Published in final edited form as:
Am J Public Health. 2014 November ; 104(11): 2147–2155. doi:10.2105/AJPH.2013.301420.

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

Darrell J. Gaskin,
Hopkins Center for Health Disparities Solutions and the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health.

Roland J. Thorpe Jr.,
Hopkins Center for Health Disparities Solutions and the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health.

Emma E. McGinty,
Hopkins Center for Health Disparities Solutions and the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health.

Thomas A. LaVeist,
Hopkins Center for Health Disparities Solutions and the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health.

Kelly Bower-Joffe,
Hopkins Center for Health Disparities Solutions and the Department of Health Behavior and Society at the Johns Hopkins Bloomberg School of Public Health and, the Department of Community Public Health, Johns Hopkins School of Nursing.

Charles Rohde,
Hopkins Center for Health Disparities Solutions and the Department of Biostatistics at the Johns Hopkins Bloomberg School of Public Health.

J. Hunter Young, and
Department of Epidemiology at the Johns Hopkins Bloomberg School of Public Health and the Welch Center for Prevention, Epidemiology and Clinical Research in the Johns Hopkins School of Medicine.

Lisa Dubay
Urban Institute.

Abstract

Corresponding Author. Darrell J. Gaskin, PhD, Hopkins Center of Health Disparities Solutions, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health 624 N. Broadway, Suite 441 Baltimore, MD 21205 (dgaskin@jhsph.edu).

Contributors

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-Joffe 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-Joffe, 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 the reviewing and editing the final draft of the article.

Human Participant Protection

The Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health approved the study.

Objectives—This study seeks to determine the role of neighborhood poverty and racial composition on race disparities in diabetes prevalence.

Methods—Using data from the 1999–2004 National Health and Nutrition Examination Survey (NHANES) and 2000 U.S. Census, we 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 was higher for blacks compared to 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, and high crime rates, and greater exposures to environmental toxins. Housing and development policies in urban areas should avoid creating high poverty neighborhoods.

Nationally, 25.6 million or 11.3% of adults 20 years and over had diabetes in 2010.[1] Non-Hispanic blacks had the highest prevalence at 12.6% compared to 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, biological factors, and environmental factors.[2–4] Little work has been conducted to understand how individual and environmental level factors operate together to produce disparities in diabetes prevalence. This article examines the race disparity in prevalence of diabetes between non-Hispanic whites and non-Hispanic blacks and explores whether the disparity is associated with individual race and poverty status, and/or neighborhood racial composition and poverty concentration.

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 and colleagues found that higher diabetes rates were related to lack of availability of neighborhood resources that support physical activity and healthy nutrition.[5] Schootman and colleagues found that poor housing conditions were associated with diabetes prevalence.[6] African American 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 compared to 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 and colleagues compared disparities in diabetes in an urban, racially integrated low-income community to 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 and colleagues, using data from the Moving to Opportunity demonstration project, found a lower prevalence of diabetes among low-income adults who moved from high poverty neighborhoods to low poverty neighborhoods compared to 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.

This article explores whether the nexus of race, poverty, and neighborhood racial composition and poverty concentration illuminates the race disparities in diabetes. Specifically, does diabetes prevalence increase in predominately African American neighborhoods compared to predominately white neighborhoods? Is diabetes prevalence higher in poor neighborhoods compared to non-poor neighborhoods? Does the impact of neighborhood racial composition and poverty concentration on the risk of diabetes vary by race? We hypothesize that residential segregation and concentrated poverty: increase African Americans' exposure to environmental risks associated with poor health; reduce their access to community amenities that promote good health and healthy behaviors; and limit their access to social determinants that promote good health such as quality jobs, education, public safety and social networks.[7,22–24]

METHODS

Data

The National Health and Nutrition Examination Survey (NHANES) is designed to determine the health, functional, and nutritional status of the U.S. population. Since 1999, NHANES has been conducted as a continuous, annual survey with public use data files released in two-year increments. Each sequential series of this cross-sectional survey is a nationally representative sample of the civilian non-institutionalized population that consists of an over sample of participants ages 12–19 years, participants ages 60 years and older, Mexican Americans, African Americans, and low-income individuals.[25] Each of these surveys used a stratified, multistage probability sampling design.[25] Data were collected from respondents in two 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.

The NHANES data was linked to 2000 U.S. Census data in order 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. The Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health approved the study protocol for the protection of study participants. In this analysis we used the combined 1999–2004 datasets of adults who completed the household interview, physical examination and laboratory components. We restricted the analysis to African Americans/blacks (n=1202) and non-Hispanic whites (n=3201) who were age 25 and older. (For ease of exposition, we refer to the study groups as blacks and whites.)

Key Dependent Variable and Independent Variable(s)

We identified persons with diabetes as respondents who had a fasting glucose >=126 mg/dl, had hemoglobin A1c values >=6.5%, or reported taking medications for diabetes. Persons with normal glycemic values who reported taking metformin were excluded from this definition. Independent variables of interests are 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 two 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. Poverty income ratio was coded as a five-level categorical variable that indicate each individual's household poverty ratio and ranged from below FPL to above 400 percent of FPL. This categorization was used in our race-place model. Also, a binary poverty variable indicating whether individuals had household incomes below and above 200 percent of the FPL was used 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 1,500 to 8,000 persons who are similar with respect to population characteristics, economic status and living conditions. Neighborhood racial composition was designated as predominately white, black or other race (Asian or Hispanic) if that group was greater than 65 percent of the census tract's population. The racial composition of a neighborhood was designated as integrated if at least two groups were each more that 35 percent of the census tract's population. Neighborhoods were classified as having concentrated poverty if greater than or equal to 20 percent of families in the census tract have incomes below the FPL.

Other covariates included demographic variables (age and gender), and socioeconomic factors (education and health insurance status) and family history of diabetes. Age was measured as a continuous variable. We included age and age squared to control for non-linearities. Gender was coded as a dichotomous variable. Educational attainment was coded as four categories (<12 years of school, high school graduate/GED, some college, or college graduate or higher). Health insurance coverage was coded as four categories (privately insured, Medicare, Medicaid/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 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 2-by-N Chi-square tests 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 eight 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 interacted individual poverty with neighborhood poverty. We created a variable with four categories: non-poor in non-poor neighborhood, poor in non-poor neighborhood, non-poor in poor neighborhood, and poor in poor neighborhood. The race poverty place model interacted individual race and poverty with neighborhood poverty. We created a variable with eight categories: non-poor white in non-poor neighborhood, non-poor white in poor neighborhood, poor white in non-poor neighborhood, poor white in poor neighborhood, non-poor black in non-poor neighborhood, non-poor black in poor neighborhood, poor black in non-poor neighborhood, and poor black in poor neighborhood.

The sampling design for the NHANES is a complex, stratified multistage probability sample of non-institutionalized individuals. Therefore, sample weights were developed to account for both the differential probability of being sampled and differential response rates. Sample weights were applied to account for the differential probability of being selected, non-response adjustments, and adjustments to national control totals in the NHANES[26]. Parameter estimates and standard errors were adjusted for the multi-stage sampling design using Taylor linearization methods. Following the algorithm described by the National Center for Health Statistics,[27] a six-year sample weight variable was created by assigning 2/3 of the 4-year weight for 1999–2002 if the person was sampled in 1999–2002 or assigning 1/3 of the 2-year weight for the 2003–2004 if the person was sampled in the 2003–2004. We used the SVY commands in STATA 12 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 (See Table 1). Blacks had a higher rate of diabetes than whites (0.123 vs. 0.084; p = 0.03). The prevalence/proportion 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 that 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 = 0.019). This neighborhood difference is similar to the individual race difference.

When we interacted 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) compared to whites in white neighborhoods (0.083). When we interacted individual poverty with neighborhood poverty concentration, we found that compared to non-poor adults in non-poor neighborhoods, poor adults in poor and non-poor 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.

Non-poor whites had lower rates of diabetes compared with blacks and poor whites. Non-poor whites in poor and non-poor neighborhoods had similar diabetes rates. There was a place gradient for poor whites. Poor whites in poor neighborhoods had highest diabetes rates (0.15), while the diabetes rate was lower for poor whites in non-poor neighborhoods (0.121). For blacks there appears to be a race poverty place gradient with non-poor blacks in non-poor neighborhoods with the lowest rates of diabetes (0.100), followed by poor blacks in non-poor neighborhoods (0.114), non-poor 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 (See 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 to adults living at 400 FPL, the odds of having diabetes were 1.93 (95% confidence interval (CI)= 1.21–3.07) for the near poor (between 100 and 199 FPL) 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 was related to adults' racial identity relative to the racial composition of their neighborhood (See 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 indicators variables were statistically insignificant.

The results from the poverty place models tested whether odds of having diabetes was related to adults' poverty status relative to their neighborhood's poverty concentration (See Table 3). We found that poor adults in non-poor and poor neighborhoods had greater odds of having diabetes compared to non-poor adults in non-poor neighborhoods. The odds of having diabetes for poor adults in poor neighborhoods were higher compared with poor adults in non-poor 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 compared to 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 non-poor blacks in the logistic analysis. We found that compared to non-poor whites in non-poor neighborhoods, poor whites in poor 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 non-poor neighborhoods (OR=1.73; 95% CI = 1.16–2.57). Compared to non-poor whites in non-poor neighborhoods, poor blacks in poor neighborhoods and non-poor 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). The size of the disadvantage was slightly lower for poor blacks in non-poor neighborhoods (OR=2.34; 95% CI 1.22–4.46), and lower non-poor blacks in poor neighborhoods (OR=2.08; 95% CI = 1.26–3.44). While the confidence intervals 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 adjusting for age, gender, socioeconomic status and diabetes family history (See 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 associated with diabetes risk for non-poor 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 non-poor whites. Blacks and poor whites have a higher odds of diabetes compared to non-poor 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 (MTO) 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 show that MTO participants who relocated to low-income neighborhoods experienced a 26% reduction in gylcated hemoglobin level of 6.5% or more.[28] 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.[28]

Why does living in a poor neighborhood increases 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 (> 20%) compared to 11% of urban whites and 30% of poor urban whites.[29] The Exploring Health Disparities in Integrated Communities (EHDIC) Study reported that when poor blacks and whites live in an integrated poor community, they have similar diabetes prevalence (10.4% versus 10.5%).[20] The narrowing of the disparities was due to the white residents of this poor community having higher rates of diabetes. Other analyses of the EHDIC data found similar results for obesity, hypertension, and use of health services.[19] The authors conclude 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 compared to 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 due to the decreased availability of healthy food and limited walkability. These neighborhoods are often referred to as “food deserts” due to limited access to a supermarket or large grocery store. Poor black neighborhoods are more 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 in comparison with 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.[30] This is important because consumption of leafy green vegetables is associated with a 14% reduced risk of type II diabetes.[31] There is strong evidence suggesting that the walkability of neighborhoods is positively associated with physical activity and walking behaviors of adults.[32] In addition, residents of highly walkable neighborhoods are less likely to be overweight or obese.[32–34]

We did not find strong associations between diabetes prevalence and an individual racial identity and the neighborhood racial composition. Similarly, we did not find strong associations between diabetes and an individual’s poverty status and the neighborhood’s poverty rate. While 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 due to 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.”[29]

LIMITATIONS

Our study is 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 to whites. The analysis pools six (1999–2004) years 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 use the 2000 U.S. Census data to measure neighborhood racial composition and poverty concentration, and this assumes 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 multi-level modeling. However, after we control for the

NHANES' complex survey design, there are a small number of observations sharing the same census tract.

CONCLUSION

Consistent with the health and socioeconomic gradient literature,[35–37] we found individual poverty status matters for diabetes prevalence in both blacks and whites. Therefore, policies that address individual poverty (i.e. – increasing the minimum wage, job training and employment, quality of public education systems, access to higher education, access to healthcare, etc.) will reduce diabetes risk for black 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.[18,23,38–40] Poor communities are also at greater risk of environmental toxins that negatively impact health.[41] In addition, poor communities lack the political and economic power to improve these conditions. It is the responsibilities of local, state, and the 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 Department of Housing and Urban Development continues it policy of revitalizing poor urban communities under Hope VI, more research is needed to understand the mechanisms by which changes in neighborhood poverty influence diabetes risk. Specifically, policymakers need to know what neighborhood level factors matter most for residents of poor communities.

Acknowledgments

This research was supported a grant from the National Heart, Lung and Blood Institute (5R01HL092846-02). The analysis was conducted at the Research Data Center of the National Center for Health Statistics. The findings and conclusions are those of the authors and do not necessarily represent the views of the NCHS or the Centers for Disease Control and Prevention.

References

1. Centers for Disease Control and Prevention. National Diabetes Fact Sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2011.
2. Elbein SC. Genetics factors contributing to type 2 diabetes across ethnicities. Journal of diabetes science and technology. 2009 Jul; 3(4):685–689. [PubMed: 20144314]
3. Schulz AJ, Zenk S, Odoms-Young A, et al. Healthy eating and exercising to reduce diabetes: exploring the potential of social determinants of health frameworks within the context of community-based participatory diabetes prevention. Journal Information. 2005; 95(4)

4. Ross NA, Gilmour H, Dasgupta K. 14-year diabetes incidence: the role of socio-economic status. Health Rep. 2010; 21(3):19–28. [PubMed: 20973430]
5. Auchincloss AH, Diez Roux AV, Brown DG, Erdmann CA, Bertoni AG. Neighborhood Resources for Physical Activity and Healthy Foods and Their Association With Insulin Resistance. Epidemiology. 2008; 19(1)
6. Schootman M, Andresen EM, Wolinsky FD, et al. The effect of adverse housing and neighborhood conditions on the development of diabetes mellitus among middle-aged African Americans. American journal of epidemiology. 2007; 166(4):379–387. [PubMed: 17625220]
7. Williams DR, Collins C. Racial residential segregation: a fundamental cause of racial disparities in health. Public health reports. 2001; 116(5):404. [PubMed: 12042604]
8. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. Journal Information. 2005; 95(4)
9. Morland K, Filomena S. Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. Public health nutrition. 2007; 10(12):1481–1489. [PubMed: 17582241]
10. Kressin NR, Orner MB, Manze M, Glickman ME, Berlowitz D. Understanding contributors to racial disparities in blood pressure control. Circulation: Cardiovascular Quality and Outcomes. 2010; 3(2):173–180. [PubMed: 20233981]
11. Chung C, Myers SL Jr. Do the poor pay more for food? An analysis of grocery store availability and food price disparities. Journal of consumer affairs. 1999; 33(2):276–296.
12. Franco M, Diez Roux AV, Glass TA, Caballero B, Brancati FL. Neighborhood characteristics and availability of healthy foods in Baltimore. 2008
13. Hosler AS, Varadarajulu D, Ronsani AE, Fredrick BL, Fisher BD. Low-fat milk and high-fiber bread availability in food stores in urban and rural communities. Journal of Public Health Management and Practice. 2006; 12(6):556–562. [PubMed: 17041304]
14. Jetter KM, Cassady DL. The availability and cost of healthier food alternatives. American journal of preventive medicine. 2006; 30(1):38–44. [PubMed: 16414422]
15. Gittelsohn J, Franceschini MCT, Rasooly IR, et al. Understanding the food environment in a low-income urban setting: implications for food store interventions. Journal of Hunger & Environmental Nutrition. 2008; 2(2–3):33–50.
16. Glanz K, Sallis JF, Saelens BE, Frank LD. Nutrition environment measures survey in stores (NEMS-S). American journal of preventive medicine. 2007; 32(4):282–289. [PubMed: 17383559]
17. Morland K, Filomena S. The utilization of local food environments by urban seniors. Preventive medicine. 2008; 47(3):289. [PubMed: 18440626]
18. Massey DS, Condran GA, Denton NA. The Effect of Residential Segregation on Black Social and Economic Well-Being. Social Forces. 1987 Sep 1; 66(1):29–56. 1987.
19. Laveist T, Pollack K, Thorpe R Jr, Fesahazion R, Gaskin D. Place, not race: disparities dissipate in southwest Baltimore when blacks and whites live under similar conditions. Health affairs (Project Hope). 2011 Oct; 30(10):1880–1887. [PubMed: 21976330]
20. LaVeist T, Thorpe R, Galarraga J, Bower K, Gary-Webb T. Environmental and Socio-Economic Factors as Contributors to Racial Disparities in Diabetes Prevalence. Journal of General Internal Medicine. 2009; 24(10):1144–1148. [PubMed: 19685264]
21. Ludwig J, Sanbonmatsu L, Gennetian L, et al. Neighborhoods, obesity, and diabetes—a randomized social experiment. New England Journal of Medicine. 2011; 365(16):1509–1519. [PubMed: 22010917]
22. Landrine H, Corral I. Separate and unequal: residential segregation and black health disparities. Ethnicity & disease. 2009 Spring;19(2):179–184. [PubMed: 19537230]
23. Charles CZ. THE DYNAMICS OF RACIAL RESIDENTIAL SEGREGATION. Annual Review of Sociology. 2003; 29(1):167–207.
24. Marmot, M.; Wilkerseon, R. Social Determinants of Health. New York, New York: Oxford University Press; 2006.
25. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and

Prevention; 2004. National health and Nutrition Examination Survey Data. http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm.

26. Centers for Disease Control and Prevention National Center for Health Statistics. [Retrieved May 2, 2012] National Health and Nutrition Examination Survey. 2000. from http://www.cdc.gov/nchs//data/nhanes/gendoc.pdf.
27. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). Hyattsville, MD: U. S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2004. Specifiying Weighting Parameters. http://www.cdc.gov/nchs/nhanes/nhanes_citation.htm.
28. Orr, L.; Fein, J.; Jacob, R.; Beecroft, E.; Sanbonmatsu, L.; Katz, L. Moving to Opportunity for Fair Housing Demonstration Program Interim Impacts Evaluation. US Department of Housing and Urban Development; 2003.
29. Pendall R, Davies E, Freiman L, Pitingolo R. A Lost Decade: Neighborhood Poverty and Urban Crisis of the 2000s. Joint Center for Political and Economic Studies. 2001 *Available at:*http://www.jointcenter.org/research/a-lost-decade-neighborhood-poverty-and-the-urban-crisis-of-the-2000s.
30. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan. Ethnicity & disease. 2006; 16(1):275. [PubMed: 16599383]
31. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. BMJ. 2010; 341 2010-08-20 00:05:28.
32. Sallis J, Glanz K. Physical activity and food environments: Solutions to the obesity epidemic. The Milbank Quarterly. 2009; 87(1):123–154. [PubMed: 19298418]
33. Papas M, Alberg A, Ewing R, Helzlsouer K, Gary T, Klassen A. The built environment and obesity. Epidemiologic Reviews. 2007; 29(1):129–143. [PubMed: 17533172]
34. Booth K, Pinkston M, Poston W. Obesity and the built environment. Journal of the American Dietetic Association. 2005; 2005(105):5.
35. Adler N, Newman K. Socioeconomic disparities in health: pathways and policies. Health Affairs. 2002; 21(2):60–76. [PubMed: 11900187]
36. Deaton A. Policy Implications of the Gradient of Health and Wealth. Health Affairs. 2002; 21(2): 13–30. [PubMed: 11900153]
37. Duncan G, Daly M, McDonough P, Williams D. Optimal Indicators of Socioeconomic Status for Health Research. American Journal of Public Health. 2002; 92(7):1151–1157. [PubMed: 12084700]
38. Wilson, WJ. The truly disadvantaged: the inner city, the underclass, and public policy. Chicago: The University of Chicago Press; 1987.
39. Alba RD, Logan JR, Bellair PE. Living with Crime: The Implications of Racial/Ethnic Differences in Suburban Location. Social Forces. 1994 Dec 1; 73(2):395–434. 1994.
40. Gaskin D, Dinwiddie G, Chan K, McCleary R. Residential Segregation and the Availability of Primary Care Physicians. Health Services Research. 2012 forthcoming;
41. Morello-Frosch R, Jesdale B. Separate and unequal: Residential segregation and estimated cancer risks associated with ambient air toxics in U.S. metropolitan areas. Environmental Health Perspectives. 2006; 114(3):386–393. [PubMed: 16507462]

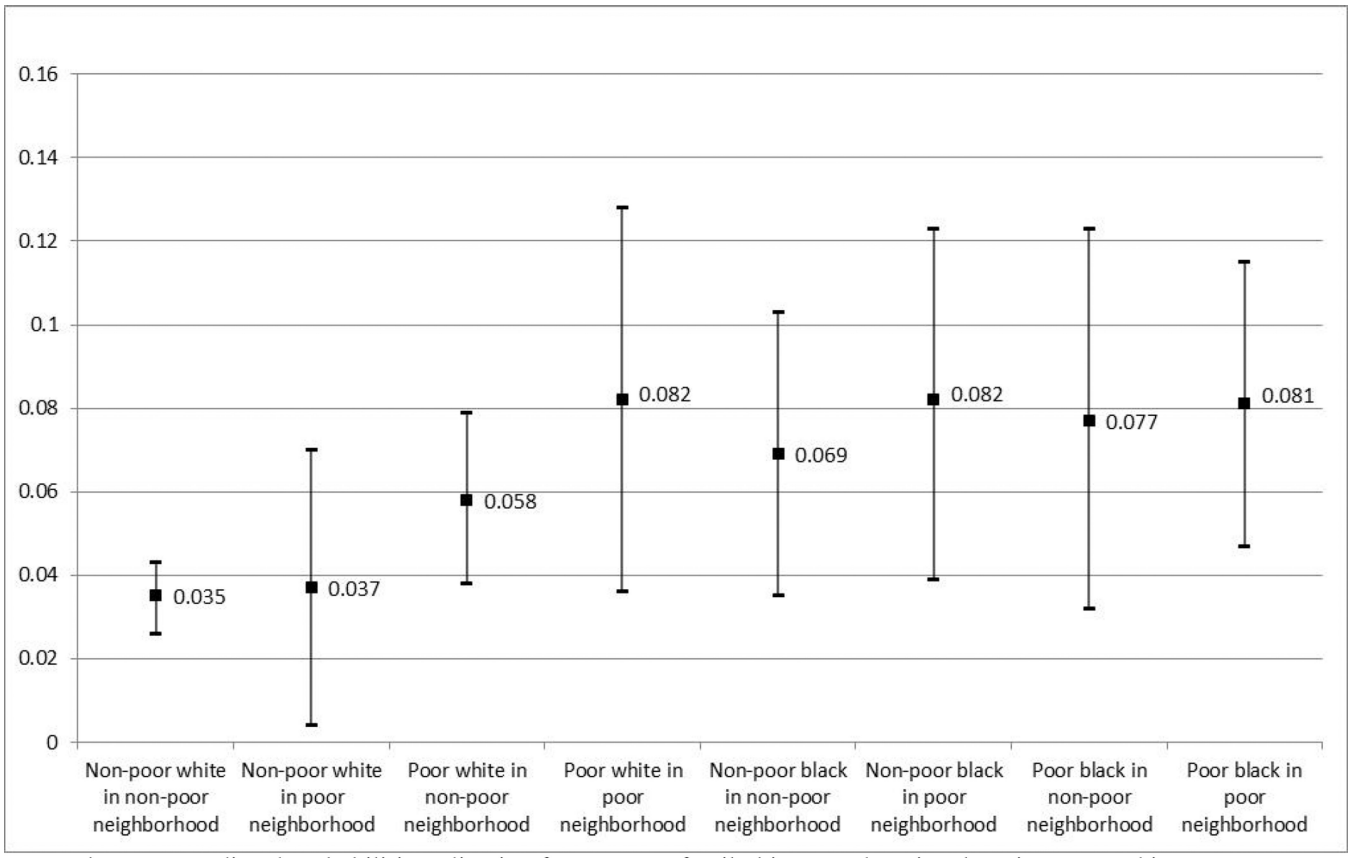

Figure 1.

Predicted Probabilities by Race, Poverty and Place Category

Note: These are predicted probabilities adjusting for age, sex, family history, educational attainment, and insurance status.

Table 1

Diabetes Prevalence by the Independent Variables

			Diabetes		
Independent Variables	**Categories**	**N**	**Mean**	**95% CI**	**P-Value**
Individual Race	Black	2605	0.123	0.103–0.144	0.03
	White	7184	0.084	0.072–0.958	
Individual Poverty	Household poverty 4 or > FPL	2989	0.053	0.036–0.071	Ref
	Household poverty 3–3.99 FPL	1135	0.087	0.059–0.116	0.014
	Household poverty 2–2.99 FPL	1507	0.107	0.077–0.137	0.017
	Household poverty 1–1.99 FPL	2093	0.127	0.097–0.157	<0.001
	Household poverty below FPL	1165	0.121	0.0.87–0.156	0.004
Neighborhood Poverty	Neighborhood concentrated poverty	2083	0.116	0.089–0.143	0.037
	Neighborhood no concentrated poverty	7701	0.084	0.072–0.096	
Neighborhood Racial Composition	Predominantly white neighborhood	6668	0.084	0.071–0.097	Ref
	Predominantly black neighborhood	1236	0.130	0.101–0.159	0.005
	Predominantly other race neighborhood	200	0.119	0.036–0.020	0.418
	Integrated neighborhood	1680	0.094	0.063–0.124	0.559
Race-Place Individual Race and Neighborhood Racial Composition	White in white neighborhood	6114	0.083	0.070–0.096	Ref
	White in black neighborhood	42	0.072	0.000–0.216	0.874
	White in other race neighborhood	128	0.123	0.021–0.224	0.451
	White in integrated neighborhood	895	0.083	0.046–0.121	0.994
	Black in black neighborhood	1194	0.134	0.104–0.165	0.002
	Black in white neighborhood	554	0.106	0.059–0.153	0.0258
	Black in other race neighborhood	72	0.108	0.000–0.223	0.681
	Black in integrated neighborhood	785	0.123	0.083–0.164	0.048
Poverty-Place Individual Poverty and Neighborhood Poverty Concentration	Non-poor in non-poor neighborhood	4866	0.701	0.058–0.082	Ref
	Poor in non-poor neighborhood	2149	0.120	0.095–0.145	<0.001
	Non-poor in poor neighborhood	760	0.089	0.048–0.130	0.339
	Poor in poor neighborhood	1109	0.140	0.010–0.179	0.003

			Diabetes		
Independent Variables	**Categories**	**N**	**Mean**	**95% CI**	**P-Value**
Race-Place-Poverty Individual Race and Poverty and Neighborhood Poverty Concentration	Non-poor white in non-poor neighborhood	4119	0.068	0.056–0.080	Ref
	Non-poor white in poor neighborhood	275	0.062	0.014–0.111	0.828
	Poor white in non-poor neighborhood	1743	0.121	0.095–0.147	<0.001
	Poor white in poor neighborhood	350	0.150	0.071–0.219	0.043
	Non-poor black in non-poor neighborhood	667	0.100	0.061–0.141	0.125
	Non-poor black in poor neighborhood	485	0.136	0.074–0.198	0.030
	Poor black in non-poor neighborhood	406	0.114	0.057–0.170	0.132
	Poor black in poor neighborhood	759	0.129	0.129–0.083	0.011
Sex	Male	5137	0.069	0.058–0.080	<0.001
	Female	4652	0.110	0.091–0.129	
Family History of Diabetes	History of Diabetes	4600	0.122	0.103–0.142	<0.001
	No History of Diabetes	5137	0.054	0.043–0.065	
Educational Attainment	Less than 9^{th} grade	775	0.195	0.130–0.259	0.067
	$9–12^{th}$ grade, no diploma	1547	0.124	0.090–0.159	0.006
	High school graduate	2559	0.091	0.071–0.111	Ref
	Some college	2611	0.088	0.068–0.108	0.077
	College graduate or higher	2265	0.054	0.032–0.076	0.002
Health Insurance Status	Private Insurance	6212	0.077	0.065–0.090	Ref
	Medicare	1702	0.200	0.153–0.248	<0.001
	Medicaid, SCHIP, other government insurance	572	0.098	0.060–0.133	0.569
	No insurance	1303	0.054	0.033–0.075	0.005

Table 2

Estimated Odds of Having Diabetes Controlling for the Race, Concentrated Poverty and Racial Composition of Neighborhood and Race-Racial Composition of Neighborhood.

	Base Model		Race-Place Model	
	OR	**95% CI**	**OR**	**95% CI**
Black	1.63	0.94–2.83	--	--
Neighborhood concentrated poverty	1.02	0.45–1.93	1.13	0.75–1.72
Predominantly white neighborhood	Ref	Ref	--	--
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	--	--
White in white neighborhood	--	--	Ref	Ref
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
Household poverty 4 or higher	Ref	Ref	Ref	Ref
Household poverty 3–3.99 FPL	1.44	0.92–2.28	1.56	0.96–2.53
Household poverty 2–2.99 FPL	1.48	0.93–2.37	1.65*	1.01–2.68
Household poverty 1–1.99 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
Male	2.02***	1.59–2.56	2.17***	1.64–2.86
Family History of Diabetes	3.27***	2.54–4.21	2.94***	2.22–3.88
Less than 9th grade	1.19	0.79–1.79	1.01	0.60–1.70
9–12th grade, no diploma	1.08	0.71–1.64	1.00	0.63–1.58
High school graduate	Ref	Ref	Ref	Ref
Some college	1.12	0.79–1.57	1.07	0.75–1.54
College graduate or higher	0.64	0.36–1.13	0.61	0.33–1.14
Private Insurance	Ref	Ref	Ref	Ref
Medicare	1.26	0.92–1.72	1.29	0.90–1.84
Medicaid, SCHIP, other gov't. 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

* denote P<0.05,

** denotes P<0.01 and

*** denotes P<0.001.

Also the models controlled for age and quadratic age, which were significant predictors (P<0.001).

Table 3

Estimated Odds of Having Diabetes Controlling for the Nexus of Poverty-Place and Race-Poverty-Place.

	Poverty-Place Model		Race-Poverty-Place Model	
	OR	**95% CI**	**OR**	**95% CI**
Black	1.59*	1.11–2.28	--	--
Non-poor in non-poor neighborhood	Ref	Ref	--	--
Poor in non-poor neighborhood	1.67**	1.14–2.44	--	--
Non-poor in poor neighborhood	1.26	0.72–2.21	--	--
Poor in poor neighborhood	1.98*	1.16–3.39	--	--
Non-poor white in non-poor neighborhood	--	--	Ref	Ref
Non-poor white in poor neighborhood	--	--	1.07	0.44–2.59
Poor white in non-poor neighborhood	--	--	1.73**	1.16–2.57
Poor white in poor neighborhood	--	--	2.51**	1.31–4.81
Non-poor black in non-poor neighborhood	--	--	2.08**	1.26–3.44
Non-poor black in poor neighborhood	--	--	2.49***	1.48–4.19
Poor black in non-poor neighborhood	--	--	2.34*	1.22–4.46
Poor black in poor neighborhood	--	--	2.45***	1.50–4.01
Male	2.15	1.63–2.85	2.15***	1.63–2.84
Family History of Diabetes	2.95***	2.21–3.92	2.94***	2.21–3.91
Less than 9th grade	1.04	0.62–1.73	1.05	0.63–1.74
9–12th grade, no diploma	1.03	0.65–1.64	1.05	0.66–1.66
High school graduate	Ref	Ref	Ref	Ref
Some college	1.05	0.73–1.49	1.05	0.74–1.49
College graduate or higher	0.55	0.30–1.01	0.55	0.30–1.01
Private Insurance	Ref	Ref	Ref	Ref
Medicare	1.34	0.94–1.90	1.33	0.92–1.89
Medicaid, SCHIP, other gov't. 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

* denote P<0.05,

** denotes P<0.01 and

*** denotes P<0.001.

Also the models controlled for age and quadratic age, which were significant predictors (P<0.001).