.17(12.97)	55.17(12.61)
BMI	29.83(6.25)	32.91(7.62)
Waist (cm)	101.18(15.18)	100.54(16.78)
Energy (Kcal)	2489.0(1336.1)	1967.3(1089.8)
Total Dietary Fiber (g)	18.00(8.83)	14.80(6.77)
Calories from Fat (%)	34.88(6.52)	34.96(7.11)
Calories from Carbohydrates (%)	49.38(8.87)	51.60(9.68)
Total Physical Activity Score	8.69(2.63)	8.26(2.57)

Table 2

Age-adjusted proportions of diabetes prevalence, of lack of awareness, of lack of treatment, and of diabetes control by levels of SES for the total sample and men and women, Jackson Heart Study 2000–2004

Total Sample						
	%Diabetic	% Unaware		% Untreated		% Controlled
	18.2	10.6		14.0		38.2
	MEN			Women		
	% Diabetic	% Unaware	% Untreated	% Controlled	% Diabetic	% Untreated
Income						
Low	18.3	17.1	15.1	25.7	23.2	10.0
Middle	17.6	9.3	17.1	33.5	18.3	12.3
High	10.5	18.7	17.4	33.9	14.3	11.2
P-Trend	0.0004	0.47	0.83	0.55	<0.0001	0.79
Education						
< HS	17.0	11.9	15.9	27.3	23.5	14.1
HS4-C1-3	16.0	12.0	20.2	29.4	18.0	12.1
C4+	12.3	14.2	11.2	41.5	15.9	9.3
P-Trend	0.05	0.70	0.5269	0.14	0.001	0.26
Occupation						
Production	16.7	14.3	20.6	34.2	18.4	18.2
Service	15.3	11.9	16.1	25.4	19.5	12.6
Management	12.5	11.0	12.2	38.7	16.4	8.7
P-Trend	0.05	0.53	0.18	0.72	0.13	0.06
						0.59
						0.65

Table 3
Relative probability (RP 95% CI) of diabetes prevalence by levels of socioeconomic status, Jackson Heart Study 2000

	Men			Women		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income (ref: high income)						
Low	1.68** (1.15–2.47)	1.75** (1.21–2.52)	1.94** (1.28–2.92)	1.57*** (1.25–1.98)	1.29* (1.02–1.63)	1.35* (1.04–1.74)
Middle	1.63*** (1.25–2.14)	1.69*** (1.29–2.21)	1.93*** (1.45–2.55)	1.27* (1.03–1.56)	1.15 (0.94–1.41)	1.22 (0.98–1.51)
Education (ref: C4+)						
< HS	1.34 (0.97–1.87)	1.43* (1.03–1.99)	1.56* (1.11–2.20)	1.42** (1.15–1.76)	1.19 (0.96–1.48)	1.23 (0.97–1.56)
H4-C1-3	1.29 (0.98–1.71)	1.33* (1.01–1.77)	1.38* (1.03–1.84)	1.13 (0.94–1.36)	1.04 (0.87–1.25)	1.11 (0.91–1.35)
Occupation (ref: Management)						
Production	1.31 (0.99–1.73)	1.33* (1.01–1.76)	1.39* (1.05–1.85)	1.12 (0.87–1.45)	0.98 (0.75–1.27)	0.95 (0.72–1.25)
Service	1.21 (0.89–1.64)	1.18 (0.87–1.60)	1.10 (0.80–1.52)	1.18 (1.0–1.39)	1.09 (0.92–1.29)	1.12 (0.94–1.33)

Model 1: age; Model 2: model 1 + BMI, Waist Circumference; Model 3: model 2 + diet, physical activity

* p≤.05;
** p≤.01;
*** p≤.001,

† Diet includes 4 variables: 1) Energy; 2) Total Dietary Fiber; 3) % Cal from Fat; 4) % Cal from Carbohydrates

Relative probabilities (RP 95% CI) of not being aware of having diabetes and of not being treated for diabetes (among diabetics) and of having diabetes controlled (among treated diabetics) among women by socioeconomic status, Jackson Heart Study 2000–2004

Table 4

	Lack of Awareness		Non Treatment		Control	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Income (ref: high income)						
Low	1.38 (0.57–3.35)	1.37 (0.57–3.29)	2.06 (0.91–4.66)	2.01 (0.89–4.51)	1.07 (0.73–1.55)	1.10 (0.75–1.60)
Middle	1.35 (0.66–2.74)	1.29 (0.64–2.64)	1.68 (0.81–3.48)	1.62 (0.78–3.35)	0.90 (0.65–1.25)	0.90 (0.65–1.26)
Education (ref: C4+)						
< HS	2.45* (1.10–5.44)	2.28* (1.01–5.18)	2.69** (1.30–5.60)	2.52* (1.19–5.34)	1.01 (0.72–1.41)	1.01 (0.72–1.41)
H4-C1-3	1.59 (0.81–3.12)	1.59 (0.82–3.09)	1.81 (0.96–3.42)	1.80 (0.96–3.38)	0.78 (0.58–1.04)	0.78 (0.58–1.05)
Occupation (ref: management)						
Production	2.59* (1.08–6.24)	2.62* (1.08–6.33)	1.38 (0.53–3.60)	1.40 (0.53–3.68)	0.91 (0.57–1.44)	0.88 (0.54–1.42)
Service	1.61 (0.84–3.08)	1.54 (0.81–2.95)	1.46 (0.86–2.49)	1.41 (0.82–2.40)	1.02 (0.78–1.33)	1.02 (0.78–1.34)

Model 1: age, BMI, Waist circumference, diet, physical activity; Model 2: model 1 + health care access

* p≤.05;

** p≤.01;

*** p≤.001

[†] Diet includes 4 variables: 1) Energy; 2) Total Dietary Fiber; 3) % Cal from Fat; 4) % Cal from Carbohydrates