DIABETES MANAGEMENT AND VACCINATION RATES IN THE SOUTHEAST UNITED STATES, 2000 THROUGH 2007

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Objective: To examine trends in diabetes management, by race and sex, in the southeast United States.

Design: Population-based survey.

Setting: Southeast United States (ie, Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee).

Participants: Whites and Blacks surveyed through the Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System between 2000 and 2007 in the southeast United States.

Main Outcome Measures: Total diabetes management included personal factors (checking blood glucose and feet), healthcare provider factors (visiting a doctor, checking hemoglobin A1c, checking feet) and vaccinations (influenza, pneumonia).

Results: Vaccination levels were low throughout the study period, and a racial disparity in vaccination rates developed because trends in prevalence increased more rapidly in Whites relative to Blacks. Personal diabetes management increased significantly in all race/sex groups with greater increases in Black than White men, resulting in White men having lower point estimates of prevalence than Black men. Healthcare provider diabetes management increased significantly in all race/sex groups with the exception of Black men. Considering vaccinations together with personal and provider diabetes management criteria, diabetes management improved significantly in all race/sex groups, but remained low in 2007 (ie, 8.8%, Black women; 14.0%, White women; 11.5%, Black men; 12.8% White men).

Conclusion: Emphasis should be placed on improving vaccination levels, diabetes patient self-management and provider-management in the southeast United States. Although diabetes management improved over the study time period, in 2007 the percent of individuals meeting all of the diabetes management criteria examined remained very low ranging from 8.8% in Black women to 14.0% in White women. (*Ethn Dis.* 2011;21:13–19)

Key Words: Diabetes Management, Vaccine, Southeast United States, Racial Disparities

INTRODUCTION

In 2006, diabetes was the sixth leading cause of death in the United States.[1] Studies have shown that the prevalence of diabetes has dramatically increased over the past 20 to 30 years, and has disproportionately affected minority populations with higher disease prevalence and worse disease outcomes.[2,3]

The southeast United States is the region with the highest prevalence of heart disease, stroke, congestive heart failure and renal failure in the country.[4–6] Diabetes management has been shown to differ between racial groups, often influenced by socioeconomic factors, access to care, and disease awareness and knowledge, and may influence the racial disparities in diabetes outcomes.[7–13] Effective diabetes management, including self-care, healthcare provider-care, and getting vaccinated against influenza and pneumonia, is vital in reducing diabetes morbidity and mortality.

As diabetes prevalence continues to rise, it is important to understand secular trends and racial disparities in disease management in individuals with diabetes. Therefore, this study aimed to examine the trends in diabetes prevalence and diabetes management, by race and sex, in the southeast United States between 2000 and 2007.

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METHODS

Study Population and Data

This study utilized the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System (BRFSS). The survey uses random digit dialing to collect health data from individuals aged ≥18 years from all 50 states, the District of Columbia, the US Virgin Islands, Guam and Puerto Rico. The median state survey response rate for the BRFSS ranged from 48.9% to 53.2% between 2000 and 2007.[14]

Respondents located in the southeast United States who were surveyed between 2000 and 2007 were included in this study. The Department of Health and Human Services' Region Four, used to define the southeast US, includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. Each survey

Table 1. Unadjusted* characteristics (% or mean) of respondents with diabetes by year

	2000 (*n*=2198)	2001 (*n*=2868)	2002 (*n*=3505)	2003 (*n*=4685)	2004 (*n*=5458)	2005 (*n*=6569)	2006 (*n*=7748)	2007 (*n*=13092)
	%(se)							
White males	30.8 (1.0)	31.0 (.9)	31.1 (.8)	30.2 (.7)	29.8 (.6)	29.7 (.6)	31.7 (.6)	32.8 (.4)
White females	43.0 (1.1)	44.1 (1.0)	43.6 (.9)	42.4 (.8)	45.0 (.7)	44.4 (.6)	44.3 (.6)	45.0 (.5)
Black males	7.6 (.6)	7.7 (.5)	7.5 (.5)	8.2 (.4)	7.0 (.4)	7.9 (.4)	6.9 (.3)	6.3 (.2)
Black females	18.5 (.9)	17.1 (.7)	17.8 (.7)	19.2 (.6)	18.1 (.5)	18.1 (.5)	17.1 (.5)	15.8 (.3)
Age, years (se)	59.4 (14.1)	58.7 (14.9)	60.2 (14.3)	59.8 (14.2)	60.9 (13.9)	61.2 (13.5)	61.6 (13.7)	62.6 (13.2)
High school	68.3 (1.0)	70.7 (.9)	71.4 (.8)	71.9 (.7)	73.2 (.6)	74.3 (.5)	76.2 (.5)	77.4 (.4)
Access to care	82.7 (.8)	85.8 (1.9)	90.2 (.5)	80.7 (.6)	81.3 (.5)	82.8 (.5)	83.4 (.4)	84.3 (.3)

* In this table participant characteristics have not been weighted to account for the BRFSS study design and the *n* reflects the actual number of individuals interviewed.

respondent was weighted to account for differences in probability of selection, the number of residential telephones in the household, the number of adults in the household, non-coverage, and non-response.

Definitions

Diabetes was defined based on a positive response to the following question, "Have you ever been told by a doctor that you have diabetes?" Women who reported diabetes only when pregnant were classified as non-diabetic individuals. Non-Hispanic White and non-Hispanic Black racial groups were determined from self-reported race and ethnicity. All diabetes management variables, including vaccination rates, were determined from self-reported data. Management variables were determined based on recommendations by the American Diabetes Association, the CDC, *Healthy People 2010* and the questions included in the BRFSS.[14–18] An individual was considered to personally manage their diabetes if they reported checking their blood glucose level at least once a day and if they checked their feet for sores or irritations at least once per day. An individual was considered to manage their diabetes at the healthcare provider level if they visited a doctor at least twice a year, had their hemoglobin A1c checked at least twice a year, and had their feet checked for sores or irritations by a healthcare professional at least once a year. A respondent was adequately vaccinated if they received an influenza vaccination within the previous year and if they had ever received a pneumonia vaccination. A respondent was considered to have total diabetes management if they managed their diabetes on a personal and healthcare provider level and they were adequately vaccinated.

Statistics

We did not use BRFSS weighting that accounts for differences in probability of selection, the number of residential telephones in the household, the number of adults in the household, non-coverage, and non-response for the initial descriptive characterization of the study sample (ie. Table 1), but we used the weighting for all subsequent analyses.[14]

Data were analyzed using the SAS System (version 9.1; SAS institute; Cary, NC) and its complex survey-specific procedures. A multivariate logistic regression model was used to assess the age-adjusted prevalence of each outcome variable in each race/sex group for each year. The model included age, and 31 race/sex/year combination variables. The average age of the diabetic population, 61.5 years was included in the model when solving for each race/sex/year group. The model was weighted to account for the survey design of the data.[14]

Logistic regression models, including year, three race/sex groups and three interaction terms that were the race/sex groups multiplied by year, were used to determine if there was a linear trend in the outcome over the study time period in each race/sex group, and the percent change in outcome prevalence over the study time period. The model also included either age, or age/socioeconomic status/access to care to control for possible confounding effects. Self-reported education level was used as a surrogate for socioeconomic status; access to care was also self-reported. Wald chi-square probabilities were utilized to determine significant values for year variables, indicating significant linear trends over the study time period in the outcome variable in each race/sex group. Models were solved for year to determine the percent change in outcome prevalence over the study time for each race/sex group. The derivation for the confidence intervals for percent change in outcome prevalence over the study time period is found in the Appendix.

Lastly, a logistic regression model including year, race, sex, year/race, year/sex, race/sex, and year/race/sex variables was used to determine if there were significantly different linear trends in an outcome over the study time period between racial groups. A year/race variable indicated that there was a significant difference in the outcome's linear trend over the study time period between either White and Black men or White and Black women.

Table 2. Percent change of each outcome variable trend over the study time period, the confidence interval, and *P* for trend

	Age-adjusted % change			Fully-adjusted % change†		
	2000–2007			2000–2007		
	% change	95% CI	*P* for trend	% change	95% CI	*P* for trend
Diabetes						
White males	4.22	(3.11–5.34)	<.0001	4.35	(3.23–5.47)	<.0001
White females	3.03	(2.26–3.80)	<.0001*	2.75	(1.97–3.52)	<.0001*
Black males	3.53	(−.33–7.38)	.0269	3.90	(.09–7.72)	.0134
Black females	1.78	(−.78–4.33)	.092*	1.36	(−1.18–3.90)	.1897*
Personal diabetes management						
White males	4.50	(−.61–9.61)	.0391*	5.77	(.30–11.24)	.0132*
White females	6.05	(1.64–10.46)	.0014	6.99	(2.13–11.86)	.0006
Black males	15.5	(4.57–26.43)	.001*	16.75	(5.10–28.39)	.0008*
Black females	8.91	(1.67–16.14)	.0041	10.68	(2.95–18.41)	.0011
Healthcare provider diabetes management						
White males	7.17	(2.07–12.28)	.001	2.98	(−2.63–8.60)	.2135
White females	7.69	(3.28–12.11)	<.0001	4.38	(−.67–9.42)	.0396
Black males	7.34	(−4.61–19.29)	.1498	0.02	(−13.22–13.26)	.9971
Black females	9.69	(2.41–16.98)	.0017	3.31	(−4.80–11.42)	.332
Vaccinations						
White males	7.62	(2.42–12.82)	.0007	6.91	(.99–12.84)	.0071
White females	6.65	(1.98–11.32)	.001	7.78	(2.34–13.21)	.0009
Black males	−2.07	(−14.35–10.22)	.6778	3.28	(−10.37–16.93)	.5582
Black females	3.63	(−3.28–10.54)	.2081	4.51	(−3.58–12.60)	.1826
Total diabetes management						
White males	7.02	(4.33–9.71)	<.0001	5.95	(2.67–9.22)	<.0001
White females	7.35	(4.81–9.89)	<.0001	7.60	(4.54–10.66)	<.0001
Black males	6.23	(.68–11.78)	.003	8.47	(2.18–14.76)	.0004
Black females	5.75	(2.38–9.12)	<.0001	6.21	(2.01–10.40)	.0002

All estimates take the sample design/weighting into effect.
* Indicates significantly different racial trends.
† Fully adjusted model is adjusted for age, socioeconomic status, and access to care.

A $P<.05$ was considered statistically significant. No correction for multiple testing has been applied to reported *P*.

Results

Over the study time period, a total of 425,020 individuals responded to the BRFSS in the southeast United States. Of those, 46,121 (10.9%) had self-reported diabetes. Of the individuals with diabetes, the highest proportion of respondents was from Florida (20.2%), and the lowest proportion of respondents was from Tennessee (6.9%). Over the study time period, 44.4% of the respondents with diabetes were White females, 31.2% were White males, 17.3% were Black females, and 7.2% were Black males. The average age of respondents with diabetes was 61.5 ± 13.3 years and ranged from 58.7 ± 14.9 to 62.6 ± 13.2 between 2000 and 2007. An average of 74.4% of respondents with diabetes completed high school, obtained their GED, or had a higher education level, and an average of 83.6% had access to care (Table 1). Descriptive characteristics presented above are unweighted and therefore are reflective of the actual study population utilized rather than the population distribution in the southeast United States.

In 2000, the diabetes prevalence in the southeast United States ranged from 7.7% in White women to 20.1% in Black women. Over the study time period, there was a significantly increasing age-adjusted trend in diabetes prevalence in White men, White women, and Black men, but no significant change in Black women in the southeast United States. The age-adjusted diabetes prevalence increased by 4.22% (95% CI: 3.11–5.34%) in White men, 3.03% (95% CI: 2.26–3.80%) in White women, and 3.53% (95% CI: −0.33–7.38%) in Black men. The age-adjusted trend in diabetes prevalence in White women was significantly different than that in Black women, with the racial disparity decreasing by 1.25% (95% CI: −2.07–4.57%) over the study time period (data not shown). These trends remained significant after adjusting for SES and access to care (Table 2).

Personal diabetes management ranged from 39.9% in Black men to

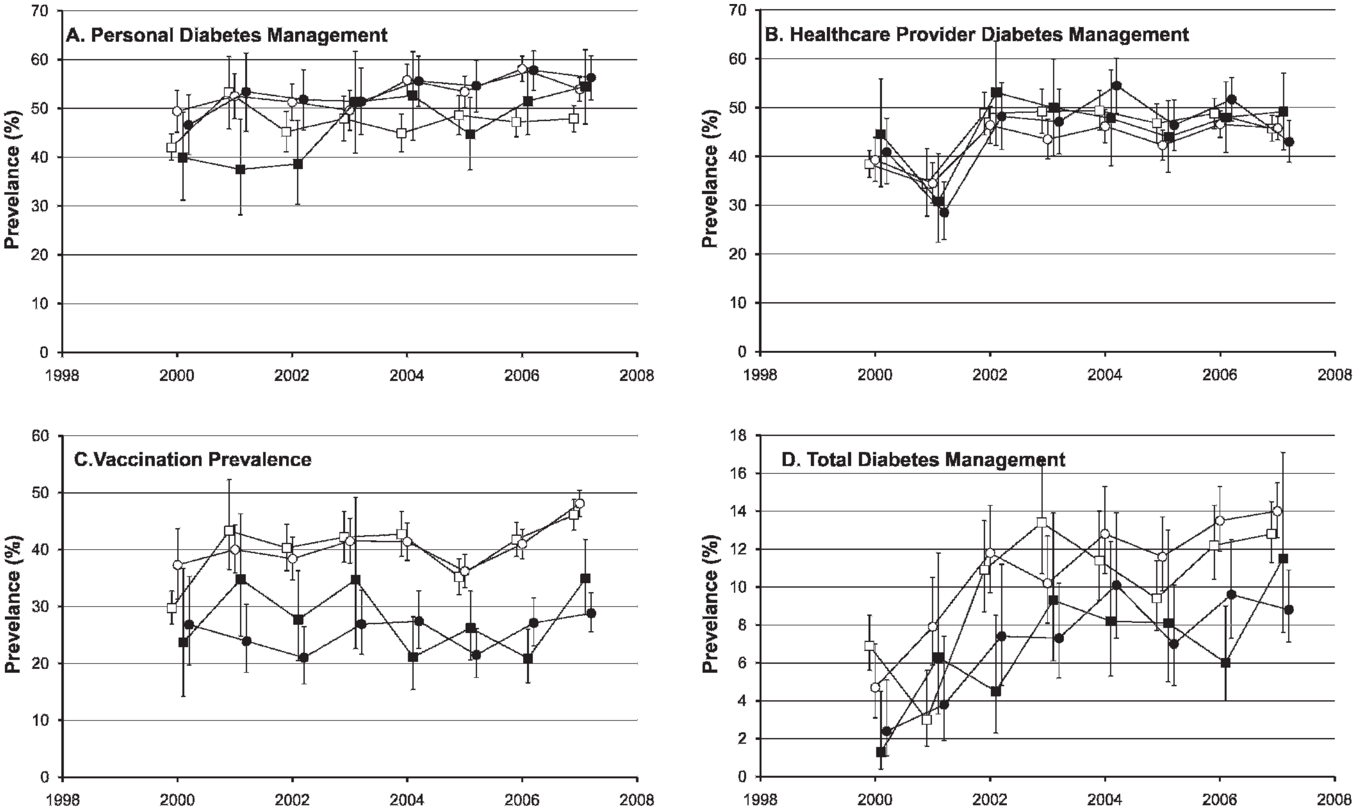

Fig 1. Trends in diabetes management in the southeast United States 2000-2007 stratified by sex and race. (A) personal diabetes management; (B) health provider diabetes management; (C) vaccination prevalence; (D) total diabetes management ○ White women ● Black women □ White men ■ Black men

49.4% in White women with diabetes in 2000. All four race/sex groups experienced significantly increasing age-adjusted trends in personal diabetes management prevalence over the study time period, increasing 4.50% (95% CI: −0.61–9.61%) in White men, 6.05% (95% CI: 1.64–10.46%) in White women, 15.50% (95% CI: 4.57–26.43%) in Black men, and 8.91% (95% CI: 1.67–16.14%) in Black women. The increasing trend in Black men was significantly larger than the trend in White men, resulting in the prevalence in Black men crossing over that of White men (Figure 1A). No racial disparity was seen in personal diabetes management throughout the study time period. All trends in personal diabetes management remained significant after adjusting for SES and access to care.

Healthcare provider diabetes management ranged from 38.5% in White men to 44.6% in Black men with diabetes in 2000 (Figure 1B). White men, White women, and Black women experienced significantly increasing age-adjusted trends in healthcare provider diabetes management prevalence over the study time period. Healthcare provider diabetes management increased 7.17% (95% CI: 2.07–12.28%) in White men, 7.69% (95% CI: 3.28–12.11%) in White women, and 9.69% (95% CI: 2.41–16.98%) in Black women. However, after adjusting for SES and access to care, the trends in healthcare provider diabetes management in White men and Black women failed to reach statistical significance. No significant trend in healthcare provider diabetes management was seen in Black men with diabetes.

The vaccination prevalence ranged from 23.7% in Black men to 37.3% in White women with diabetes in 2000. There were significantly increasing age-adjusted trends in vaccination in White men and women with diabetes over the study time period, with prevalence increasing 7.62% (95% CI: 2.42–12.82%) in White men and 6.65% (95% CI: 1.98–11.32%) in White women. The trends remained significant after adjusting for SES and access to care. No significant trends in vaccination prevalence were seen in Black men or women and the increasing trends in Whites led to development of a racial disparity in vaccination prevalence by 2007 (Figure 1C).

Total diabetes management prevalence ranged from 1.3% in Black men to 6.9% in White males with diabetes in 2000. Over the study time period, there were significantly increasing age-adjusted trends, and age-, SES-, and access to care-adjusted trends in total diabetes management prevalence in all four race/sex groups (Figure 1D). Total diabetes management increased 7.02% (95% CI: 4.33–9.71%) in White men, 7.35% (95% CI: 4.81–9.89%) in White women, 6.23% (95% CI: 0.68–11.78%) in Black men, and 5.75% (95% CI: 2.38–9.12%) in Black women. By 2007 among women a racial disparity emerged with White women (14.0% [95% CI: 12.6, 15.5]) having a higher prevalence of total diabetes management than Black women [8.5% (95% CI: 7.1, 10.9)].

All diabetes management outcomes were stratified by age to determine if there were differences in trends in individuals in each race/sex group aged <65 years and ≥65 years. No significant differences were found, with the following exceptions: while there was no significant trend in personal diabetes management prevalence in White women aged <65, there was a significantly increasing age-, SES-, and access to care-adjusted trend in White women ≥65, with the prevalence increasing 12.7% (95% CI: 9.36–21.1%). Similar results were seen in Black women where the prevalence increased 24.1% (95% CI: 10.9–37.2%) in Black women ≥65.

This study showed that from 2000 to 2007, White individuals with diabetes not only had significantly higher rates of vaccinations than Black individuals with diabetes, but their rates were significantly increasing over the study time period…

Discussion

In summary, we found racial disparities in both sexes in vaccination rates in the southeast United States. Vaccination levels were low throughout the study time period, and a racial disparity in vaccination rates developed during the study time period due to the increasing trends in prevalence in White relative to Black individuals. Personal diabetes management increased significantly in all race/sex groups with greater increases in Black than White men; moreover, although no racial disparity was seen throughout the study, the prevalence of personal diabetes management in Black individuals overcame that in White individuals by the end of the study. In contrast, for healthcare provider diabetes management, we found statistically significant improvement in all race/sex groups with the exception of Black men. Finally, we found that although total diabetes management was increasing in all race/sex groups in the southeast United States, management prevalence, according to our criteria, remained very low in 2007 ranging from 8.8% in Black women to 14.0% in White women.

Individuals with diabetes are more susceptible to influenza and pneumonia, and they often have higher death rates from influenza than people without diabetes.[19–21] Results from this study concur with a few other studies that have shown higher vaccination rates in White than Black individuals with diabetes, even after adjusting for socioeconomic status and access to care.[10,11] Furthermore, this study showed that from 2000 to 2007, White individuals with diabetes not only had significantly higher rates of vaccinations than Black individuals with diabetes, but their rates were significantly increasing over the study time period while no significant trends in vaccination rates were seen in Black men or women with diabetes. As a result, a racial disparity in vaccination rates developed during the study time period. The target vaccination rate for individuals with diabetes is 65% in individuals <65 years and 90% for individuals ≥65 years.[18] This study found no significant difference in vaccination rates for individuals between the two age groups, but rates for the entire diabetic population are far from desired with White women having the highest vaccination rate in 2007 at 48%, and Black women having the lowest vaccination rate at 29%.

This study showed that the majority of individuals with diabetes in the southeast United States do not meet management guidelines for diabetes; however, significantly increasing trends in total diabetes management in all four race/sex groups studied were observed, which may reflect increasing trends in personal diabetes management. Increases in personal diabetes management in this study could be a result of increased diabetes knowledge or awareness over the study time period. In addition to more media messages about diabetes, there are 59 Centers for Disease Control and Prevention funded diabetes prevention and control programs (DPCP), which are actively building capacity and implementing programs related to diabetes prevention and control and there is a DPCP in each of the states surveyed for this study. Recently, a focus of the programs has been on improving diabetes care within systems as well as policy changes that improve diabetes care and outcomes. Several states have implemented programs that focus on improving diabetes care and outcomes. For example, the South Carolina Legislature provides funding to improve diabetes outreach, diabetes care by health professionals and surveillance of diabetes by the Diabetes Initiative of South Carolina.[22] This funding has been used to improve self-care and care by health professionals, implement statewide policies for improving care, as well as providing infrastructure and data to obtain other funding for improving diabetes outcomes.[22] Other diabetes programs such as *REACH 2010: Charleston and Georgetown Diabetes Coalition* and REACH programs in North Carolina, Tennessee, and Georgia have focused on decreasing disparities for diabetes and related complications,[23] and have organized free influenza and pneumonia vaccinations with community partners.

There were several limitations to this study. First, different race/sex groups may be more susceptible to undiagnosed diabetes, misrepresenting the diabetic population in this study. National estimates show Black women have the highest prevalence of undiagnosed diabetes (4.1%), followed by White men (3.5%), Black men (3.2%), and White women (1.9%).[3] If this study included all individuals with diabetes instead of those with diagnosed diabetes only, diabetes management levels would have been lower, especially in Black women, widening racial disparities in women. Second, this study relies on self-reported data. Self-reported data may be more susceptible to recall bias, an overestimation of positive health behaviors and an underestimation of negative health behaviors. Another limitation of this study was that Black males represented a small proportion (7.1%) of the study respondents; even with weighted data, the relatively small number of Black men reduces the precision of outcome estimates in Black males. This study does not examine behavioral health factors, such as smoking status and physical activity levels or include outcome data such as hemoglobin A1c levels, complication rates, hospitalization rates or emergency department visit rates which may impact racial disparities in diabetes outcomes. Lastly, our definitions of personal and healthcare provider diabetes management were limited to information collected.

A strength of the study is that for each state the BRFSS sample is designed to be representative of the non-institutionalized population and studies have shown the BRFSS is valid against the general population.[24,25]

In summary, the results from this study suggest that a more aggressive diabetes management approach needs to be made across all race/sex groups in the southeast United States. Though diabetes management showed increases over the study time period, prevalence according to our criteria remained very low in 2007 ranging from 8.8% in Black women to 14.0% in White women. Hence, despite marked improvement at the present rate it will take decades for the majority of individuals with diabetes in the southeast United States to meet our minimal criteria for diabetes management.

Specifically, improved self-management and health provider care for diabetes are needed. Effective diabetes self-management includes not only self-care related to monitoring glucose and checking feet, but also eating healthy, increasing physical activity, effectively managing stress, healthy coping with daily living, reducing risks of obesity, managing dental problems, eye problems, high blood pressure and cardiovascular disease as well as taking medications, if needed, to control glucose, lipids, blood pressure, and other cardiovascular problems. Quality care by health providers includes not only semi-annual visits for care and A1c testing and foot checks, but also care by dentists, eye care professionals, and foot care if indicated. Guidelines for diabetes care by health providers are graded according to current evidence and are updated annually by the American Diabetes Association and other health professional organizations.[17,26] These guidelines include recommendations for vaccination for influenza and pneumonia. Additionally, *Healthy People 2010* have established goals for diabetes care and outcomes, as well as a goal that 90% of high-risk persons receive a pneumococcal vaccination and an annual influenza vaccine.[18] Finally, interventions are needed that target barriers to influenza and pneumonia vaccines among Black individuals with diabetes.

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REFERENCES

1. Heron M, Hoyert DL, Murphy SL, Xu J, Kochanek KD, Tejada-Vera B. Deaths: final data for 2006. *Natl Vital Stat Rep*. 2009; 57(14):1–134.
2. Mokdad A. Diabetes trends in the U.S.: 1990–1998. *Diabetes Care*. 2000;23(9):1278–1283.
3. Cowie CC, Rust KF, Byrd-Holt DD, et al. Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population: National Health And Nutrition Examination Survey 1999–2002. *Diabetes Care*. 2006; 29(6):1263–1268.
4. Cushman M, Cantrell RA, McClure LA, et al. Estimated 10-year stroke risk by region and race in the United States: geographic and racial differences in stroke risk. *Ann Neurol*. 2008; 64(5):507–513.
5. Jones D. Managing hypertension in the southeastern United States: applying the guidelines from the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI). *Am J Med Sci*. 1999;318(6):357–364.
6. Rich DQ, Gaziano JM, Kurth T. Geographic patterns in overall and specific cardiovascular disease incidence in apparently healthy men in the United States. *Stroke*. 2007;38(8):2221–2227.
7. Oladele C, Barnett E. Racial/ethnic and social class differences in preventive care practices among persons with diabetes. *BMC Public Health*. 2006;6:259.
8. Chou A, Brown AF, Jensen RE, Shih S, Pawlson, Scholle SH. Gender and racial disparities in the management of diabetes mellitus among Medicare patients. *Women's Health Issues*. 2007;17(3):150–161.
9. Nwasuraba C, Khan M, Egede LE. Racial/ethnic differences in multiple self-care behaviors in adults with diabetes. *J Gen Intern Med*. 2007;22:115–120.
10. Egede L, Zheng M. Racial/ethnic differences in influenza vaccination coverage in high-risk adults. *Am J Public Health*. 2003;93(12): 2074–2079.
11. Egede L, Zheng M. Racial/ethnic differences in adult vaccination among individuals with diabetes. *Am J Public Health*. 2003;93(2): 324–329.
12. Centers for Disease Control and Prevention. Preventive-care practices among persons with diabetes–United States, 1995 and 2001. *MMWR Morb Mortal Wkly Rep*. 2002;51(43): 965–969.

13. Harris M. Racial and ethnic differences in health care access and health outcomes for adults with type 2 diabetes. *Diabetes Care*. 2001;24(3):454–459.
14. Centers for Disease Control and Prevention. *Behavioral Risk Factor Surveillance System*. Available at: http://www.cdc.gov/brfss/index.htm. Last accessed on July 29, 2008.
15. Bridges CB, Fukuda K, Cox NJ, Singleton JA. Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep*. 2001;50(RR-4):1–44.
16. Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep*. 1997;46(RR-8):1–24.
17. American Diabetes Association. Clinical practice recommendations. *Diabetes Care*. 2009;32 Suppl 1:S1–S97.
18. *Healthy People 2010: Understanding Improving Health*. 2 ed. Washington, D.C: US Dept of Health and Human Services; 2000.
19. Koziel H, Koziel MJ. Pulmonary complications of diabetes mellitus. Pneumonia. *Infect Dis Clin North Am*. 1995;9(1):65–96.
20. Valdez R, Narayan K, Geiss L, Engelgau MM. Impact of diabetes mellitus on mortality associated with pneumonia and influenza among non-Hispanic Black and White US adults. *Am J Pub Health*. 1999;89:1715–1721.
21. Bertoni A, Saydah S, Brancati F. Diabetes and the risk of infection-related mortality in the U.S. *Diabetes Care*. 2001;24:1044–1049.
22. South Carolina Code of Laws, Title 44 - Health, Chapter 39, Diabetes Initiative of South Carolina Act.
23. Jenkins C, McNary S, Carlson BA, et al. Reducing disparities for African Americans with diabetes: progress made by the REACH 2010 Charleston and Georgetown Diabetes Coalition. *Public Health Rep*. 2004;119(3):322–330.
24. Bowlin SJ, Morrill BD, Nafziger AN, Lewis C, Pearson TA. Reliability and changes in validity of self-reported cardiovascular disease risk factors using dual response: the behavioral risk factor survey. *J Clin Epidemiol*. 1996;49:511.
25. Shea S, Stein AD, Lantigua R, Basch CE. Reliability of the behavioral risk factor survey in a triethnic population. *Am J Epidemiol*. 1991;133:489–500.
26. AACE Diabetes Mellitus Clinical Practice Guidelines Task Force. American Association of Clinical Endocrinologists medical guidelines for clinical practice for the management of diabetes mellitus. 2007. Available at: http://www.aace.com/pub/pdf/guidelines/DMGuidelines2007.pdf. Last accessed on November 27, 2010.

AUTHOR CONTRIBUTIONS

Design concept of study: Hardman, Hunt, Carter, Jenkins, Hill
Acquisition of data: Hardman, Hunt,
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Statistical expertise: Hardman, Hunt, Carter
Acquisition of funding: Lackland
Administrative: Jenkins
Supervision: Hardman, Hunt, Carter, Jenkins

APPENDIX

Percent change and percent change confidence interval derivation for Table 2.

$$\hat{p} = \hat{p}_{2007} - \hat{p}_{2000}$$

$$\hat{p} = \left(\frac{1}{1+e^{-x\beta}}\right)_{2007} - \left(\frac{1}{1+e^{-x\beta}}\right)_{2000}$$

$$CI(\hat{p}) = \hat{p} \pm 1.96(se)$$

$$\hat{p}_{UB} = \hat{p} + 1.96(se)$$

$$se(\hat{p}) = \frac{\hat{p}_{UB} - \hat{p}}{1.96}$$

$$var(\hat{p}) = [se(\hat{p})]^2$$

$$var(\hat{p}) = \left[\frac{\hat{p}_{UB} - \hat{p}}{1.96}\right]^2$$

$$var(\hat{p}_{2007} - \hat{p}_{2000}) = var(\hat{p}_{2007}) + var(\hat{p}_{2000})$$

$$se(\hat{p}_{2007} - \hat{p}_{2000}) = \sqrt{var(\hat{p}_{2007}) + var(\hat{p}_{2000})}$$

$$se(\hat{p}_{2007} - \hat{p}_{2000}) = \sqrt{\left(\frac{\hat{p}_{2000\ UB} - \hat{p}_{2000}}{1.96}\right)^2 + \left(\frac{\hat{p}_{2007\ UB} - \hat{p}_{2007}}{1.96}\right)^2}$$

$$95\%\ CI(\hat{p}) = \hat{p} \pm 1.96\sqrt{\left(\frac{\hat{p}_{2000\ UB} - \hat{p}_{2000}}{1.96}\right)^2 + \left(\frac{\hat{p}_{2007\ UB} - \hat{p}_{2007}}{1.96}\right)^2}$$