Disparities in Diabetes: The Nexus of Race, Poverty, and Place

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Objectives. We sought to determine the role of neighborhood poverty and racial composition on race disparities in diabetes prevalence.

Methods. We used data from the 1999–2004 National Health and Nutrition Examination Survey and 2000 US Census to estimate the impact of individual race and poverty and neighborhood racial composition and poverty concentration on the odds of having diabetes.

Results. We found a race–poverty–place gradient for diabetes prevalence for Blacks and poor Whites. The odds of having diabetes were higher for Blacks than for Whites. Individual poverty increased the odds of having diabetes for both Whites and Blacks. Living in a poor neighborhood increased the odds of having diabetes for Blacks and poor Whites.

Conclusions. To address race disparities in diabetes, policymakers should address problems created by concentrated poverty (e.g., lack of access to reasonably priced fruits and vegetables, recreational facilities, and health care services; high crime rates; and greater exposures to environmental toxins). Housing and development policies in urban areas should avoid creating high-poverty neighborhoods. (*Am J Public Health.* 2014;104:2147–2155. doi:10.2105/AJPH.2013.301420)

In the United States, 25.6 million or 11.3% of adults aged 20 years and older had diabetes in 2010.[1] Non-Hispanic Blacks had the highest prevalence at 12.6% compared with non-Hispanic Whites at 7.1%.[1] Traditional explanations for the observed race disparity in diabetes prevalence include differences in health behaviors, socioeconomic factors, family history of diabetes, biological factors, and environmental factors.[2–4] Little work has been conducted to understand how individual and environment-level factors operate together to produce disparities in diabetes prevalence.

A relatively new line of research has begun to show that risk of diabetes is associated with neighborhood attributes that are also associated with race. Auchincloss et al. found that higher diabetes rates were related to lack of availability of neighborhood resources that support physical activity and healthy nutrition.[5] Schootman et al. found that poor housing conditions were associated with diabetes prevalence.[6] Black neighborhoods are more likely to be characterized by these risk factors (i.e., having food deserts, being less likely to have recreational facilities, and tending to have lower-quality housing than White neighborhoods).[7–18] As such it stands to reason that failing to adjust national estimates of diabetes prevalence for these social conditions might influence perceptions of diabetes disparities. LaVeist et al. compared disparities in diabetes in an urban, racially integrated, low-income community with a national sample from the National Health Interview Survey.[19,20] They found that when urban Whites and Blacks resided in the same low-income community, the race disparity in diabetes prevalence disappeared, largely because the prevalence rate for Whites increased substantially.[19] Ludwig et al. used data from the Moving to Opportunity demonstration project and found a lower prevalence of diabetes among low-income adults who moved from high-poverty neighborhoods to low-poverty neighborhoods compared with low-income adults who moved from a high-poverty neighborhood to another high-poverty neighborhood.[21] Findings from these studies suggest the need to further explore the role of place in race disparities in diabetes.

We explored whether the nexus of race, poverty, and neighborhood racial composition and poverty concentration illuminates the race disparities in diabetes. Specifically, we examined (1) whether diabetes prevalence increases in predominantly Black neighborhoods compared with predominantly White neighborhoods, (2) whether diabetes prevalence is higher in poor neighborhoods than in nonpoor neighborhoods, and (3) whether the impact of neighborhood racial composition and poverty concentration on the risk of diabetes varies by race. We hypothesized that residential segregation and concentrated poverty (1) increase Black individuals' exposure to environmental risks associated with poor health, (2) reduce their access to community amenities that promote good health and healthy behaviors, and (3) limit their access to social determinants that promote good health such as quality jobs, education, public safety, and social networks.[7,22–24]

METHODS

The National Health and Nutrition Examination Survey (NHANES) was designed to determine the health, functional, and nutritional status of the US population. Since 1999, NHANES has been conducted as a continuous, annual survey with public use data files released in 2-year increments. Each sequential series of this cross-sectional survey is a nationally representative sample of the civilian noninstitutionalized population that consists of an oversample of participants aged 12 to 19 years, participants aged 60 years and older, Mexican Americans, Blacks, and low-income individuals.[25] Each of these surveys used a stratified, multistage probability sampling design.[25] Data were collected from respondents in 2 phases. The first phase consisted of a home interview in which information

regarding the participant's health history, health behaviors, health utilization, and risk factors were obtained. The second phase was a medical examination. At the conclusion of the home interview participants were invited to receive a detailed physical examination at a mobile examination center.[25] Among those who participated in the physical examination, a nationally representative subset underwent laboratory tests, including measurement of fasting glucose.

We linked the NHANES data to 2000 US Census data[26] to measure the residential segregation and concentrated poverty within respondents' census tract of residence. Because we accessed the respondents' census tract information, the analysis was performed at the National Center for Health Statistics (NCHS) Research Data Center under the supervision of NCHS staff to preserve the privacy, confidentiality, and anonymity of the NHANES respondents. In this analysis we used the combined 1999–2004 data sets of adults who completed the household interview, physical examination, and laboratory components. We restricted the analysis to Blacks (n = 1202) and non-Hispanic Whites (n = 3201) who were aged 25 years and older.

Key Dependent Variable and Independent Variables

We identified persons with diabetes as respondents who had a fasting glucose of 126 milligrams per deciliter or higher, had hemoglobin A1c values of 6.5% or higher, or reported taking medications for diabetes. We excluded persons with normal glycemic values who reported taking metformin from this definition. Independent variables of interest were individual race, individual poverty status, neighborhood racial composition, and neighborhood poverty concentration. Race was self-reported in the NHANES as either non-Hispanic African American/Black or non-Hispanic White. We measured poverty status 2 ways. The poverty–income ratio is a ratio of household income to the federal poverty level (FPL) and is based on the respondent's household income and size.[27] Poverty–income ratio was coded as a 5-level categorical variable that indicates each individual's household poverty ratio (below 100% of FPL [poor], 100% to 199% of FPL (near-poor), 200% to 299% of FPL, 300% to 399% of FPL and greater than or equal to 400% of FPL). We used this categorization in our race–place model. Also, we used a binary poverty variable indicating whether individuals had household incomes between 0% and 199% of FPL or greater than or equal to 200% of the FPL in our poverty–place model.

We used the respondent's census tract to measure neighborhood characteristics because census tracts are small, permanent, statistical subdivisions within a county that range from 1500 to 8000 persons who are similar with respect to population characteristics, economic status, and living conditions. We designated neighborhood racial composition as predominantly White, Black, or other race (Asian or Hispanic) if that group was greater than 65% of the census tract's population. We designated the racial composition of a neighborhood as integrated if at least 2 groups were each more that 35% of the census tract's population. We classified neighborhoods as having concentrated poverty if greater than or equal to 20% of families in the census tract had incomes below the FPL.

Other covariates included demographic variables (age and gender), socioeconomic factors (education and health insurance status), and family history of diabetes. We measured age as a continuous variable. We included age and age squared to control for nonlinearities. We coded gender as a dichotomous variable. We coded educational attainment as 5 categories (< 9 years of school, 9 to 12 years of school but no diploma, high-school graduate or general equivalency diploma, some college, or college graduate or higher). We coded health insurance coverage as 4 categories (privately insured, Medicare, Medicaid or other government coverage, or uninsured). We also controlled for self-reported family history of diabetes, if the respondent had any biological relatives (grandparents, parents, brothers, or sisters) who had been told by a health professional that they had diabetes.

Statistical Analysis

We conducted bivariate analysis comparing the diabetes prevalence across the categories for each of our main independent variables. We used the 2-by-N χ^2 test to determine proportional differences by diabetes status. We estimated a series of logistic regression models to assess the intersection between diabetes disparities and individual race and poverty and neighborhood racial composition and poverty concentration. The base model included all of our key independent variables and covariates. The race–place model interacted individual race with neighborhood racial composition. To do this, we created a variable with 8 categories: White in White neighborhood, White in Black neighborhood, White in other race neighborhood, White in integrated neighborhood, Black in Black neighborhood, Black in White neighborhood, Black in other race neighborhood, and Black in integrated neighborhood.

The poverty–place model combined individual poverty with neighborhood poverty. We created a variable with 4 categories: nonpoor in nonpoor neighborhood, poor in nonpoor neighborhood, nonpoor in poor neighborhood, and poor in poor neighborhood. The race–poverty–place model combined individual race and poverty with neighborhood poverty. We created a variable with 8 categories: nonpoor White in nonpoor neighborhood, nonpoor White in poor neighborhood, poor White in nonpoor neighborhood, poor White in poor neighborhood, nonpoor Black in nonpoor neighborhood, nonpoor Black in poor neighborhood, poor Black in nonpoor neighborhood, and poor Black in poor neighborhood.

The sampling design for the NHANES is a complex, stratified, multistage probability sample of noninstitutionalized individuals. Therefore, we developed sample weights to account for both the differential probability of being sampled and differential response rates. We applied sample weights to account for the differential probability of being selected, nonresponse adjustments, and adjustments to national control totals in the NHANES.[28]

We adjusted parameter estimates and standard errors for the multistage sampling design with Taylor linearization methods. Following the algorithm described by the NCHS,[29] we created a 6-year sample weight variable by assigning two thirds of the 4-year weight for 1999–2002 if the person was sampled in 1999–2002 or assigning one third of the 2-year weight for 2003–2004 if the person was sampled in 2003–2004. We used the SVY commands in Stata version 12 (StataCorp LP, College Station, TX) to produce nationally

representative estimates and appropriate standard errors for all estimation.

RESULTS

The prevalence of diabetes varied with the key independent variables and covariates (Table 1). Blacks had a higher rate of diabetes than Whites (0.123 vs 0.084; $P = .03$). The prevalence of diabetes was inversely related to household poverty level. Adults in poor and near-poor households had the highest rates of diabetes (0.12 and 0.127), followed by adults between 200% and 299% FPL (0.108), followed by adults between 300% and 399% FPL (0.087), followed by adults in households greater than or equal to 400% FPL (0.054). Adults in predominantly Black neighborhoods had higher rates of diabetes than those in predominantly White neighborhoods (0.13 vs 0.084; $P = .019$). This neighborhood difference is similar to the individual race difference.

When we combined individual race with neighborhood racial composition, we found that Blacks living in Black neighborhoods, Blacks living in integrated neighborhoods, and Blacks living in White neighborhoods had significantly higher rates of diabetes (0.134, 0.123, and 0.106) than Whites in White neighborhoods (0.083). When we combined individual poverty with neighborhood poverty concentration, we found that, compared with nonpoor adults in nonpoor neighborhoods, poor adults in poor and nonpoor neighborhoods had higher rates of diabetes. When we categorized adults by their race, poverty status, and neighborhood poverty concentration, we found that individual and neighborhood poverty status were associated with diabetes for Blacks and Whites.

Nonpoor Whites had lower rates of diabetes than Blacks and poor Whites. Nonpoor Whites in poor and nonpoor neighborhoods had similar diabetes rates. There was a place gradient for poor Whites. Poor Whites in poor neighborhoods had the highest diabetes rates (0.15), but the diabetes rate was lower for poor Whites in nonpoor neighborhoods (0.121). For Blacks there appears to be a race–poverty–place gradient with nonpoor Blacks in nonpoor neighborhoods having the lowest rates of diabetes (0.100), followed by poor Blacks in nonpoor neighborhoods (0.114), nonpoor

TABLE 1—Diabetes Prevalence by the Independent Variables: 1999–2004 National Health and Nutrition Examination Survey and 2000 US Census

Independent Variables	No.	Diabetes Mean (95% CI)	Diabetes *P*
Individual race			.03
Black	2605	0.123 (0.103, 0.144)	
White	7184	0.084 (0.072, 0.958)	
Individual poverty			
Household poverty ≥400% FPL (Ref)	2989	0.053 (0.036, 0.071)	
Household poverty 300%–399% FPL	1135	0.087 (0.059, 0.116)	.014
Household poverty 200%–299% FPL	1507	0.107 (0.077, 0.137)	.017
Household poverty 100%–199% FPL	2093	0.127 (0.097, 0.157)	<.001
Household poverty below FPL	1165	0.121 (0.0.87, 0.156)	.004
Neighborhood poverty			.037
Neighborhood concentrated poverty	2083	0.116 (0.089, 0.143)	
Neighborhood no concentrated poverty	7701	0.084 (0.072, 0.096)	
Neighborhood racial composition			
Predominantly White neighborhood (Ref)	6668	0.084 (0.071, 0.097)	
Predominantly Black neighborhood	1236	0.130 (0.101, 0.159)	.005
Predominantly other race neighborhood	200	0.119 (0.036, 0.020)	.418
Integrated neighborhood	1680	0.094 (0.063, 0.124)	.559
Race–place individual race and neighborhood racial composition			
White in White neighborhood (Ref)	6114	0.083 (0.070, 0.096)	
White in Black neighborhood	42	0.072 (0.000, 0.216)	.874
White in other race neighborhood	128	0.123 (0.021, 0.224)	.451
White in integrated neighborhood	895	0.083 (0.046, 0.121)	.994
Black in Black neighborhood	1194	0.134 (0.104, 0.165)	.002
Black in White neighborhood	554	0.106 (0.059, 0.153)	.0258
Black in other race neighborhood	72	0.108 (0.000, 0.223)	.681
Black in integrated neighborhood	785	0.123 (0.083, 0.164)	.048
Poverty–place individual poverty and neighborhood poverty concentration			
Nonpoor in nonpoor neighborhood (Ref)	4866	0.701 (0.058, 0.082)	
Poor in nonpoor neighborhood	2149	0.120 (0.095, 0.145)	<.001
Nonpoor in poor neighborhood	760	0.089 (0.048, 0.130)	.339
Poor in poor neighborhood	1109	0.140 (0.010, 0.179)	.003
Race–place–poverty individual race and poverty and neighborhood poverty concentration			
Nonpoor White in nonpoor neighborhood (Ref)	4119	0.068 (0.056, 0.080)	
Nonpoor White in poor neighborhood	275	0.062 (0.014, 0.111)	.828
Poor White in nonpoor neighborhood	1743	0.121 (0.095, 0.147)	<.001
Poor White in poor neighborhood	350	0.150 (0.071, 0.219)	.043
Nonpoor Black in nonpoor neighborhood	667	0.100 (0.061, 0.141)	.125
Nonpoor Black in poor neighborhood	485	0.136 (0.074, 0.198)	.030
Poor Black in nonpoor neighborhood	406	0.114 (0.057, 0.170)	.132
Poor Black in poor neighborhood	759	0.129 (0.129, 0.083)	.011
Gender			<.001
Male	5137	0.069 (0.058, 0.080)	
Female	4652	0.110 (0.091, 0.129)	

Continued

TABLE 1—*Continued*

Family history of diabetes			<.001
History of diabetes	4600	0.122 (0.103, 0.142)	
No history of diabetes	5137	0.054 (0.043, 0.065)	
Educational attainment			
< 9th grade	775	0.195 (0.130, 0.259)	.067
9th–12th grade, no diploma	1547	0.124 (0.090, 0.159)	.006
High-school graduate (Ref)	2559	0.091 (0.071, 0.111)	
Some college	2611	0.088 (0.068, 0.108)	.077
≥ college graduate	2265	0.054 (0.032, 0.076)	.002
Health insurance status			
Private insurance (Ref)	6212	0.077 (0.065, 0.090)	
Medicare	1702	0.200 (0.153, 0.248)	<.001
Medicaid, SCHIP, or other government insurance	572	0.098 (0.060, 0.133)	.569
No insurance	1303	0.054 (0.033, 0.075)	.005

Note. CI = confidence interval; FPL = federal poverty level; SCHIP = state children's health insurance program.

Blacks in poor neighborhoods (0.136), and then poor Blacks in poor neighborhoods (0.129).

The base model determined if individual covariates and neighborhood racial composition and poverty concentration separately influence the odds of having diabetes (Table 2). We found that only household poverty status, gender, and family history were significant predictors. Neighborhood racial composition and poverty concentration did not independently influence the odds of having diabetes. Compared with adults living at greater than or equal to 400% FPL, the odds of having diabetes were 1.93 (95% confidence interval [CI] = 1.21, 3.07) for the near-poor and 1.93 (95% CI = 1.09, 3.45) for the poor. The odds of males having diabetes were 2.02 (95% CI = 1.59, 2.56) compared with females. The odds of having diabetes among those with a family history of diabetes were 3.27 (95% CI = 2.54, 4.21) compared with those without a family history of diabetes.

The results from the race–place models tested whether the odds of having diabetes were related to adults' racial identity relative to the racial composition of their neighborhood (Table 2). In this model, individual poverty status, gender, and family history were still significant predictors and similar in magnitude to the base model; however, only Blacks in integrated neighborhoods had greater odds of having diabetes than Whites in White neighborhoods (OR = 2.13; 95% CI = 1.26, 3.60). The other race–place indicator variables were statistically insignificant.

The results from the poverty–place models tested whether odds of having diabetes were related to adults' poverty status relative to their neighborhood's poverty concentration (Table 3). We found that poor adults in nonpoor and poor neighborhoods had greater odds of having diabetes than nonpoor adults in nonpoor neighborhoods. The odds of having diabetes for poor adults in poor neighborhoods were higher than for poor adults in nonpoor neighborhoods (1.98 vs 1.67). Also, individual race was significant in this model. The odds of having diabetes were 1.59 (95% CI = 1.11, 2.28) times greater for Blacks than for Whites.

Finally, in the race–poverty–place model, we categorized adults by their individual race, individual poverty status, and neighborhood poverty concentration. Similar to the bivariate analysis, we found evidence of a race–poverty–place gradient for poor Whites and nonpoor Blacks in the logistic analysis. We found that, compared with nonpoor Whites in nonpoor neighborhoods, poor Whites in poor

TABLE 2—Estimated Odds Ratios of Having Diabetes by Race, Concentrated Poverty, and Racial Composition of Neighborhood: 1999–2004 National Health and Nutrition Examination Survey and 2000 US Census

Variable	Base Model, OR (95% CI)	Race-Place Model, OR (95% CI)
Individual race		
White (Ref)	1.00	. . .
Black	1.63 (0.94, 2.83)	. . .
Concentrated poverty		
Nonpoor neighborhood (Ref)	1.00	1.00
Poor neighborhood	1.02 (0.45, 1.93)	1.13 (0.75, 1.72)
Neighborhood racial composition		
Predominantly White neighborhood (Ref)	1.00	. . .
Predominantly Black neighborhood	0.93 (0.45, 1.93)	. . .
Predominantly other race neighborhood	1.16 (0.63, 2.14)	. . .
Integrated neighborhood	1.30 (0.90, 1.88)	. . .
Race–place individual race and neighborhood racial composition		
White in White neighborhood (Ref)	. . .	1.00
White in Black neighborhood	. . .	1.70 (0.24, 11.87)
White in other race neighborhood	. . .	1.32 (0.34, 5.11)
White in integrated neighborhood	. . .	1.32 (0.78, 2.24)
Black in Black neighborhood	. . .	1.44 (0.92, 2.25)
Black in White neighborhood	. . .	1.78 (0.87, 3.66)
Black in other race neighborhood	. . .	1.30 (0.31, 5.55)
Black in integrated neighborhood	. . .	2.13** (1.26, 3.60)

Continued

TABLE 2—*Continued*

Individual poverty		
Household poverty ≥400% (Ref)	1.00	1.00
Household poverty 300%–399% FPL	1.44 (0.92, 2.28)	1.56 (0.96, 2.53)
Household poverty 200%–299% FPL	1.48 (0.93, 2.37)	1.65* (1.01, 2.68)
Household poverty 100%–199% FPL	1.93** (1.21, 3.07)	2.19** (1.33, 3.61)
Household poverty below FPL	1.93* (1.09, 3.45)	2.35** (1.26, 4.40)
Gender		
Female (Ref)	1.00	1.00
Male	2.02*** (1.59, 2.56)	2.17*** (1.64, 2.86)
Family history of diabetes		
No family history of diabetes (Ref)	1.00	1.00
Family history of diabetes	3.27*** (2.54, 4.21)	2.94*** (2.22, 3.88)
Educational attainment		
< 9th grade	1.19 (0.79, 1.79)	1.01 (0.60, 1.70)
9th–12th grade, no diploma	1.08 (0.71, 1.64)	1.00 (0.63, 1.58)
High-school graduate (Ref)	1.00	1.00
Some college	1.12 (0.79, 1.57)	1.07 (0.75, 1.54)
≥ college graduate	0.64 (0.36, 1.13)	0.61 (0.33, 1.14)
Health insurance status		
Private insurance (Ref)	1.00	1.00
Medicare	1.26 (0.92, 1.72)	1.29 (0.90, 1.84)
Medicaid, SCHIP, or other government insurance	1.05 (0.63, 1.77)	0.90 (0.51, 1.58)
No insurance	0.77 (0.51, 1.16)	0.65 (0.36, 1.17)

Note. CI = confidence interval; FPL = federal poverty level; OR = odds ratio; SCHIP = state children's health insurance program. The models controlled for age and quadratic age, which were significant predictors ($P < .001$).
*$P < .05$; **$P < .01$; ***$P < .001$.

neighborhoods were the most disadvantaged (OR = 2.51; 95% CI = 1.31, 4.81). The size of the disadvantage was smaller for poor Whites in nonpoor neighborhoods (OR = 1.73; 95% CI = 1.16, 2.57). Compared with nonpoor Whites in nonpoor neighborhoods, poor Blacks in poor neighborhoods and nonpoor Blacks in poor neighborhoods were similarly disadvantaged (OR = 2.45; 95% CI = 1.50, 4.01; and OR = 2.49; 95% CI = 1.48, 4.19, respectively). The size of the disadvantage was slightly lower for poor Blacks in nonpoor neighborhoods (OR = 2.34; 95% CI = 1.22, 4.46), and lower for nonpoor Blacks in poor neighborhoods (OR = 2.08; 95% CI = 1.26, 3.44). Although the CIs overlap, the overall trends suggest that there is a place gradient for poor Whites and Blacks.

We estimated the predicted diabetes prevalence for the race–poverty–place categories with adjustment for age, gender, socioeconomic status, and diabetes family history (Figure 1). We found that, for Whites, diabetes prevalence was associated with individual poverty status, and for poor Whites, neighborhood poverty was associated with higher risk. For Blacks, diabetes risk was associated with individual and neighborhood poverty status ranging from 6.2% to 8.9%. However, neighborhood poverty had a stronger association with diabetes risk for nonpoor Blacks.

DISCUSSION

This study provides evidence that place matters for Blacks and poor Whites. Living in high-poverty neighborhoods increases the odds of having diabetes for Blacks and poor Whites but not for nonpoor Whites. Blacks and poor Whites have higher odds of diabetes than nonpoor Whites; however, living in poor neighborhoods increases their odds further such that poor Whites living in poor neighborhoods are most disadvantaged. Our findings are consistent with those of the Moving to Opportunity demonstration project, which demonstrated that enabling families to move from high-poverty neighborhoods to low-poverty neighborhoods improved their lives along several dimensions, including general health status, mental status, obesity rates, and diabetes rates.[21] Findings from a long-term follow-up survey showed that Moving to Opportunity participants who relocated to low-poverty neighborhoods experienced a 26% reduction in glycated hemoglobin level of 6.5% or higher.[30] A possible cause for this reduction was changes in eating habits to include more fruits and vegetables and an increase in the amount of exercise.[30]

Why does living in a poor neighborhood increase the odds of having diabetes for Blacks and poor Whites? A recent report issued by the Joint Center for Political and Economic Studies showed that 46% of urban Blacks and 67% of poor urban Blacks live in high-poverty neighborhoods (poverty rate > 20%) compared with 11% of urban Whites and 30% of poor urban Whites.[31] The Exploring Health Disparities in Integrated Communities study reported that when poor Blacks and Whites live in an integrated poor community, they have similar diabetes prevalence (10.4% vs 10.5%).[20] The narrowing of the disparities was attributable to the White residents of this poor community having higher rates of diabetes. Other analyses of the Exploring Health Disparities in Integrated Communities data found similar results for obesity, hypertension, and use of health services.[19] The authors concluded that community-level social and environmental factors contribute to national race disparities in diabetes. However, there are relatively few integrated and economically balanced census tracts in the United States (425 out of 66 438 in 2000). Concentrated poverty is not as large a problem for Whites as it is for Blacks. Poor Whites typically do not live in poor neighborhoods. Black poverty is more concentrated than White poverty; hence, poor Blacks have greater exposure to negative neighborhood-level health risks.

Poor Black neighborhoods may contribute to higher diabetes prevalence because of the decreased availability of healthy food and limited walkability. These neighborhoods are often referred to as "food deserts" because of limited access to a supermarket or large grocery store. Poor Black neighborhoods are more

TABLE 3—Estimated Odds Ratios of Having Diabetes With Control for the Nexus of Poverty–Place and Race–Poverty–Place: 1999–2004 National Health and Nutrition Examination Survey and 2000 US Census

Variable	Poverty–Place Model, OR (95% CI)	Race–Poverty–Place Model, OR (95% CI)
Individual race		
White (Ref)	1.00	. . .
Black	1.59* (1.11, 2.28)	. . .
Poverty–place individual poverty and neighborhood poverty concentration		
Nonpoor in nonpoor neighborhood (Ref)	1.00	. . .
Poor in nonpoor neighborhood	1.67** (1.14, 2.44)	. . .
Nonpoor in poor neighborhood	1.26 (0.72, 2.21)	. . .
Poor in poor neighborhood	1.98* (1.16, 3.39)	. . .
Race–place–poverty individual race and poverty and neighborhood poverty concentration		
Nonpoor White in nonpoor neighborhood (Ref)	. . .	1.00
Nonpoor White in poor neighborhood	. . .	1.07 (0.44, 2.59)
Poor White in nonpoor neighborhood	. . .	1.73** (1.16, 2.57)
Poor White in poor neighborhood	. . .	2.51** (1.31, 4.81)
Nonpoor Black in nonpoor neighborhood	. . .	2.08** (1.26, 3.44)
Nonpoor Black in poor neighborhood	. . .	2.49*** (1.48, 4.19)
Poor Black in nonpoor neighborhood	. . .	2.34* (1.22, 4.46)
Poor Black in poor neighborhood	. . .	2.45*** (1.50, 4.01)
Gender		
Female (Ref)	1.00	1.00
Male	2.15 (1.63, 2.85)	2.15*** (1.63, 2.84)
Family history of diabetes		
No family history of diabetes (Ref)	1.00	1.00
Family history of diabetes	2.95*** (2.21, 3.92)	2.94*** (2.21, 3.91)
Educational attainment		
< 9th grade	1.04 (0.62, 1.73)	1.05 (0.63, 1.74)
9th–12th grade, no diploma	1.03 (0.65, 1.64)	1.05 (0.66, 1.66)
High-school graduate (Ref)	1.00	1.00
Some college	1.05 (0.73, 1.49)	1.05 (0.74, 1.49)
≥ college graduate	0.55 (0.30, 1.01)	0.55 (0.30, 1.01)
Health insurance status		
Private insurance (Ref)	1.00	1.00
Medicare	1.34 (0.94, 1.90)	1.33 (0.92, 1.89)
Medicaid, SCHIP, or other government insurance	0.96 (0.54, 1.71)	0.97 (0.55, 1.72)
No insurance	0.70 (0.39, 1.27)	0.70 (0.40, 1.23)

Note. CI = confidence interval; OR = odds ratio; SCHIP = state children's health insurance program. The models controlled for age and quadratic age, which were significant predictors ($P < .001$).
*$P < .05$; **$P < .01$; ***$P < .001$.

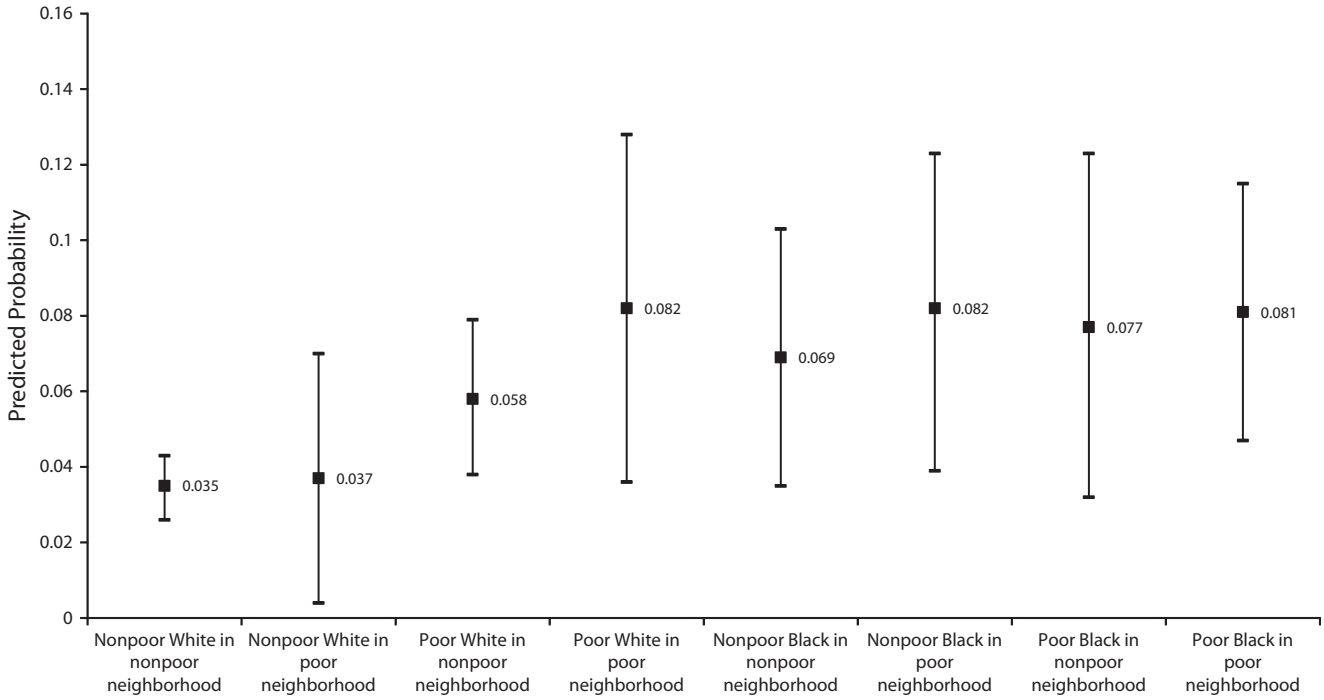
likely to be "food deserts." One study in Detroit found that poor Black neighborhoods were farther from supermarkets than poor White neighborhoods.[8] Another study found that chain supermarkets were half as likely to be located in predominantly Black neighborhoods than in predominantly White neighborhoods.[9] Several studies found that food available in low-income and minority communities was more expensive and of a lower quality.[10–16] Morland and Filomena found that a lower proportion of stores in predominantly Black neighborhoods carried fresh produce, except for bananas, potatoes, okra, and yucca.[17] Blacks in poor neighborhoods consume fewer fruits and vegetables than people in middle-income, racially integrated neighborhoods.[32] This is important because consumption of leafy green vegetables is associated with a 14% reduced risk of type 2 diabetes.[33] There is strong evidence suggesting that the walkability of neighborhoods is positively associated with physical activity and walking behaviors of adults.[34] In addition, residents of highly walkable neighborhoods are less likely to be overweight or obese.[34–36]

We did not find strong associations between diabetes prevalence and an individual's racial identity and the neighborhood racial composition. Likewise, we did not find strong associations between diabetes and an individual's poverty status and the neighborhood's poverty rate. Although there was evidence of an individual race effect, neighborhood racial composition does not seem to have an effect on the odds of having diabetes. The higher rate of diabetes prevalence among Blacks in Black neighborhoods observed in the bivariate analysis did not persist in the multivariable models. The observed bivariate association was probably because of the preponderance of poor Blacks living in poor Black neighborhoods, rather than the neighborhood's racial composition. Hence, we believe the community-level risk factors that elevate diabetes risk are associated with problems of concentrated poverty in minority communities. As concluded in a recent Joint Center for Political and Economic Studies report, "*place matters* for minority communities not because they are predominantly Black or Latino but rather because they are impoverished."[31(p26)]

Limitations

Our study was based on a nationally representative sample with an objective measure of diabetes from the NHANES. Despite these strengths, the study has a few limitations.

This study is a cross-sectional analysis and, therefore, cannot infer causality. Also, our findings are generalizable only to Blacks and Whites. Future work should consider Hispanics, particularly Mexican Americans, who have high diabetes prevalence compared with



Note. These are predicted probabilities with adjustment for age, gender, family history of diabetes, educational attainment, and insurance status.

FIGURE 1—Predicted probabilities of diabetes prevalence by race, poverty, and place category: 1999–2004 National Health and Nutrition Examination Survey and 2000 US Census.

Whites. The analysis pools 6 years (1999–2004) of data from the NHANES to obtain adequate sample sizes to study neighborhood effects. However, this assumes that these associations remained stable over time. Also, we used the 2000 US Census data to measure neighborhood racial composition and poverty concentration, and this assumes that these measures remained stable in the census tract throughout the study period. The analysis combines individual and area-level data, which could lend itself to multilevel modeling. However, after we controlled for the NHANES complex survey design, there was a small number of observations sharing the same census tract.

Conclusions

Consistent with the health and socioeconomic gradient literature,[37–39] we found that individual poverty status matters for diabetes prevalence in both Blacks and Whites. Therefore, policies that address individual poverty (e.g., increasing the minimum wage, job training and employment, quality of public education systems, access to higher education, access to health care) will reduce diabetes risk for Blacks and Whites. Because Blacks have lower socioeconomic status relative to Whites, these policies can reduce race disparities in diabetes. However, neighborhood poverty matters for Blacks. Policies should focus on improving poor neighborhoods in an effort to reduce the Black–White disparity in diabetes.

Impoverished communities are characterized by an overall lack of community-level resources, from grocery stores, parks and recreation facilities, quality schools, and public transportation options to public safety alternatives, resilient local businesses, employment opportunities, and accessible and integrated health care system.[18,23,40–42] Poor communities are also at greater risk for environmental toxins that have a negative impact on health.[43] In addition, poor communities lack the political and economic power to improve these conditions. It is the responsibilities of local, state, and federal governments to recognize the disadvantages created by concentrated poverty, especially for minority communities. City planners should use zoning regulations and urban design standards to avoid creating neighborhoods and communities where poverty is concentrated. Policymakers should work with local leaders to adopt and implement policies and programs to address community-level factors.

Finally, as the US Department of Housing and Urban Development continues its policy of revitalizing poor urban communities under the Choice Neighborhoods programs, more research is needed to understand the mechanisms by which changes in neighborhood poverty influence diabetes risk. Choice Neighborhoods is designed to transform a high-poverty neighborhood into a mixed-income neighborhood by redesigning existing public housing; improving access to quality education, transportation, health care, recreation and other community services; improving access to jobs; investing in local businesses; and reducing crime.[44] Policymakers need to know what neighborhood-level factors matter most for residents of poor communities. ■

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D. J. Gaskin and L. Dubay were the principal investigators of this project. D. J. Gaskin conceptualized and designed the analysis plan for this article. E. E. McGinty and K. Bower conducted the literature review. E. E. McGinty managed the data and conducted the statistical analysis. D. J. Gaskin, R. J. Thorpe Jr, E. E. McGinty, K. Bower, C. Rohde, J. H. Young, and T. A. LaVeist helped interpret results. D. J. Gaskin, R. J. Thorpe Jr, and E. E. McGinty drafted the article. All authors were involved in reviewing and editing the final draft of the article.

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Human Participant Protection

The institutional review board at the Johns Hopkins Bloomberg School of Public Health approved the study.

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