DISPARITIES IN SELF-MONITORING OF BLOOD GLUCOSE AMONG LOW-INCOME ETHNIC MINORITY POPULATIONS WITH DIABETES, UNITED STATES

Deborah A. Levine, MD, MPH; Jeroan J. Allison, MD, MSc; Andrea Cherrington, MD, MPH; Joshua Richman, MD, PhD; Isabel C. Scarinci, PhD, MPH; Thomas K. Houston, MD, MPH

Background: In adults with insulin-treated diabetes, self-monitoring of blood glucose (SMBG) rates may be lower in minority or low-income populations, but the effect of income on racial/ethnic differences in SMBG is unknown.

Methods: We assessed whether racial/ethnic differences in SMBG vary by income among adults with insulin-treated diabetes by using Behavioral Risk Factor Surveillance System data from 2000 through 2004. We measured the prevalence of SMBG at least once per day among 16,630 adults aged ≥19 years with insulin-treated diabetes.

Results: At incomes ≥$20,000, Hispanics and non-Hispanic Blacks reported similar but lower SMBG rates than did non-Hispanic Whites (78%, 77%, 85%; P ≤ .01). However, among those with income <$20,000, Hispanics performed SMBG substantially less than did Blacks or Whites (65%, 79%, 85%; P ≤ .01). Racial/ethnic differences in SMBG persisted after adjustment for age, sex, education, health insurance, health status, survey period, and diabetes measures. Receipt of diabetes education varied significantly by race/ethnicity in the income <$20,000 group only (Hispanics 49%, Blacks 64%, Whites 62%; P < .001). Low-income Hispanics with limited English proficiency had lower SMBG and diabetes education rates than did those with English proficiency (61% vs 79% and 44% vs 58%, respectively).

Conclusions: Among US adults with insulin-treated diabetes, Hispanics and Blacks performed daily SMBG less frequently than did Whites. Stratification by income revealed a disparity gradient in the income <$20,000 group: SMBG rates decreased from Whites to Blacks to Hispanics. Low-income Hispanics with limited English proficiency are at greater risk for reduced SMBG than are those proficient in English. (*Ethn Dis*. 2009;19:97–103)

Key Words: Diabetes Mellitus, Self-care, Healthcare Disparities, Minority Health, Income

From the Division of General Internal Medicine, College of Medicine; Division of Health Services Management and Policy, College of Public Health, Ohio State University, Columbus, Ohio (DAL); Department of Medicine, University of Alabama at Birmingham (DAL, JJA, AC, JR, ICS, TKH), Center for Surgical, Medical, Acute Care Research and Transitions, Birmingham VA Medical Center (TKH), Birmingham, Alabama.

Address correspondence and reprint requests to: Deborah A. Levine, MD, MPH; Division of General Internal Medicine and Division of Health Services Management and Policy, The Ohio State University; 466 Cunz Hall, 1841 Neil Ave; Columbus, OH 43210; 614-688-3854; dlevine@cph.osu.edu

INTRODUCTION

In 2007, 17.9 million US adults aged ≥20 years had diagnosed diabetes, and the age-adjusted prevalence among non-Hispanic Blacks (11.8%) and Hispanic/Latino Americans (10.4%) was higher than among non-Hispanic Whites (6.6%).[1] Self-monitoring of blood glucose (SMBG) is an integral component of disease management for the 4.8 million adults with diabetes (27%) who use insulin.[1] Despite 1997 guidelines recommending at least daily SMBG in persons with insulin-treated diabetes, SMBG rates are suboptimal.[2–5]

Minority adults with insulin-treated diabetes appear to have lower reported rates of SMBG. However, the US data that show racial/ethnic disparities in SMBG are more consistent for Blacks[2,3,6] and conflicting for Hispanics.[3–6] To date, studies reporting racial/ethnic differences in SMBG rates among US adults with insulin-treated diabetes have been limited by a small number of Hispanics,[6] focus on managed care populations from single states,[2,4,5] and the reliance on older (before 1995) national survey data.[3,6]

We hypothesized that low income would be associated with reduced self-monitoring of blood glucose rates for Hispanics but not for Blacks or Whites.

Although financial barriers are associated with decreased SMBG independent of race/ethnicity in adults with insulin-treated diabetes,[5–7] the effect of income on racial/ethnic differences in SMBG is unknown. A 1989 observational study found that the effect of income on SMBG may be different in Hispanics compared with Blacks or Whites, but the small number of Hispanics precluded characterization of that effect.[6] Compared with their White counterparts, Hispanics, particularly those with low incomes or less than a high school education, are less likely to have health insurance.[8] Conversely, poor or less educated Blacks are significantly more likely than are respective Whites to have health insurance.[8] We hypothesized that low income would be associated with reduced SMBG rates for Hispanics but not for Blacks or Whites. Using data from a nationally representative, population-based survey, we assessed whether income modifies racial/ethnic differences in SMBG among

Hispanic, non-Hispanic Black, and non-Hispanic White adults with insulin-treated diabetes, stratified by income. This report focuses on adults with insulin-treated diabetes, the diabetes group with the strongest evidence and recommendations for SMBG.

METHODS

The Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing, cross-sectional, state-based system of health surveys conducted in the adult US population by using telephone interviews.[9] The BRFSS is designed to collect uniform, state-based data on health risk behaviors, preventive health practices, and healthcare access primarily related to chronic disease and injury in the adult US population.[9] For the BRFSS, most states use either a disproportionate stratified sample or a Mitofsky-Waksberg-type sample design to draw a random sample from the set of all possible telephone numbers based on area codes and prefixes.[9] This process constructs representative samples of Hispanics and Blacks.[9] Data from BRFSS survey years 2000–2004, which use similar survey designs and data collection methods,[9] were combined for this report. Median Council of American Survey Research Organization response rates for BRFSS years 2000–2004 ranged from 48.9% to 58.3%.[9] Specific information regarding the BRFSS survey is available elsewhere.[9]

Persons with diabetes were identified as respondents who answered yes to the question "Have you ever been told by a doctor that you have diabetes?" Respondents aged ≥19 years who reported non-gestational diabetes and current insulin use were included in this analysis. We combined self-reported race and ethnicity to create 3 racial/ethnic groups: non-Hispanic Whites (Whites), non-Hispanic Blacks (Blacks), and Hispanics.

BRFSS respondents were asked to report their annual household income from all sources according to predefined income categories. We used 2 different income classifications: 1) <$20,000 and ≥$20,000 ($20,000 represents the approximate federal poverty threshold for a family of 2 adults and 2 children in 2005[8]) and 2) <$20,000, $20,000–$34,999, $35,000–$49,999, and ≥$50,000 (based on BRFSS response categories). Although the main analysis included adults with insulin-treated diabetes who reported income, we also examined the outcome measure among BRFSS respondents with insulin-treated diabetes who did not report their income (16% of each racial/ethnic group). The primary outcome measure was report of SMBG ≥1 time daily ("About how often do you check your blood for glucose or sugar?").

Statistical Analysis

We compared frequency of the outcome measure and covariates between racial/ethnic groups (Whites referent), overall and stratified by annual household income, by using χ^2 test or *t* test. For each racial/ethnic group, the frequency of the outcome measure, overall and stratified by income, across the individual survey years was compared by using χ^2 test for trend. Covariates were selected by using the Andersen Behavioral Model framework,[10,11] literature review, and clinical observation. Covariates were age (19–30, 31–44, 45–64, and ≥65 years), sex, health insurance (insured vs uninsured), and self-reported health status (low defined as poor or fair on a 4-point Likert scale). We controlled for number of diabetes-related provider visits to account for differences in diabetes healthcare utilization. Factors associated with SMBG frequency were included to reduce confounding by these variables: duration of diabetes duration, receipt of diabetes education, and use of oral diabetes medication.[6,12] As a marker of microvascular complications of disease (disease severity), we included diabetic retinopathy. To adjust for possible temporal trends in SMBG, we controlled for survey year. Receipt of glycosylated hemoglobin test, a surrogate marker of access to high-quality diabetes care, was not included because >33% of survey respondents in each income category did not know or refused to answer this question.

For study years 2003 and 2004 only, the BRFSS was available in English and Spanish in all US states. We repeated the entire analysis after dichotomizing Hispanics by language preference of testing (English or Spanish), a surrogate for English proficiency or limited English proficiency respectively. We limited the subgroup analysis to the income <$20,000 group because the small number of Hispanics with income ≥$20,000 ($n = 60$) who completed the BRFSS in Spanish precluded an examination of ethnicity-language interactions in detail.

Logistic regression analyses were performed to examine adjusted associations between race/ethnicity and the outcome measure. In initial logistic regression models, income significantly modified the association between Hispanic ethnicity and SMBG (P = .005) but not the association between Black race and SMBG (P = .51). Because SMBG increased over time for each of the racial/ethnic groups, we tested whether the change in SMBG over time differed across racial/ethnic groups by introducing the race × time interaction term into the logistic regression model. We then developed fully adjusted models stratified by income. All analyses used Stata statistical software version 9 (StataCorp LP, College Station, TX) to obtain proper variance estimations that accounted for the complex BRFSS sampling design and weighted results that reflect national population estimates. The University of Alabama at Birmingham provided institutional review board approval.

RESULTS

We identified 16,630 Hispanic, Black, and White adults aged ≥19 years

Table 1. Characteristics of adults with insulin-treated diabetes by race/ethnicity and income—BRFSS, 2000–2004*

Variable	Income<$20,000			Income ≥$20,000		
	Hispanics *n* = 1194	Blacks *n* = 1402	Whites *n* = 4442	Hispanics *n* = 571	Blacks *n* = 1151	Whites *n* = 7870
Mean (SE) age, years	57.2 (.93)	57.8 (.74)	61.8 (.45)	52.4 (1.20)	53.9 (.66)	56.1 (.29)
Age, years						
18–30	35 (4)‡	48 (4)‡	110 (4)	46 (10)	61 (5)‡	354 (6)
31–44	110 (19)	163 (13)	378 (9)	102 (19)	196 (19)	1233 (17)
45–64	517 (43)	695 (48)	1716 (39)	295 (48)	632 (53)	3673 (47)
≥65	532 (35)	496 (35)	2238 (48)	128 (23)	262 (23)	2610 (31)
Male	359 (41)	382 (34)§	1399 (40)	251 (44)‡	475 (48)‡	4054 (56)
Education less than high school	763 (66)‡	631 (45)‡	1364 (30)	110 (18)‡	195 (15)‡	643 (8)
No health insurance	110 (14)	249 (17)‡	523 (12)	44 (10)‡	132 (12)‡	425 (5)
Low heath status†	1022 (80)	1007 (72)	3302 (74)	312 (56)§	590 (52)	3842 (48)
Number of diabetes-related provider visits						
0	27 (5)‡	36 (4)‡	150 (4)	20 (4)‡	24 (2)	276 (3)
1–2	90 (12)	173 (12)	661 (17)	102 (21)	235 (22)	1750 (22)
3–4	239 (23)	447 (34)	1659 (38)	206 (30)	421 (40)	3447 (45)
>4	791 (61)	654 (51)	1771 (41)	234 (45)	433 (36)	2274 (30)
Duration of diabetes ≥10 years	767 (55)§	783 (59)§	2828 (65)	330 (61)	645 (55)‡	5172 (66)
Diabetic retinopathy	585 (42)	622 (45)	1930 (44)	224 (41)	455 (39)	2734 (35)
Receipt of diabetes education	528 (49)‡	863 (64)	2699 (62)	386 (73)	819 (70)	5680 (72)
Use of oral diabetes medication	554 (53)§	649 (45)	2062 (44)	291 (55)‡	505 (43)	3179 (39)
Daily self-monitoring of blood glucose	678 (65)‡	1065 (79)‡	3763 (85)	423 (78)‡	863 (77)‡	6707 (85)

BRFSS = Behavioral Risk Factor Surveillance System, SE = standard error.
* Except where noted, all data are expressed as *n* (%). Percentages are weighted according to the sampling fractions used by BRFSS.
† Low self-reported health status defined as poor or fair on a 4-point Likert scale.
‡ $P \leq .01$ compared with Whites.
§ $P \leq .05$ compared with Whites.

with insulin-treated diabetes who reported income. For all racial/ethnic groups, adults with diabetes reporting income <$20,000 were more frequently aged ≥65 years, female, and uninsured compared with those reporting income ≥$20,000 (Table 1). Most Hispanics in the income <$20,000 group lacked high school education (Hispanics 66%, Blacks 45%, Whites 30%; P ≤ .01).

Effect of Income on Racial/Ethnic Differences in SMBG among US Adults with Insulin-treated Diabetes

At incomes ≥$20,000, Hispanics and Blacks similarly reported lower SMBG frequency than did Whites (78%, 77%, 85%; P ≤ .01) (Figure 1). However, among those with income <$20,000, Hispanics performed SMBG less than did Blacks or Whites (65%, 79%, 85%; P ≤ .01). Among adults with insulin-treated diabetes who did not report income, percentages of SMBG were similar to those who reported incomes ≥$20,000 (Hispanics 76%, Blacks 78%, Whites 84%; P ≤ .01). Receipt of diabetes education varied significantly by Hispanic ethnicity (P < .001) in the income <$20,000 group (Hispanics 49%, Blacks 62%, Whites 62%).

The proportion of adults with diabetes who reported SMBG from 2000 through 2004 improved in all 3 racial/ethnic groups overall and within income groups; however, the racial/ethnic differences in SMBG persisted across the study period (data not shown). The increase in SMBG over time did not differ by race/ethnicity (P = .42 for Hispanics, P = .90 for Blacks) after adjusting for race/ethnicity, time, and income.

Effect of Adjustment for Socioeconomic, Clinical and Healthcare Access Variables

Because SMBG rates by race/ethnicity were similar at all incomes ≥$20,000, we calculated logistic regression results for the 2 income categories, <$20,000 and ≥$20,000. In unadjusted analyses ($n = 6956$, $F = 24.97$, P < .0001), lower odds of SMBG were seen in Hispanics (odds ratio [OR] .32, 95% confidence interval [CI] .23–.44) and Blacks (OR .66, 95% CI .51–.84) compared with Whites among adults with insulin-treated diabetes and income <$20,000. At higher incomes, Hispanics (OR .65, 95% CI .45–.94) and Blacks (OR .58, 95% CI .45–.75) had similar odds of SMBG ($n = 9531$, $F = 9.94$, P < .0001). In fully adjusted models, race/ethnicity was independently associated with SMBG at incomes <$20,000 and at incomes ≥$20,000 (Table 2).

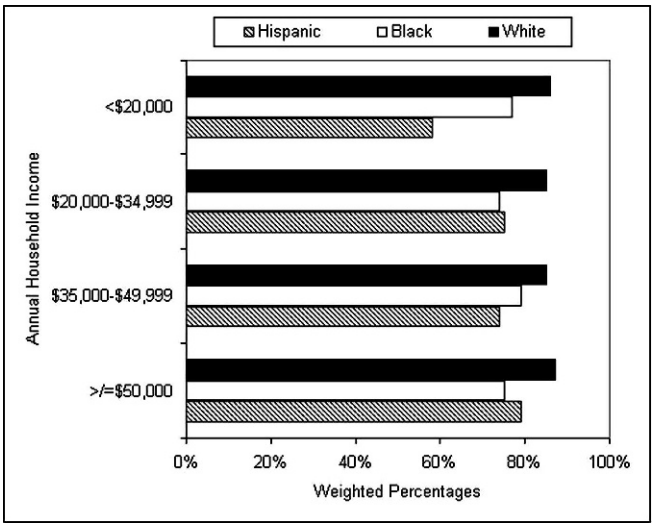

Fig 1. Daily self-monitoring of blood glucose among adults with insulin-treated diabetes by race/ethnicity and income—Behavioral Risk Factor Surveillance System (BRFSS), 2000-2004. Percentages are weighted according to the sampling fractions used by BRFSS.

Factors independently associated with SMBG for both income groups included diabetes-related provider visits, receipt of diabetes education, and survey period. For the income <$20,000 group, age >30 years, no health insurance, low health status, and no diabetic retinopathy were associated with lower odds of SMBG (model A, Table 2). Conversely, male sex, education less than high school, and use of oral diabetes medication were associated with lower odds of SMBG for the income ≥$20,000 group (model B, Table 2).

Effect of English Proficiency on SMBG among Low-income Hispanics

In the subgroup analysis for 2003 and 2004, 66% of Hispanics with

Table 2. Odds of daily self-monitoring blood glucose among adults with insulin-treated diabetes—BRFSS, 2000–2004

	Odds Ratio (95% Confidence Interval)*		
	2000–2004		2003–2004
	Income <$20,000	Income ≥$20,000	Income <$20,000
Variable	Model A n = 6175	Model B n = 9081	Model C n = 3155
Race/ethnicity			
Hispanic vs White	**.33 (.24–.47)**	**.62 (.43–.92)**	NA
Hispanic with limited English proficiency vs White	NA	NA	**.23 (.12–.41)**
Hispanic with English proficiency vs White	NA	NA	.60 (.29–1.25)
Black vs White	**.61 (.46–.82)**	**.55 (.42–.72)**	**.61 (.39–.96)**
Age >30 vs 19–30 years	**.76 (.64–.91)**	.90 (.80–1.02)	**.79 (.62–1.01)**
Female vs male sex	1.14 (.87–1.51)	**1.33 (1.09–1.63)**	.96 (.64–1.45)
Education less than high school	.79 (.61–1.03)	**.71 (.53–.97)**	.93 (.59–1.47)
No health insurance	**.58 (.41–.84)**	.84 (.58–1.23)	.66 (.37–1.16)
Low heath status†	**.71 (.53–.96)**	1.10 (.89–1.35)	.89 (.58–1.36)
Any diabetes-related provider visit within past 12 months vs no visits	**1.21 (1.04–1.40)**	**1.55 (1.37–1.75)**	**1.31 (1.04–1.65)**
Duration of diabetes <10 vs ≥10 years	.90 (.68–1.19)	.84 (.68–1.04)	.86 (.57–1.30)
Diabetic retinopathy	**1.42 (1.10–1.82)**	1.10 (.89–1.37)	**1.53 (1.01–2.32)**
Receipt of diabetes education	**1.62 (1.24–2.12)**	**1.32 (1.06–1.64)**	**1.74 (1.18–2.57)**
Use of oral diabetes medication	.90 (.70–1.16)	**.64 (.52–.78)**	.70 (.48–1.03)
Survey period 2001-2004 vs 2000	**1.18 (1.08–1.29)**	**1.19 (1.11–1.28)**	NA
Survey period 2004 vs 2003	NA	NA	.80 (.55–1.18)

BRFSS = Behavioral Risk Factor Surveillance System, NA = not applicable.

* Models adjusted for race/ethnicity, age, sex, education, health insurance, self-reported health status, number of diabetes-related provider visits, duration of diabetes, diabetic retinopathy, receipt of diabetes education, use of oral diabetes medication, and survey year. Values in boldface are significant at $P < .05$. Model A, income <$20,000: $F(df\ 13) = 8.27$, $P < .001$. Model B, income ≥$20,000: $F(df\ 13) = 10.81$, $P < .001$. Model C: $F(df\ 14) = 4.05$, $P < .001$.

† Low self-reported health status defined as poor or fair on a 4-point Likert scale.

Table 3. Daily self-monitoring of blood glucose and receipt of diabetes education among adults with insulin-treated diabetes and income <$20,000 by race/ethnicity and English proficiency—BRFSS, 2003 and 2004*

Variable	Hispanics with limited English proficiency *n* = 352	Hispanics with English proficiency *n* = 182	Blacks *n* = 768	Whites *n* = 2267
Daily self-monitoring of blood glucose	61†	79	82	86
Receipt of diabetes education	44†	58	67	61

* All data are percentages weighted according to the sampling fractions used by BRFSS.
† $P \leq .01$ compared with Whites.

incomes <$20,000 completed the BRFSS in Spanish rather than English. In this low-income group, rates of SMBG and receipt of diabetes education were substantially lower among Hispanics with limited English proficiency than those with English proficiency (Table 3). These racial/ethnic differences in SMBG persisted after full adjustment, except the difference between Blacks and Whites became significant (model C, Table 2).

DISCUSSION

In this nationally representative sample of US adults, Hispanics and Blacks with insulin-treated diabetes performed daily SMBG less frequently than did Whites. The main effect of poverty, which appears to be functioning only in Hispanics, was difficult to detect and was demonstrated after stratification by income. We found disparities in glucose monitoring among low-income minorities; the percentage of SMBG decreased from Whites to Blacks to Hispanics. Level of education, health insurance, health status, and diabetes measures, including receipt of diabetes education, did not fully explain these racial/ethnic differences in SMBG. In subgroup analysis, limited English proficiency was associated with markedly decreased SMBG rates among low-income Hispanics. Although low-income Hispanics with English proficiency had similar odds of SMBG as low-income Blacks (OR .60), the odds of SMBG were not significantly different than for Whites, perhaps because of small numbers in this Hispanic subgroup.

Hispanics and Blacks with insulin-treated diabetes performed daily self-monitoring of blood glucose less frequently than did Whites.

Prior research has demonstrated lower SMBG rates among Hispanics or Blacks compared with Whites with insulin-treated diabetes.[2,3] Two studies have not found lower SMBG rates among Hispanic adults with insulin-treated diabetes.[5,6] A 1989 cross-sectional study, based on 75 Mexican Americans, found a significant interaction between Mexican ethnicity and income and likely overestimated the true SMBG rate among poor Hispanics.[6] The second study, among adults with type 1 diabetes enrolled in a Northern California health maintenance organization, may not have found a SMBG disparity comparing all Hispanics to Whites because of attenuation of the relationship between race/ethnicity and SMBG by English proficiency, income, and out-of-pocket medical expenditures for glucose monitoring.[5] Similar to our results, Hispanics with limited English proficiency had significantly lower SMBG rates than Hispanics with English proficiency (SMBG ≥1 time daily: 40% ''not fluent'' vs 69% ''fluent"; P = .025).[5] The reasons for greater difficulty performing SMBG among low-income Hispanics, particularly those with limited English proficiency, compared with low-income Blacks or Whites in our study are uncertain but likely include racial/ethnic differences in health literacy, understanding of recommendations,[8,12,13] difficulty obtaining SMBG supplies,[14] healthcare access and utilization, and resource availability, all of which are understated by racial/ethnic differences in income.[15,16]

Our data demonstrate that SMBG frequency increases with receipt of diabetes education, regardless of income, consistent with prior research.[6] We found ethnic disparities in receipt of diabetes education among low-income minorities, with substantially lower rates among Hispanics, particularly those with limited English proficiency. The failure of low-income Hispanics to receive diabetes education may represent gaps in healthcare access and utilization similar to those that potentially explain observed SMBG differences or gaps in community resources for specific healthcare delivery components, like diabetes education for low-income Hispanics with limited English proficiency. Although the racial/ethnic differences in SMBG persisted after adjustment for receipt of diabetes education, residual confounding by diabetes education may persist.

Specifically, unmeasured differences in the type, quality, duration, date, and effectiveness of diabetes education, none of which could be assessed directly in our analysis, may partially explain the lower rates of SMBG by low-income Hispanics.

These BRFSS data are self-reported and subject to recall bias and reporting error. Although self-report of home blood glucose monitoring may not accurately reflect actual home blood glucose testing,[17] recent data suggest improved self-reported accuracy of home glucose monitoring.[5,18] The BRFSS samples people with land line telephones, not those who use only wireless telephones. People who use only wireless telephones are more likely to be Hispanic, age <30 years, below-poverty income, and uninsured and to lack a usual place for medical care and have financial barriers to health care.[19] Selection bias may occur if adults with insulin-treated diabetes and with lower SMBG adherence are less likely than those with higher SMBG adherence to be sampled by the BRFSS study design. This potential selection bias would have reduced the ability to detect the differences we observed. Several factors, including glycemic control, source and provider of diabetes care, diabetes knowledge, and physical disability preventing SMBG, could not be assessed adequately.

Given that Hispanics and Blacks have higher frequency of diabetes-related complications than do Whites,[20] efforts to improve glycemic control, including the collection and use of SMBG data in Hispanic and Black persons with insulin-treated diabetes, are warranted. Culturally tailored diabetes interventions have been shown to improve SMBG frequency and glycemic control in 2 separate low-resource, middle-aged diabetes cohorts, which included Hispanics and Blacks.[21,22] Self-management education significantly lowered glycosylated hemoglobin levels and improved diabetes knowledge scores in a Mexican American diabetic population with low levels of income, acculturation, and English proficiency.[23] Our data suggest that broader implementation of successful interventions nationally is needed to increase SMBG by low-income Hispanics with insulin-treated diabetes, particularly those with limited English proficiency.

REFERENCES

1. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2007. Atlanta, Ga: Centers for Disease Control and Prevention; 2008.
2. Trinacty CM, Adams AS, Soumerai SB, et al. Racial differences in long-term self-monitoring practice among newly drug-treated diabetes patients in an HMO. *J Gen Intern Med*. 2007;22(11):1506–1513.
3. Harris MI. Racial and ethnic differences in health care access and health outcomes for adults with type 2 diabetes. *Diabetes Care*. 2001;24(3):454–459.
4. Brown AF, Gerzoff RB, Karter AJ, et al. Health behaviors and quality of care among Latinos with diabetes in managed care. *Am J Public Health*. 2003;93(10):1694–1698.
5. Karter AJ, Ferrara A, Darbinian JA, Ackerson LM, Selby JV. Self-monitoring of blood glucose: language and financial barriers in a managed care population with diabetes. *Diabetes Care*. 2000;23(4):477–483.
6. Harris MI, Cowie CC, Howie LJ. Self-monitoring of blood glucose by adults with diabetes in the United States population. *Diabetes Care*. 1993;16(8):1116–1123.
7. Karter AJ, Stevens MR, Herman WH, et al. Out-of-pocket costs and diabetes preventive services: the Translating Research Into Action for Diabetes (TRIAD) study. *Diabetes Care*. 2003;26(8):2294–2299.
8. Agency for Healthcare Research and Quality. 2006 National Healthcare Disparities Report. Rockville, Md, US Department of Health and Human Services; 2006. AHRQ publication number 07-0012.
9. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at http://www.cdc.gov/brfss/. Accessed June 9, 2008.
10. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc*. 1973;51(1):95–124.
11. Gelberg L, Andersen RM, Leake BD. The Behavioral Model for Vulnerable Populations: application to medical care use and outcomes for homeless people. *Health Serv Res*. 2000;34(6):1273–1302.
12. Goldman DP, Smith JP. Can patient self-management help explain the SES health gradient? *Proc Natl Acad Sci U S A*. 2002;99(16):10929–10934.
13. von Goeler DS, Rosal MC, Ockene JK, Scavron J, De Torrijos F. Self-management of type 2 diabetes: a survey of low-income urban Puerto Ricans. *Diabetes Educ*. 2003;29(4):663–672.
14. Piette JD. Perceived access problems among patients with diabetes in two public systems of care. *J Gen Intern Med*. 2000;15(11):797–804.
15. Waidmann TA, Rajan S. Race and ethnic disparities in health care access and utilization: an examination of state variation. *Med Care Res Rev*. 2000;57(Suppl 1):55–84.
16. Williams DR, Collins C. Racial residential segregation: a fundamental cause of racial disparities in health. *Public Health Rep*. 2001;116(5):404–416.
17. Adams AS, Mah C, Soumerai SB, Zhang F, Barton MB, Ross-Degnan D. Barriers to self-monitoring of blood glucose among adults with diabetes in an HMO: a cross sectional study. *BMC Health Serv Res*. 2003;3(1):6.
18. Heisler M, Smith DM, Hayward RA, Krein SL, Kerr EA. How well do patients' assessments of their diabetes self-management correlate with actual glycemic control and receipt of recommended diabetes services? *Diabetes Care*. 2003;26(3):738–743.
19. Blumberg SJ, Luke JV. Wireless substitution: early releases of estimates based on data from the National Health Interview Survey, July-December 2006. National Center for Health Statistics. Available at http://www.cdc.gov/nchs/nhis.htm. Accessed June 9, 2008.
20. State of Diabetes Complications in America. Jacksonville, Fla, American Association of Clinical Endocrinologists; 2007. Available at http://www.aace.com/newsroom/press/2007/images/DiabetesComplicationsReport_FINAL.pdf. Accessed June 9, 2008.
21. Piette JD, Weinberger M, McPhee SJ, Mah CA, Kraemer FB, Crapo LM. Do automated calls with nurse follow-up improve self-care and glycemic control among vulnerable patients with diabetes? *Am J Med*. 2000;108(1):20–27.
22. Two Feathers J, Kieffer EC, Palmisano G, et al. Racial and Ethnic Approaches to Community Health (REACH) Detroit partnership: improving diabetes-related outcomes among African American and Latino adults. *Am J Public Health*. 2005;95(9):1552–1560.
23. Brown SA, Garcia AA, Kouzekanani K, Hanis CL. Culturally competent diabetes self-management education for Mexican Americans:

the Starr County border health initiative. *Diabetes Care*. 2002;25(2):259–268.

AUTHOR CONTRIBUTIONS

Design concept of study: Levine, Allison, Scarinci, Houston
Acquisition of data: Houston
Data analysis and interpretation: Levine, Allison, Cherrington, Richman, Scarinci, Houston
Manuscript draft: Levine, Richman
Statistical expertise: Levine, Allison, Richman, Houston
Administrative, technical, or material assistance: Levine, Cherrington, Houston
Supervision: Levine

DISCLAIMER

All analyses, interpretations, and conclusions reached are attributed to the authors (recipients of the data file) and not to the US Department of Health and Human Services, Centers for Disease Control and Prevention which is responsible only for the initial data.
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