

Mechanisms for Racial and Ethnic Disparities in Glycemic Control in Middle-aged and Older Americans in the Health and Retirement Study

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Background: Mechanisms for racial/ethnic disparities in glycemic control are poorly understood.

Methods: A nationally representative sample of 1901 respondents 55 years or older with diabetes mellitus completed a mailed survey in 2003; 1233 respondents completed valid at-home hemoglobin A_{1c} (HbA_{1c}) kits. We constructed multivariate regression models with survey weights to examine racial/ethnic differences in HbA_{1c} control and to explore the association of HbA_{1c} level with sociodemographic and clinical factors, access to and quality of diabetes health care, and self-management behaviors and attitudes.

Results: There were no significant racial/ethnic differences in HbA_{1c} levels in respondents not taking antihyperglycemic medications. In 1034 respondents taking medications, the mean HbA_{1c} value (expressed as percentage of total hemoglobin) was 8.07% in black respondents and 8.14% in Latino respondents compared with 7.22% in white respondents ($P < .001$). Black respondents had worse medication adherence than white re-

spondents, and Latino respondents had more diabetes-specific emotional distress ($P < .001$). Adjusting for hypothesized mechanisms accounted for 14.0% of the higher HbA_{1c} levels in black respondents and 19.0% in Latinos, with the full model explaining 22.0% of the variance. Besides black and Latino ethnicity, only insulin use ($P < .001$), age younger than 65 years ($P = .007$), longer diabetes duration ($P = .004$), and lower self-reported medication adherence ($P = .04$) were independently associated with higher HbA_{1c} levels.

Conclusions: Latino and African American respondents had worse glycemic control than white respondents. Socioeconomic, clinical, health care, and self-management measures explained approximately a fifth of the HbA_{1c} differences. One potentially modifiable factor for which there were racial disparities—medication adherence—was among the most significant independent predictors of glycemic control.

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BLACK AND LATINO ADULTS experience a 50% to 100% higher burden of illness and mortality due to diabetes mellitus than white Americans.¹⁻³ National studies⁴⁻⁶ have found worse glycemic and blood pressure control in African American and Latino patients with diabetes than other groups. Approximately 10% of racial differences in mortality in the United States have been attributed to diabetes alone.⁷

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Inadequate access to health care contributes to higher rates of adverse diabetes outcomes in African American and Latino patients in the United States.^{6,8} African American and Latino patients often receive worse diabetes medical care than white patients in the same facilities and are more likely than white patients to re-

ceive care in resource-poor facilities with lower overall quality of care.⁹⁻¹¹ Studies adjusting for socioeconomic, clinical, and health care factors, however, have explained only a small percentage of racial/ethnic variation in glycemic control.

Differences in patient self-management attitudes and behaviors are hypothesized to contribute to worse glycemic control among diabetic adults from different ethnic backgrounds.¹² Few studies to date, however, have had sufficient data on respondents' diabetes self-management to systematically evaluate this hypothesis. Previous national studies have used surrogate self-care measures, such as physical activity, current smoking,¹³ and home glucose monitoring frequency,³ but lacked measures of a full range of diabetes self-management attitudes and behaviors. In addition, previous national studies have not contained comprehensive data on patient characteristics, including sociode-

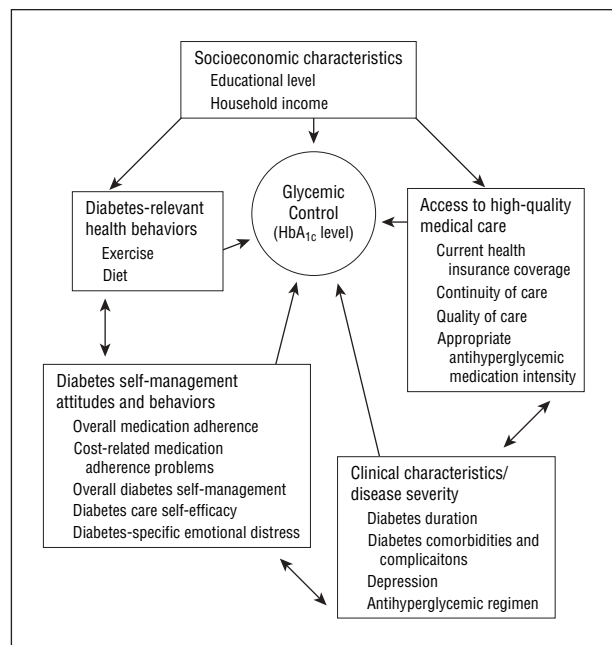


Figure. Hypothesized mechanisms for racial/ethnic disparities in glycemic control. HbA_{1c} indicates hemoglobin A_{1c}.

mographics, diabetes severity, comorbidities, self-management attitudes and behaviors, health care access barriers, and quality of received health care, to be able to rigorously assess the relative contribution of these different hypothesized factors to disparities in diabetes outcomes.

The Health and Retirement Study¹⁴ (HRS), a nationally representative longitudinal study of Americans 50 years and older, offers an excellent opportunity to examine these issues. In 2003, the National Institute on Aging authorized a study of people with self-reported diabetes followed up in the HRS. We developed a conceptual framework of factors found in previous research or hypothesized to contribute to racial/ethnic disparities in glycemic control and collected information on these in a mailed survey in conjunction with measured HbA_{1c} levels (**Figure**). We examine 2 questions in the present study: (1) Are there racial/ethnic disparities in HbA_{1c} levels? (2) If so, what patient-level factors contribute to the observed disparities in HbA_{1c} levels?

METHODS

STUDY POPULATION

The HRS is a nationally representative, biennial longitudinal study of more than 30 000 individuals.¹⁴ The HRS oversamples black and Latino individuals; gathers in-depth economic, financial, and health information from respondents; and represents the US population older than 50 years. Telephone or in-person interviews are conducted every 2 years (<http://hrsonline.isr.umich.edu>).

HRS DIABETES SURVEY AND HbA_{1c} TEST

In October 2003 the survey was sent in 2 mailings to 2350 HRS respondents who reported having diabetes in 2002. A Spanish

translation was provided to Spanish-speaking respondents. The survey included questions assessing the main components of current behavioral theoretical models for factors affecting diabetes self-management behaviors and attitudes.¹⁵⁻¹⁹ A \$40 incentive was included with the first survey mailing. Survey respondents were sent a self-administered HbA_{1c} fingerstick kit; 1901 completed the survey (80.9% response rate), and 1285 completed the at-home HbA_{1c} kits, of which 1233 yielded valid samples (52.5%). Black and Latino ethnicity, lower educational and income levels, longer duration of diabetes, more depressive symptoms, and lower evaluations of diabetes health care quality were each associated with not returning the HbA_{1c} kits. Diabetes study weights corrected for nonresponse using a propensity model and reweighted participants who completed the HbA_{1c} kit to be representative of all study participants. Of the 1901 respondents, 4 were excluded for missing data on race/ethnicity, 49 younger than 55 years were excluded for sampling weights of zero, and 649 were excluded for lacking a valid HbA_{1c} score or having a sampling weight of zero for a non-age-related reason. The resulting sample size was 1199. The University of Michigan institutional review board approved the study.

MEASURES OF GLYCEMIC CONTROL AND RACIAL/ETHNIC IDENTITY

Level of HbA_{1c} is the dependent variable in all the analyses. This measure integrates glycemic control during the previous 6 to 8 weeks.²⁰ We used a mail-in HbA_{1c} assay (At-Home; FlexSite Diagnostics Inc, Palm City, Florida) that uses the Roche Uni-mate immunoassay and the Cobas Integra analyzer (F. Hoffmann–La Roche Ltd, Basel, Switzerland) calibrated to a synthetic HbA_{1c} standard. This test has been evaluated against Diabetes Control and Complications Trial reference technology and has been extensively tested in the laboratory and in company-sponsored supplements to clinical trials. The manufacturer reports a test coefficient of variation of 2.54% or less (a coefficient of variation <5% is recommended by the American Diabetes Association).²⁰

The principal independent variable was participants' self-reported race/ethnicity, coded as non-Latino white, non-Latino black, or Latino.

MEASURES FOR HYPOTHEZED MECHANISMS FOR RACIAL/ETHNIC DISPARITIES IN GLYCEMIC CONTROL

Sociodemographic Characteristics

Sociodemographic covariates included age (<65 vs ≥65 years), sex, years of formal education (less than high school, high school, or more than high school), and annual household income (total of all income during the previous year, including employment, Social Security benefits, private pensions, and investments²¹) adjusted for household composition. Because the income variable was highly skewed, we used the log of income as a continuous variable.

Clinical Characteristics

Clinical variables included antihyperglycemic treatment regimen (no medications, oral medications with no daily blood glucose testing, oral medications with daily testing, and insulin—with or without oral medications). We divided the oral medications category in this manner because respondents taking oral medications who reported daily blood glucose testing

Table 1. Hemoglobin A_{1c} (HbA_{1c}) Levels in 1199 Respondents by Age, Race, and Medication Use^a

Age and Race/Ethnicity	No Medications		Medications	
	HbA _{1c} , Mean, % of Total Hemoglobin	P Value	HbA _{1c} , Mean, % of Total Hemoglobin	P Value
All	n = 165		n = 1034	
White	6.39	1 [Reference]	7.22	1 [Reference]
Black	7.17	.18	8.07	.001
Latino	6.55	.72	8.14	.002
55-64 y	n = 47		n = 286	
White	6.25	1 [Reference]	7.46	1 [Reference]
Black	6.90	.24	8.96	.003
Latino	6.63	.50	8.91	.001
≥65 y	n = 118		n = 748	
White	6.45	1 [Reference]	7.11	1 [Reference]
Black	7.39	.32	7.46	.02
Latino	6.24	.38	7.60	.02

^a All estimates are weighted using appropriate sample weights. Overall, mean (95% confidence interval) levels of hemoglobin A_{1c} were 7.09% (6.99%-7.20%) in white respondents, 7.94% (7.53%-8.35%) in black respondents ($P < .001$), and 7.97% (7.44%-8.49%) in Latino respondents ($P = .002$).

had significantly higher HbA_{1c} levels than those taking oral medications and not testing daily. Other clinical characteristics included diabetes duration in years (continuous), severity and number of diabetes comorbidities as measured using diabetes-related components of the Total Illness Burden Index, a validated scale that ranges from 0 to 100,²²⁻²⁴ and depressive symptoms reported in the 2002 wave as measured using the 8-item Center for Epidemiologic Studies–Depression Scale.^{25,26}

Access to High-Quality Medical Care

We created variables for whether respondents reported having insurance in the 2002 survey wave, duration with the same diabetes care provider, respondents' evaluation of the overall quality of the diabetes health care they receive, and whether they received an HbA_{1c} test in the previous 12 months. In separate bivariate analyses, we assessed racial/ethnic differences in number and types of antihyperglycemic medications.

Diabetes-Relevant Health Behaviors

We included a measure of minutes of physical activity during the previous week standardized to minutes of a low-intensity activity such as walking^{27,28} and healthy diet during the previous 7 days using the diet subscale from the Summary of Diabetes Self-Care Activities Scale.²⁹ We did not include body mass index because in the present sample, as in other national samples of adults with diabetes, contrary to the hypothesis, higher body mass indexes were associated with lower HbA_{1c} levels.^{30,31}

Diabetes Self-management Attitudes and Behaviors

We used items from well-validated scales to measure patients' reported diabetes self-management in 5 domains (medications, diet, exercise, glucose monitoring, and foot care),^{32,33} diabetes care self-efficacy,^{19,33,34} and diabetes-specific emotional distress (the Problem Areas in Diabetes scale) and scored these as unweighted continuous scales using standard procedures.^{35,36} To assess reported medication adherence in respondents receiving medications, we constructed a dichotomous variable from respondents' answers to 2 questions on how often in a typical week they miss a prescribed dose of their oral diabetes medications and, if receiving insulin, how often in a typical week they miss a scheduled insulin dose. We dichotomized the vari-

able between the response category of "never" and the other 4 response categories ("rarely," < 1 of 10 scheduled doses; "sometimes," 1 or 2 of 10 scheduled doses; "often," 3 or 4 of 10 scheduled doses; and "very often," ≥ 5 of 10 scheduled doses). In sensitivity analyses, we used different cutoff points and found no significant differences. Finally, we included a variable for whether respondents reported in the 2002 HRS survey wave that they had cut back on medication use because of cost.

STATISTICAL ANALYSES

We compared all the characteristics by race/ethnicity using χ^2 tests for dichotomous and categorical variables and generalized linear models for continuous variables. Because of our particular interest in assessing diabetes self-management practices, we looked at differences in HbA_{1c} levels by race between those taking antihyperglycemic medications and those not taking medications. We found no significant racial differences in HbA_{1c} levels in those not taking medications (**Table 1**). We thus restricted the sample to respondents who reported taking medications (n = 1034) to be able to evaluate the association of medication adherence with glycemic control.

We constructed 5 multivariate linear regression models with HbA_{1c} level as the dependent variable, adding sequentially the clusters of variables hypothesized to contribute to racial/ethnic disparities in glycemic control. We used standardized β coefficients to compare the relative strength of the association of each variable with HbA_{1c}. The clusters were added to the model with race/ethnicity in the following order: (1) sociodemographic variables of age, sex, education, and annual household income; (2) clinical variables of diabetes duration, antihyperglycemic regimen, diabetes comorbidities, and depressive symptoms; (3) health care access and quality variables measuring current health insurance, continuity of care, reported quality of care, and receipt of an HbA_{1c} test in the previous 12 months; (4) diet and exercise; and (5) diabetes care self-efficacy, overall diabetes self-management, diabetes-specific emotional distress, overall medication adherence, and cost-related medication underuse. Adding the clusters in different orders did not affect the results. To check whether the results were sensitive to nonlinear effects, we also constructed the previously mentioned models using multivariate logistic regression with different HbA_{1c} cutoff values (7.0% and 8.0% of total hemoglobin).^{20,37} Results did not differ significantly using

these cutoff values, so we report only the linear regression model results. Finally, because we hypothesized that respondents' access to Medicare might further mitigate unmeasured differences in health insurance coverage, we conducted separate stratified analyses of respondents younger than 65 years and of respondents 65 years or older.

To avoid selection bias and inaccurate inferences from listwise deletion, we imputed covariates for which any data were missing using a hot-deck imputation technique that fills in missing values on incomplete records using values from similar but complete records in the same data set.³⁸ Missing items from multiple-item scales were imputed at the item level using conditional mean imputation procedures. Rates of item-level missing data were less than 10% for all covariates used in the analyses. There were no differences in results of multivariate analyses using imputed or nonimputed variables. Regression diagnostic procedures yielded no evidence of substantive multicollinearity or calibration problems in any of the regression models. There were no significant interactions between race/ethnicity and any of the self-management variables. We performed all analyses using a software program (STATA 9.2; StataCorp, College Station, Texas). All analyses were adjusted for the oversampling design of the HRS and for nonresponse to the questionnaire and the HbA_{1c} test.

RESULTS

SAMPLE CHARACTERISTICS

Table 2 summarizes the characteristics of respondents who reported taking antihyperglycemic medications (n = 1034) and notes the racial/ethnic differences in these characteristics.

CORRELATES OF GLYCEMIC CONTROL

Bivariate Analyses

Most of the variables tested in these models (Figure) were associated with HbA_{1c} levels in bivariate analyses as hypothesized (**Table 3**, column 1). Of the variables for which we found racial differences (Table 2), taking insulin (black patients) ($P < .001$), more diabetes-related comorbidities (black patients) ($P = .007$), lacking health insurance (Latino patients) ($P = .01$), reporting worse medication adherence (black patients) ($P = .002$), and higher levels of diabetes-specific distress (Latino patients) ($P < .001$) were all associated with higher HbA_{1c} levels. In addition, age younger than 65 years ($P < .001$), longer duration of diabetes ($P < .001$), following a healthy diet fewer days in the past week ($P = .06$), a worse reported overall diabetes self-management ($P = .002$), worse reported diabetes self-care self-efficacy ($P = .04$), and having to cut back on medications because of cost ($P = .008$) were each associated with higher HbA_{1c} levels.

Multivariate Linear Regression Analyses

Table 3 gives the cumulative effect of adding to the model the clusters of variables on the differences in HbA_{1c} levels between black and white respondents and between Latino and white respondents. In unadjusted analyses, black respondents on average had HbA_{1c} levels 0.85%

higher than white respondents; the fully adjusted model accounted for 14.0% of this disparity (the black-white HbA_{1c} difference was 0.73% in the full model). For Latino respondents, the full model accounted for 19.0% of the ethnic disparities (unadjusted differences in HbA_{1c} were 0.92% vs 0.74% in the full model). The percentage of explained variation in HbA_{1c} levels increased from 0.06% with just race in the model to 22.0% in the fully adjusted model. In the fully adjusted linear regression model (Table 3, model 5), the independent variables associated with lower HbA_{1c} levels were white race/ethnicity, age older than 65 years, shorter diabetes duration, taking only oral medications compared with insulin, and being adherent to medications.

In fully adjusted linear regressions that also included respondents not taking medications (model $R^2 = 0.25$), the pattern of results was identical to that just described except that higher diabetes care self-efficacy also became independently associated with lower HbA_{1c} levels ($P < .05$).

Age-Stratified Analyses

In the fully adjusted linear regression model for respondents younger than 65 years, the black-white HbA_{1c} differential was 1.39% ($P < .05$), with the model explaining 33.0% of the variance in HbA_{1c} levels, whereas the differential was 0.33% for respondents 65 years or older, a difference that was not significant (model $R^2 = 0.12$). For Latino respondents, the pattern of age effects after full adjustment for potential confounders was similar. Among those younger than 65 years, the adjusted Latino-white HbA_{1c} differential was 0.92% ($P < .05$), and among respondents 65 years or older it was 0.57% ($P < .05$). In these fully adjusted models, insulin use, medication adherence, diabetes care self-efficacy, and diabetes-specific emotional distress were most significantly associated with HbA_{1c} levels. Among respondents younger than 65 years, lack of current health insurance was also independently associated with higher HbA_{1c} levels.

COMMENT

In this nationally representative 2003 sample of middle-aged and older Americans with diabetes, African American and Latino respondents had significantly worse glycemic control than white respondents. The disparities were especially marked in respondents younger than 65 years. Previously published national reports on racial/ethnic differences in HbA_{1c} values used data from the mid-1990s to 2000.^{4,6,13} In analyses we conducted of data from the National Health and Nutrition Examination Survey (NHANES) from 2003-2004,³⁰ mean HbA_{1c} levels in respondents 55 years or older were slightly lower but comparable with those found in this sample (in NHANES, mean HbA_{1c} levels were 6.74% in white patients, 7.57% in black patients, and 8.08% in Latino patients). These findings suggest that in middle-aged and older Americans we are still far from achieving the goal set by the Initiative to Eliminate Racial and Ethnic Disparities in Health to eliminate racial/ethnic differences in glycemic control by 2010.

Table 2. Characteristics of 1034 Study Participants Taking Antihyperglycemic Medications^a

Characteristic	White (n = 767)	Black (n = 165)	P Value ^b	Latino (n = 102)	P Value ^b
Age, y, % (SE)					
55-64	31.60 (2.72)	41.20 (6.21)	.13	41.70 (7.54)	.17
≥ 65	68.50 (2.72)	58.80 (6.21)		58.30 (7.54)	
Male sex, % (SE)	54.20 (2.03)	28.57 (3.65)	<.001	44.91 (5.91)	.11
Education, % (SE)					
< High school	25.0 (2.00)	58.11 (5.10)	<.001	70.18 (6.44)	<.001
High school	38.55 (2.14)	20.58 (2.63)		11.16 (3.14)	
> High school	36.48 (2.08)	21.32 (4.10)		18.66 (6.16)	
Annual household income, mean (SE), \$	52 218 (3043)	32 342 (3616)	<.001	35 382 (4410)	.002
Antihyperglycemic regimen, % (SE)					
Oral medications only	26.91 (1.74)	19.61 (3.88)	.04	25.37 (6.57)	.96
Oral medications and daily blood glucose testing	46.17 (2.51)	41.75 (4.47)		46.27 (5.56)	
Insulin	26.92 (2.00)	38.64 (4.80)		28.37 (6.57)	
Taking > 1 antihyperglycemic medication	20.83 (2.07)	17.59 (3.87)	.50	26.79 (6.27)	.35
Taking > 1 daily dose of insulin	19.64 (1.53)	23.63 (6.80)	.47	20.21 (2.28)	.64
Taking insulin and metformin	7.12 (1.06)	4.14 (1.45)	.15	6.63 (2.32)	.85
Taking insulin and a thiazolidinedione	5.51 (1.18)	7.1 (1.71)	.47	5.62 (2.33)	.96
Hemoglobin A _{1c} , mean (SE), % of total hemoglobin ^c	7.22 (0.06)	8.07 (0.24)	.001	8.14 (0.28)	.002
Hemoglobin A _{1c} > 8.0%, % (SE), % of total hemoglobin	18.20 (1.56)	37.75 (4.60)	<.001	44.10 (7.90)	<.001
Diabetes duration, mean (SE), y	10.72 (0.38)	10.84 (0.97)	.90	12.81 (1.62)	.21
Diabetes comorbidities TIBI score (range, 0-100), mean (SE) ^d	38.0 (1.00)	43.70 (2.20)	.02	38.84 (2.16)	.70
Depression CES-D score (range, 0-8), mean (SE) ^d	1.77 (0.10)	2.41 (0.27)	.02	2.55 (0.33)	.03
No insurance at 2002 wave, % (SE)	3.28 (0.77)	5.22 (2.39)	.31	18.07 (5.45)	<.001
Duration with diabetes care provider, mean (SE), y	3.35 (0.04)	3.26 (0.11)	.43	3.13 (0.12)	.09
Perceived poor quality of diabetes health care score (range, 1-5), mean (SE) ^d	2.85 (0.04)	3.05 (0.12)	.09	3.28 (0.12)	.001
Received a hemoglobin A _{1c} test in the past year, % (SE)	85.43 (1.45)	80.03 (4.37)	.19	73.28 (5.14)	.009
Total physical activity per week, standardized, mean (SE), min ^e	297.72 (13.30)	196.2 (24.50)	<.001	385.60 (43.33)	.06
Healthy diet score (range, 0-7), mean (SE), No. of days in past week	5.04 (0.04)	4.90 (0.14)	.39	5.07 (0.11)	.81
Diabetes self-management score (range, 0-100), mean (SE) ^f	78.43 (0.62)	77.15 (1.07)	.30	78.05 (1.65)	.82
Diabetes care self-efficacy score (range, 1-4), mean (SE) ^f	3.88 (0.04)	3.88 (0.11)	.98	3.92 (0.12)	.74
Diabetes-specific distress scale score (range, 1-5), mean (SE) ^d	1.70 (0.03)	1.82 (0.07)	.12	1.98 (0.08)	.001
Medication adherent in typical week, % (SE)	66.14 (1.97)	55.41 (5.61)	.05	66.0 (7.14)	.99
Reported cutting back on medications because of cost, % (SE)	9.76 (1.45)	14.92 (4.49)	.23	18.63 (6.29)	.10

Abbreviations: CES-D, Center for Epidemiologic Studies–Depression Scale; TIBI, Total Illness Burden Index.

^aThe sample contained 1034 respondents who were taking medication and had valid hemoglobin A_{1c} scores, nonzero weights, and no missing data on the variables in the table. All estimates are weighted using appropriate sample weights. Because of rounding, percentages may not equal 100.

^bThe P values show the significance of bivariate comparisons of black respondents compared with white respondents and Latino respondents compared with white respondents using χ^2 tests for dichotomous and categorical variables and generalized linear models for continuous variables.

^cHemoglobin A_{1c} values were obtained from blood kits mailed to survey respondents.

^dFor these measures, higher scores reflected more diabetes-related comorbidities, more depressive symptoms on the CES-D, worse evaluations of the quality of received diabetes health care, and more diabetes-specific distress on the Problem Areas in Diabetes scale.

^eMinutes of activity per week standardized to minutes of a low-intensity activity (such as walking). Respondents were asked to report the number of sessions per week and the average amount of time per session doing a variety of activities, including exercise and household chores, in the past 2 weeks. Higher-intensity activities were given larger weights so that the total number of physical activity minutes in the standardized measure represents the number of minutes per week of the lowest-intensity activity.

^fFor these measures, higher scores reflected better diabetes self-management and higher diabetes care self-efficacy.

The present study builds on past research in several ways. Previous studies have not reported analyses stratified by whether respondents are taking antihyperglycemic medications. We found no significant racial/ethnic disparities in respondents who reported not being prescribed any antihyperglycemic medications, and these respondents overall had significantly lower HbA_{1c} levels than respondents taking medications. Among respondents taking medications, we also found significant differences

across white, black, and Latino respondents in characteristics found in previous research to contribute to disparities in health care and outcomes. Diabetes outcomes have been shown to be worse in those of lower socioeconomic status,^{39,40} in those with impaired access to quality health care,^{1,9,41,42} and for racial/ethnic minorities compared with white patients in multiple health care settings with uniform health coverage.^{11,42-44} The present findings suggest that racial differences in crucial self-

Table 3. Regression Models for Cumulative Effect of Different Factors on Racial/Ethnic Differences in Mean Hemoglobin A_{1c} Levels in 1034 Respondents Taking Antihyperglycemic Medications

Characteristic	Unadjusted	Model 1: Demographics + SES	Model 2: Model 1 + Clinical Characteristics	Model 3: Model 2 + Access and Quality	Model 4: Model 3 + Health Behaviors	Model 5: Model 4 + Adherence and Self-management Attitudes
Black race ^a	0.85 ^b	0.81 ^b	0.74 ^b	0.74 ^b	0.73 ^b	0.73 ^b
Latino race ^a	0.92 ^b	0.89 ^b	0.88 ^b	0.75 ^b	0.76 ^b	0.74 ^b
Age ≥65 y	-0.71	-0.63 ^b	-0.55 ^b	-0.43 ^b	-0.41 ^b	-0.33 ^b
Male sex	-0.19	-0.10	-0.09	-0.10	-0.12	0.11
Education category	-0.03	0.04	0.05	0.04	0.05	0.03
Log income	-0.03	0.04	0.04	0.06	0.06	0.06
Medication regimen	0.58 ^b	NA	0.46 ^b	0.48 ^b	0.49 ^b	0.46 ^b
Diabetes duration, y	0.03 ^b	NA	0.02 ^b	0.01 ^b	0.02 ^b	0.02 ^b
Diabetes comorbidities (TIBI scale) ^c	0.01 ^b	NA	0.002	0.001	-0.0002	-0.003
CES-D depressive symptoms ^c	0.04	NA	-0.02	-0.03	-0.03	0.04
No current health insurance	1.35 ^b	NA	NA	0.93 ^d	0.93 ^d	0.87 ^d
Duration with diabetes care provider	-0.09	NA	NA	-0.05	-0.05	-0.05
Poor quality of diabetes health care ^c	0.08	NA	NA	0.01	0.008	0.04
Received hemoglobin A _{1c} test in past 12 mo	0.10	NA	NA	0.07	0.07	0.13
Total minutes of physical activity (standardized) ^e	-0.05	NA	NA	NA	-0.04	-0.004
Days of healthy diet during the previous 7 days	-0.09 ^d	NA	NA	NA	-0.08 ^d	-0.03
Overall assessment of diabetes self-management ^f	-0.01 ^b	NA	NA	NA	NA	-0.003
Diabetes self-efficacy ^f	-0.20 ^b	NA	NA	NA	NA	-0.16 ^d
Diabetes-specific distress scale (PAID) ^c	0.39 ^b	NA	NA	NA	NA	0.15 ^d
Overall medication adherence	-0.43 ^b	NA	NA	NA	NA	-0.24 ^b
Cut back on medications because of cost in 2002	0.70 ^b	NA	NA	NA	NA	0.29
R ²		0.11	0.18	0.20	0.20	0.22

Abbreviations: CES-D, Center for Epidemiologic Studies–Depression Scale; PAID, Problem Areas in Diabetes; SES, socioeconomic status; TIBI, Total Illness Burden Index.

^aThe regression β coefficients listed for these categories indicate the differences in mean hemoglobin A_{1c} values between respondents in these ethnic groups and white respondents, adjusting for the other covariates in the models. All estimates are weighted using appropriate sample weights.

^b $P < .05$.

^cFor these measures, higher scores reflected more diabetes-related comorbidities, more depressive symptoms on the CES-D, worse evaluations of the quality of received diabetes health care, and more diabetes-specific distress on the PAID scale.

^d $P < .10$.

^eMinutes of activity per week standardized to minutes of a low-intensity activity (such as walking). Respondents were asked to report the number of sessions per week and the average amount of time per session doing a variety of activities, including exercise and household chores, in the past 2 weeks. Higher-intensity activities were given larger weights so that the total number of physical activity minutes in the standardized measure represents the number of minutes per week of the lowest-intensity activity.

^fFor these measures, higher scores reflected better diabetes self-management and higher diabetes care self-efficacy.

management behaviors and attitudes that have not been comprehensively measured in previous national studies also contribute to racial disparities in glycemic control in middle-aged and older Americans, in particular, medication adherence in black patients and diabetes-specific emotional distress in Latino patients. In contrast, socioeconomic status, access, and health care quality variables, except for health insurance status in respondents younger than 65 years, were no longer independently associated with HbA_{1c} levels in the fully adjusted models.

Significant residual disparities in glycemic control persist even in the fully adjusted model, and the full model explains less than a quarter of the variance in HbA_{1c} levels. Potentially important unexplored mechanisms are genetic and other possible physiologic factors, such as stress,³ measures of treatment intensity that include actual antihyperglycemic medication dosages, and environmental variables.⁶ Whereas current research suggests suboptimal treatment intensification in diabetic patients of all ethnicities,^{4,45} further research should explore potential race-specific differences in provider intensification of an-

tiyperglycemic treatment or patient acceptance of more intensive treatment. The different patterns of disparities in glycemic control we found in the age-stratified analyses, with significantly greater racial/ethnic disparities in respondents younger than 65 years, raise additional questions that warrant further exploration.

The hypothesized mechanisms examined in this study only partially explained the significant racial/ethnic disparities in glycemic control occurring in these middle-aged and older Americans. However, the significant independent effect of medication adherence, and to a lesser extent of diabetes care self-efficacy and diabetes-specific emotional distress, reinforces the importance of these modifiable self-management attitudes and behaviors for glycemic control. In light of the lower rates of medication adherence in black respondents and of worse diabetes-specific emotional distress in Latinos, these findings provide useful insights for designing interventions to improve glycemic control in ethnic/racial minority groups. Such interventions should seek to understand and address the multiple barriers to medication adherence,

enhance self-efficacy, and address sources of diabetes-related emotional distress. For example, it is important to identify barriers to medications adherence that minority patients face, exploring possible factors such as less effective communication and education on medications from providers,⁴⁶ more external obstacles to adherence (eg, competing demands, lack of prescription drug coverage, and high out-of-pocket prescription medication costs),⁴⁷⁻⁴⁹ and possible differences in attitudes affecting medication use, such as confidence in the effectiveness of medications⁵⁰ or trust in health care providers.⁵¹ Well-designed interventions seeking to enhance patients' diabetes self-management and reduce diabetes-specific emotional distress will further help elucidate the pathways contributing to racial/ethnic disparities in diabetes outcomes.

Several limitations of this study should be highlighted. All independent variables were based on respondents' self-report and thus may be subject to specification problems and, especially for the adherence measures, social desirability bias. There is no evidence to suggest, however, that different racial/ethnic groups are more susceptible to such bias than others. Moreover, the insurance measures are not sensitive to detecting differences in the extent of insurance to ascertain underinsurance, which is more prevalent in racial/ethnic minorities. Second, the present study was cross-sectional and thus can only suggest associations and not causality. Finally, respondents were significantly more likely to have higher incomes and more education, to be white, and to report better health than nonrespondents. Thus, although we included weights for nonresponse, respondents at greater risk for worse diabetes severity were less likely to participate in this study, and only 52.5% of the sampled population returned their HbA_{1c} kits.

In conclusion, black and Latino adults taking diabetes medications had worse glycemic control than their white counterparts in this national sample of older Americans. Key self-management attitudes and behaviors exerted a more significant independent effect on glycemic control than sociodemographic and health care quality and access variables. These findings suggest useful targets for interventions seeking to reduce racial/ethnic disparities and to improve overall diabetes outcomes. However, this extensive set of socioeconomic, clinical, health care, and self-management measures still explained only a small portion of the racial/ethnic disparities in glycemic control. The major contributors to these large and recalcitrant disparities in glycemic control remain elusive.

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