# DIABETES RISK, DIAGNOSIS, AND CONTROL: DO PSYCHOSOCIAL FACTORS PREDICT HEMOGLOBIN A1C DEFINED OUTCOMES OR ACCURACY OF SELF-REPORTS?

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**Objective:** To evaluate the accuracy of self-reported diabetes among multi-ethnic older adults by psychosocial factors and assess predictors of diabetes risk, diagnosis, and control.

**Design and Methods:** The 2006 Health and Retirement Study ($N$=5,594) was used to determine agreement between self-reported diabetes and measured diabetes (HbA1c≥ 6.5%) by age, sex, race/ethnicity, nativity, education, health insurance coverage, body mass index, depressive symptoms, and prior report of racial discrimination. We also examined associations between these factors and pre-diabetes (HbA1c ≥6.0–<6.5%) among individuals without diabetes, and those with undiagnosed and poorly controlled (HbA1c ≥8.0%) diabetes.

**Results:** Accuracy of self-reported diabetes was good (ie, sensitivity ≥ 80% and specificity ≥ 95%) among all demographic subgroups and across most social strata. Among those who reported racial discrimination, sensitivity of self-reported diabetes was lower among Blacks who reported racial discrimination in comparison to Blacks who did not report racial discrimination (82.7% vs 89.0%) an association that was marginally statistically significant ($P$=.05). Blacks and Hispanics had higher odds of pre-diabetes, undiagnosed diabetes, and poor glycemic control.

**Conclusions:** Self-reported diabetes corresponded well with HbA1c assessed disease for all social strata examined in this sample of multi-ethnic older adults. Blacks with a history of racial discrimination may be less likely to know diabetes status. (*Ethn Dis*. 2014; 24[1]:19–27)

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## INTRODUCTION

Several large-scale chronic disease surveillance and population-based studies rely upon self-report of outcomes such as diabetes to describe and monitor population health status.[1–4] Although the accuracy of self-reports may be compromised by several factors including undiagnosed disease, ability to recall diagnoses, willingness to report, and accessibility to health services,[5] validation studies of self-reported diabetes conducted in the United States and Europe have suggested moderate to good accuracy.[5–17] These studies have primarily focused on the accuracy of self-reported diabetes by demographic characteristics such as age, sex, and education. To our knowledge, one European study examined the accuracy of self-reported diabetes by ethnicity (ie, Turkish, Surinamese and Dutch).[11] Results from this study suggested that self-reports of diabetes among an ethnic minority (Surinamese) group were less accurate in comparison to the ethnic majority group (Dutch). However, studies assessing the accuracy of self-reported diabetes by race, ethnicity, or nativity in the United States are not as well-described as other demographic characteristics. Moreover, studies examining validity of self-reports do not typically assess the influence of psychosocial factors such as perceived racial discrimination and depression. These factors, which have been associated with barriers to seeking medical care, less trust in providers, and lower usage of preventive care,[18–21] may cause underdiagnosis and lead to underreporting.

Adequate management of diabetes requires adherence to a complex array of self-care management behaviors such as monitoring dietary intake, engaging in physical activity, taking prescribed medications, and frequent medical check-ups. Psychosocial factors such as depression and perceived discrimination may present obstacles to preventing diabetes and effective management among Blacks and Latinos. For example, depression, which is a significant predictor of pre-diabetes, decreased adherence to self-care behaviors and prescribed medications, and poorer glycemic control,[22–24] has been demonstrated to be more strongly associated with inadequate diabetes control among Blacks in comparison to Whites.[25] Research examining perceived racial discrimination and diabetes self-management behaviors found mixed results; some studies have shown a positive association with select self-management behaviors,[26] while others have not demonstrated an association.[1] Further, report of discrimination in health care was associated with higher HbA1c levels.[27] However, perceived racial discrimination as a risk factor for pre-diabetes, particularly among older adults, has not been addressed in previous studies. Identifying psychosocial factors that reduce effective diabetes management can help improve delivery of medical care and design of patient-centered interventions to improve outcomes.

In addition to its use as an indicator of diabetes control, HbA1c has now been adopted by the American Diabetes Association as an appropriate measure to screen for and diagnose type 2

diabetes.[28] It has been demonstrated that the HbA1c threshold of 6.5% performs well as a diagnostic tool when compared to stringent clinical definitions of diabetes.[16,17] Comparing the accuracy of self-reported diabetes to the recently adopted guidelines is important for the interpretation of evidence from major studies that rely on self-reported diabetes for surveillance or etiologic research. For example, the Health and Retirement Study, one of the largest and longest running longitudinal panel studies of older adults, is extensively used to examine health outcomes, health disparities, and health transitions among middle aged and older Americans. Although the survey has been conducted biennially since 1992, HbA1c biomarker data were collected among selected subsamples in only a few years. Due to the absence of longitudinally collected biomarkers for diabetes, researchers must often rely upon self-reported data to study determinants of diabetes incidence, prevalence, and disparities.[3,29,30]

The objective of our study was to assess sensitivity and specificity of self-reported diabetes in an older multiethnic population, using the newly recommended HbA1c criteria and determine whether selected psychosocial factors influenced accuracy of self-report. In addition, the factors that may compromise the validity of self-reported diabetes information may also predict pre-diabetes (indicating likely progression to diabetes), undiagnosed diabetes and poorly controlled diabetes among diabetics. However, there has been relatively little research examining psychosocial predictors of pre-diabetes, and almost none conducted within nationally representative samples of older adults.[31] Towards this end, we additionally examined psychosocial predictors of pre-diabetes and undiagnosed and poorly controlled diabetes. We hypothesized that racial/ethnic differences in these conditions would be in part explained by depression and perceived racial discrimination.

# METHODS

## Study Population

The Health and Retirement Study (HRS) is a longitudinal biennial-interview study of a nationally representative sample of non-institutionalized US adults born between 1931–1941. Initiated in 1992, study participants complete a comprehensive battery of questions related to physical health and functioning, cognition, disability, socioeconomic factors, and health care expenditures. The original response rate was 81.4% and response rates for subsequent waves have been between 85–90%. Details of the sample design, recruitment, and measurement validation have been documented elsewhere.[32,33]

The 2006 HRS wave included the core interview, an enhanced face-to-face interview that entailed a collection of selected biomarkers (ie, HbA1c and blood lipid levels), physical performance measures, and a leave-behind questionnaire assessing psychosocial factors (ie, indicators of social support, religiosity, and experiences of everyday discrimination). A random sample of households was preselected for the enhanced face-to-face interview; 8,392 age-eligible participants were randomly selected from the full age-eligible HRS cohort for participation in the biomarker assessments and 6,507 (77.6%) had valid HbA1c data. We excluded respondents who self-identified race/ethnicity as other or whose race/ethnicity was missing ($n=344$). Respondents were also excluded from the analyses if information on self-reported diabetes ($n=47$) or discrimination ($n=522$) was missing or incomplete, yielding a final analytic sample of 5,594 respondents.

## Measures

Self-reported diabetes was based on the question: ''Has a doctor ever told you that you have diabetes or high blood sugar?'' Respondents who reported a diabetes diagnosis were additionally asked the following two questions: ''In order to treat or control your diabetes, are you now taking medication that you swallow?'' and ''Are you now using insulin shots or a pump?'' Individuals who responded yes to either question about medication were coded yes for diabetes medication use. As the reference standard for diabetes, a definition based on HbA1c values ≥6.5% and/or self-report of current medication use was constructed. Blood acquisition and determination was performed using kits from Biosafe Laboratories (Chicago, Il). Based on the recent recommendations, participants were classified as normal (HbA1c <6.0); pre-diabetes, high-risk for progressing to diabetes (HbA1c ≥6.0–<6.5%); or diabetic (HbA1c ≥6.5%).[28] Poor glycemic control among individuals with diabetes was defined as HbA1c ≥8.0%.[34]

Other variables included in analyses were sex (male, female), age (<65, ≥65), and educational attainment (<high school, ≥high school graduate) and health insurance (insured, uninsured). Three race/ethnicity groups were considered: Hispanics, non-Hispanic Whites, and non-Hispanic Blacks. Place of birth was dichotomized into US- and foreign-born. Body mass index (BMI) was categorized normal, overweight, or obese. A modified Center for Epidemiologic Studies Depression (CES-D) scale was used to measure depressive symptoms. Respondents were asked whether they had experienced one of eight symptoms (I felt depressed; I felt that everything I did was an effort; my sleep was restless; I could not get going; I felt lonely; I enjoyed life; I felt sad; I was happy) much of the time in the past week. Affirmative responses (with the two items of positive affect being reverse coded) were summed; total scores ranged between 0 and 8, and higher scores reflected more depressive symptoms. Scores were dichotomized (<3, ≥3) because prior analysis indicated this threshold best corresponded with the Composite International Diagnostic Interview short

form.[35] Self-reported everyday racial discrimination was assessed based on the frequency of occurrence of five events: treated with less courtesy or respect than others; received poorer services than others; threatened or harassed; people act afraid of you; think you are not smart.[36] Response options ranged from 1 (never) to 6 (almost every day) with a higher score indicating more frequent exposure to discrimination. Respondents were asked to ascribe reasons for the differential treatment; individuals indicating race as a response to at least one event were coded as having experienced racial discrimination.

### Analytic Plan

The validity of self-reported diabetes was assessed by calculating sensitivity (fraction of people with biomarker criterion-based diabetes who self-report a diagnosis) and specificity (fraction of people without biomarker criterion-based diabetes who do not self-report a diagnosis). We compared sensitivity and specificity for each racial/ethnic group stratified by age, sex, educational attainment, nativity, depressive symptoms, and racial discrimination. Three separate multiple logistic regression models were used to examine factors associated with elevated HbA1c among non-diabetics, poor glycemic control among diabetics, and undiagnosed diabetes. Model 1 adjusted for race/ethnicity, age, sex, nativity, educational attainment, health insurance, and BMI. Model 2 adjusted for variables in Model 1 and additionally adjusted for racial discrimination. Model 3 adjusted for variables in Model 1 and additionally adjusted for depressive symptoms. Model 4 adjusted for variables in Model 1 and additionally adjusted for depressive symptoms and racial discrimination. All models were adjusted to account for the complex multistage, clustered sample design and nonresponse. Analyses were conducted using SAS 9.2.[37]

## RESULTS

Characteristics of the study population are summarized in Table 1. Blacks and Hispanics represented 11.6% and 6.5%, respectively, of the total population. The crude prevalence of diabetes as defined by a biomarker-based criterion was higher among Hispanics (36.5%) and Blacks (32.8%) than among Whites (17.2%). Blacks (5.2%) and Hispanics (5.3%) were more likely to have biomarker-identified diabetes but not self-report a diagnosis in comparison to Whites (2.5%). Among individuals who did not meet the biomarker-based criterion for diabetes, Blacks (18.8%) and Hispanics (17.6%) were more likely than Whites (9.9%) to have elevated HbA1c (indicating a higher risk for developing diabetes). Among diabetics, Blacks and Hispanics were also at greater risk of elevated HbA1c compared to Whites.

Sensitivity was high overall, 85.9%, 87.9%, and 86.5% for Blacks, Hispanics, and Whites, respectively, and high in each of the specific categories examined (Table 2). Among Blacks, sensitivity was lower among individuals who reported experiencing racial discrimination than those who did not (82.7% vs 89.0%, $P=.0505$ for test of difference in sensitivity by racial discrimination). The specificity of self-reported diabetes was also high for all racial/ethnic groups. Specificity was similarly high (>95%) across nearly all social factors examined, including within race/ethnicity by age, sex, nativity, educational attainment, depressive symptoms, and report of racial discrimination. The only exception was specificity of 91.7% among Hispanics with a self-reported history of racial discrimination.

Among non-diabetics, after adjusting for sociodemographic characteristics, depressive symptoms and BMI, Blacks (OR=2.07; 95% CI: 1.48, 2.89) and Hispanics (OR=2.20; 95% CI: 1.24, 3.94) had higher odds of prediabetes compared with Whites (Model 3, Table 3). Additional adjustment for racial discrimination and depressive symptoms did not attenuate the elevated ORs for pre-diabetes among Blacks and Hispanics. Older age was consistently associated with pre-diabetes.

Table 4 depicts the adjusted association between undiagnosed diabetes and participant characteristics. Blacks had 1.81 times the odds of undiagnosed diabetes compared to Whites. Adjustment for racial discrimination and depressive symptoms changed the point estimates very little, although the CI widened and included the null in the fully adjusted model. In fully adjusted models, Hispanics had elevated odds of undiagnosed diabetes compared to Whites.

Among individuals with diabetes, age was an independent predictor of glycemic control. Black and Hispanic race/ethnicity were strong predictors of poor control after adjusting for sociodemographic factors, racial discrimination and depressive symptoms.

## DISCUSSION

To our knowledge, this is the first study investigating accuracy of self-reported diabetes by race, ethnicity, and nativity using recently recommended HbA1c criteria and the first study to assess whether accuracy is lower in highly vulnerable subgroups such as individuals with a history of racial discrimination or elevated depressive symptoms. In this diverse, national sample of older adults, we observed that self-reported diabetes had very good correspondence with HbA1c. Self-reports performed well for all subgroups and were unaffected by key demographic and social factors with the possible exception of racial discrimination among Blacks. Finally, despite stark racial/ethnic disparities in diabetes prevalence, risk, and poor control, neither history of racial discrimination nor depressive symptoms predicted these outcomes.

**Table 1. Sample characteristics and diabetes status by race/ethnicity**

| Characteristics | Blacks | | Hispanics | | Whites | |
|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % |
| Total[a] | 649 | 11.6 | 362 | 6.5 | 4583 | 81.9 |
| Age | | | | | | |
| <65 | 274 | 42.2 | 151 | 41.7 | 1683 | 36.7 |
| ≥65 | 375 | 57.8 | 211 | 58.3 | 2900 | 63.3 |
| Sex | | | | | | |
| Male | 214 | 33.0 | 149 | 41.2 | 1929 | 42.1 |
| Female | 435 | 67.0 | 213 | 58.8 | 2654 | 57.9 |
| Nativity | | | | | | |
| US-born | 616 | 94.9 | 166 | 45.9 | 4413 | 96.3 |
| Foreign-born | 33 | 5.1 | 196 | 54.1 | 170 | 3.7 |
| Educational attainment | | | | | | |
| <HS | 240 | 37.0 | 201 | 55.5 | 664 | 14.6 |
| ≥HS | 409 | 63.0 | 161 | 44.5 | 3898 | 85.4 |
| Health insurance | | | | | | |
| Uninsured | 46 | 7.1 | 45 | 12.4 | 156 | 3.4 |
| Insured | 603 | 92.9 | 317 | 87.6 | 4427 | 96.6 |
| BMI | | | | | | |
| Normal | 130 | 20.2 | 70 | 19.7 | 1445 | 31.9 |
| Overweight | 214 | 33.3 | 140 | 39.3 | 1750 | 38.6 |
| Obese | 299 | 46.5 | 146 | 41.0 | 1339 | 29.5 |
| Diabetes medication use[b] | | | | | | |
| Yes | 177 | 89.4 | 110 | 89.4 | 650 | 81.0 |
| No | 21 | 10.6 | 13 | 10.6 | 153 | 19.0 |
| Depressive symptoms | | | | | | |
| CES-D <3 | 439 | 67.6 | 224 | 61.9 | 3639 | 79.4 |
| CES-D ≥3 | 210 | 32.4 | 138 | 38.1 | 944 | 20.6 |
| Racial discrimination | | | | | | |
| Yes | 305 | 47.0 | 72 | 19.9 | 118 | 2.6 |
| No | 344 | 53.0 | 290 | 80.1 | 4465 | 97.4 |
| Outcomes | | | | | | |
| Pre-diabetes ($HbA_{1c}$ = 6.0–6.5%) | 75 | 18.8 | 38 | 17.6 | 357 | 9.9 |
| Self-reported diabetes | 199 | 30.7 | 123 | 34.0 | 803 | 17.5 |
| Biomarker criterion diabetes ($HbA_{1c}$ ≥6.5%)[c] | 213 | 32.8 | 132 | 36.5 | 787 | 17.2 |
| Undiagnosed diabetes | 34 | 5.2 | 19 | 5.3 | 114 | 2.5 |
| Uncontrolled diabetes ($HbA_{1c}$ ≥8.0%) | 29 | 6.0 | 33 | 9.1 | 74 | 1.6 |

[a] Sample size may not add up to 5,594 due to missing data.
[b] Diabetes medication use is only asked among respondents who reported a diabetes diagnosis.
[c] Based on biomarker criterion and/or use of medication (oral medications and insulin).

While few studies have used HbA1c to compare with self-reported diabetes, our results parallel the findings from previous validation studies that used impaired fasting glucose, impaired glucose tolerance test, or medical records as reference standards. The majority of previously published validation studies of diabetes conducted in the United States demonstrate relatively low levels of sensitivity among older adults, while reports of specificity tend to be higher.[6,15] The differences in sensitivity may be attributable to several factors including the reference standard chosen. An analysis of Atherosclerosis Risk In Communities (ARIC) participants validated prevalent self-reported diabetes and medication use against a diagnostic criterion based on HbA1c criteria and reported sensitivity of 59.4%,[16] considerably lower than the sensitivity observed in our study. The previous article did not evaluate variations in sensitivity by individual characteristics, but the lower sensitivity in their analysis may reflect the younger population or differences between this nationally representative sample and the four locations represented in the ARIC cohort.

Although diabetes is frequently assessed by self-report, to our knowledge, no prior study in the United States has evaluated validity of self-reported dia-

**Table 2. Sensitivity[a] and specificity of self-reported diabetes by race/ethnicity and participant characteristics**

| | Black | | Hispanic | | White | |
|---|---|---|---|---|---|---|
| | Sensitivity (%, CI) | Specificity (%, CI) | Sensitivity (%, CI) | Specificity (%, CI) | Sensitivity (%, CI) | Specificity (%, CI) |
| Total | 85.9 (81.2, 90.6) | 96.3 (94.5, 98.1) | 87.9 (82.3, 93.5) | 97.0 (94.7, 99.2) | 86.5 (84.2, 88.9) | 96.8 (96.2, 97.4) |
| Age | | | | | | |
| <65 | 85.7 (77.9, 93.5) | 95.9 (93.2, 98.7) | 84.3 (74.3, 94.3) | 97.0 (93.7, 100.0) | 89.4 (85.5, 93.3) | 97.9 (97.1, 98.6) |
| ≥65 | 86.0 (80.2, 91.9) | 96.7 (94.4, 98.9) | 90.1 (83.6, 96.6) | 96.9 (94.0, 99.9) | 85.3 (82.3, 88.3) | 96.1 (95.4, 96.9) |
| Sex | | | | | | |
| Male | 84.6 (75.8, 93.4) | 96.0 (92.8, 99.1) | 88.0 (79.0, 97.0) | 98.0 (95.2, 100.0) | 88.4 (85.2, 91.6) | 96.8 (95.9, 97.7) |
| Female | 86.5 (81.0, 92.0) | 96.5 (94.4, 98.6) | 87.8 (80.7, 94.9) | 96.2 (92.9, 99.5) | 84.8 (81.3, 88.3) | 96.8 (96.1, 97.5) |
| Nativity | | | | | | |
| US-born | 85.9 (81.2, 90.7) | 96.1 (94.2, 98.0) | 90.5 (83.2, 97.7) | 96.1 (92.4, 99.9) | 86.6 (84.2, 89.0) | 96.8 (96.2, 97.3) |
| Foreign-born | 85.7 (59.8, 100.0) | 100 | 85.5 (77.2, 93.8) | 97.6 (95.0, 100.0) | 85.2 (71.8, 98.6) | 97.2 (94.5, 99.9) |
| Educational attainment | | | | | | |
| <HS | 85.7 (78.2, 93.2) | 95.5 (92.3, 98.8) | 85.9 (78.2, 93.6) | 96.8 (93.6, 99.9) | 89.2 (84.2, 94.2) | 96.1 (94.5, 97.8) |
| ≥HS | 86.1 (80.1, 92.0) | 96.8 (94.7, 98.9) | 90.7 (83.0, 98.5) | 97.2 (94.1, 100.0) | 86.0 (83.3, 88.7) | 96.9 (96.3, 97.5) |
| Health insurance | | | | | | |
| Uninsured | 100 | 97.6 (87.1, 99.9) | 75.0 (53.4, 96.2) | 96.5 (82.2, 99.9) | 95.8 (78.9, 99.8) | 98.5 (94.6, 99.2) |
| Insured | 85.6 (80.0, 90.1) | 96.2 (94.3, 98.1) | 89.6 (83.8, 95.4) | 97.0 (94.6, 99.4) | 86.2 (83.4, 88.7) | 96.7 (96.2, 97.3) |
| BMI | | | | | | |
| Normal | 84.6 (65.1, 95.6) | 99.0 (94.6, 99.9) | 81.3 (54.3, 95.6) | 98.2 (90.1, 99.9) | 78.6 (70.9, 86.2) | 97.4 (96.5, 98.2) |
| Overweight | 81.0 (70.9, 91.1) | 95.5 (92.2, 98.8) | 86.7 (82.6, 90.9) | 95.8 (89.7, 98.8) | 86.7 (82.6, 90.9) | 96.9 (96.1, 97.8) |
| Obese | 89.1 (83.6, 94.4) | 95.3 (92.2, 98.5) | 85.9 (77.8, 94.0) | 97.3 (90.7, 99.6) | 89.9 (86.2, 90.9) | 95.5 (94.2, 96.8) |
| Depressive symptoms | | | | | | |
| CES-D <3 | 84.9 (78.7, 91.0) | 96.4 (94.3, 98.5) | 84.9 (76.7, 93.1) | 96.0 (92.9, 99.1) | 86.1 (83.3, 88.9) | 96.8 (96.1, 97.4) |
| CES-D ≥3 | 87.7 (80.5, 94.8) | 96.1 (92.8, 99.5) | 91.5 (84.4, 98.6) | 98.7 (96.3, 100.0) | 87.9 (83.3, 92.4) | 96.9 (95.7, 98.2) |
| Racial discrimination | | | | | | |
| Yes | 82.7 (75.4, 90.0) | 95.0 (92.0, 98.0) | 95.8 (87.8, 100.0) | 91.7 (83.9, 99.5) | 92.3 (82.1, 100.0) | 95.7 (91.5, 99.8) |
| No | 89.0 (83.1, 94.9) | 97.5 (95.4, 99.5) | 86.1 (79.6, 92.6) | 98.4 (96.5, 100.0) | 86.3 (83.9, 88.8) | 96.8 (96.3, 97.4) |

[a] Diabetes defined as HbA1c ≥6.5% or use of medication (oral medications and insulin) was used as the biomarker criterion standard.

betes against a biomarker criterion by nativity or race/ethnicity. Selvin and colleagues demonstrated no substantial differences between Blacks and Whites when comparing the test performance of HbA1c for diagnosis of prevalent diabetes or prediction of incidence diabetes;[17] however, the assessment of Hispanic ethnicity or foreign-born status was not included in the analysis. Our results are consistent with a prior study comparing validity of self-reported hypertension of US- vs foreign-born older adults where accuracy of self-reported hypertension was good in both groups.[38]

Racial/ethnic differences were observed in the influence of perceived racial discrimination and validity of self-reported diabetes. The sensitivity of self-reported diabetes was highest among Whites and Hispanics who reported discrimination but lowest among Blacks who reported such discrimination. The reasons for the observed relationship among Whites is not clear and may be spurious due to the small sample of Whites reporting racial discrimination and the multiple comparisons reported here. For Latinos, the aggregation of heterogeneous ethnic groups into one category may have introduced confounding, if both discrimination and diabetes reports differed between ethnic groups. For example, prior studies have found substantial differences in the reports of perceived racial discrimination, by Latino ethnic group.[39,40] Additionally, it has been suggested that experiences and the contextualization of discrimination differs substantially between Latinos and Blacks due to patterns of immigration.[40] Our findings of sensitivity differences in self-reported diabetes based on perceived discrimination should be interpreted cautiously until replicated given the marginal statistical significance. Nonetheless, health consequences associated with experiences of inter-personal discrimination have been documented.[41,42] Reports of discrimination may be associated with interpersonal processes of care including lower quality of patient and provider communication among patients with diabetes.[27] Reduced sensitivity of self-reports among individuals who experience racial discrimination may in part reflect delays in seeking or receiving care and therefore longer periods of undiagnosed diabetes. Although the difference in sensitivity by self-reported history of discrimination was marginally significant

**Table 3. Odds ratios and 95% confidence intervals[a] for patient characteristics associated with pre-diabetes[b] before and after adjusting for indicators of exposure to social stress**

| | Model 1[c] | | Model 2[d] | | Model 3[e] | | Model 4[f] | |
|---|---|---|---|---|---|---|---|---|
| **Characteristics** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** |
| Race/ethnicity | | | | | | | | |
| Blacks | 2.05 | 1.46, 2.88 | 2.35 | 1.52, 3.64 | 2.07 | 1.48, 2.89 | 2.37 | 1.53, 3.66 |
| Hispanics | 2.18 | 1.20, 3.96 | 2.28 | 1.26, 4.12 | 2.20 | 1.24, 3.94 | 2.31 | 1.30, 4.11 |
| Whites | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Age | | | | | | | | |
| <65 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| ≥65 | 2.27 | 1.69, 3.06 | 2.26 | 1.68, 3.04 | 2.14 | 1.62, 2.81 | 2.25 | 1.67, 3.04 |
| Sex | | | | | | | | |
| Male | .83 | .62, 1.11 | .83 | .62, 1.13 | .82 | .62, 1.10 | .83 | .61, 1.11 |
| Female | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Nativity | | | | | | | | |
| US-born | .92 | .81, 1.04 | .92 | .80, 1.05 | .92 | .81, 1.04 | .92 | .81, 1.05 |
| Foreign-born | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Educational attainment | | | | | | | | |
| < HS | .98 | .76, 1.28 | .99 | .77, 1.29 | 1.00 | .77, 1.30 | .99 | .76, 1.29 |
| ≥ HS | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Health insurance | | | | | | | | |
| Insured | .79 | .41, 1.51 | .78 | .41, 1.48 | .79 | .41, 1.50 | .78 | .41, 1.48 |
| Uninsured | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| BMI | | | | | | | | |
| Normal | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Overweight | 1.78 | 1.34, 2.35 | 1.77 | 1.35, 2.36 | 1.76 | 1.33, 2.34 | 1.78 | 1.34, 2.35 |
| Obese | 2.34 | 1.72, 3.19 | 2.34 | 1.71, 3.21 | 2.35 | 1.72, 3.20 | 2.35 | 1.72, 3.22 |
| Racial discrimination | | | | | | | | |
| Yes | | | .74 | .44, 1.26 | | | .74 | .44, 1.26 |
| No | | | 1.00 | | | | 1.00 | |
| Depressive symptoms | | | | | | | | |
| <3 | | | | | 1.00 | | 1.00 | |
| ≥3 | | | | | .90 | .65, 1.25 | .91 | .65, 1.26 |

[a] Blank cells in each row indicate the variable corresponding to the row was not included in the specific model.
[b] Analyses restricted to non-diabetic respondents (n=4,462) with biomarker-based criterion of diabetes.
[c] Model 1 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, and BMI.
[d] Model 2 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, and racial discrimination.
[e] Model 3 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, and depressive symptoms.
[f] Model 4 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, racial discrimination, and depressive symptoms.

among Blacks, the consequences for research are modest at the observed levels of sensitivity, specificity and prevalence.

It has been suggested that the expanded use of HbA1c to screen for and diagnose type 2 diabetes could potentially impact national surveillance estimates and trends of diabetes.[43] The prevalence estimates of diagnosed, undiagnosed, and poor control of diabetes in our study are fairly comparable with other studies.[34,43] We demonstrate that older Hispanics are at a disproportionate risk for undiagnosed diabetes; among non-diabetics, Blacks and Hispanics are more likely to have pre-diabetes elevated HbA1c and therefore high risk of progression to diabetes; and among diabetics, Blacks and Hispanics are more likely to have poor glycemic control. However our findings did not indicate that any of these outcomes was strongly associated with other indicators of exposure to psychosocial risk, including perceptions of racial discrimination or depressive symptoms. This suggests that the disparities observed may be in part explained by other racially patterned exposures such as residential segregation or neighborhood socioeconomic conditions.

A major strength of our study is the assessment of the accuracy of self-reported diabetes in a nationally representative, multi-ethnic population. Second, psychosocial risks such as perceived racial discrimination, which is typically not collected in large nationally representative datasets, were available to

**Table 4. Odds ratios and 95% confidence intervals[a] for patient characteristics associated with undiagnosed diabetes[b] and poor glycemic control (HbA1c ≥ 8) before and after adjusting for indicators of exposure to social stress**

| | Undiagnosed Diabetes | | | | | | | | Poor Glycemic Control | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1[c] | | Model 2[d] | | Model 3[e] | | Model 4[f] | | Model 1[c] | | Model 2[d] | | Model 3[e] | | Model 4[f] | |
| Characteristics | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Race/ethnicity | | | | | | | | | | | | | | | | |
| Blacks | 1.81 | 1.09, 3.03 | 1.74 | .95, 3.20 | 1.85 | 1.10, 3.11 | 1.76 | .95, 3.27 | 2.72 | 1.66, 4.45 | 2.99 | 1.67, 5.40 | 2.68 | 1.62, 4.41 | 2.88 | 1.63, 5.08 |
| Hispanics | 2.34 | 1.21, 4.52 | 2.31 | 1.16, 4.57 | 2.43 | 1.23, 4.77 | 2.38 | 1.19, 4.79 | 5.15 | 2.40,11.06 | 5.29 | 2.47,11.32 | 4.99 | 2.28,10.94 | 5.14 | 2.35, 11.24 |
| Whites | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Age | | | | | | | | | | | | | | | | |
| <65 | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| ≥65 | 1.49 | 1.04, 2.15 | 1.50 | 1.04, 2.16 | 1.47 | 1.02, 2.14 | 1.48 | 1.02, 2.15 | .67 | .45, .96 | .65 | .39, .97 | .59 | .40, .87 | .66 | .46, .96 |
| Sex | | | | | | | | | | | | | | | | |
| Male | 1.09 | .74, 1.62 | 1.09 | .74, 1.62 | 1.07 | .72, 1.60 | 1.07 | .72, 1.59 | 1.35 | .97, 1.91 | 1.38 | .97, 1.97 | 1.36 | .96, 1.98 | 1.39 | .98, 1.99 |
| Female | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Nativity | | | | | | | | | | | | | | | | |
| US-born | .99 | .87, 1.12 | .97 | .85, 1.10 | .98 | .87, 1.12 | .99 | .87, 1.12 | .91 | .75, 1.11 | .90 | .76, 1.08 | .91 | .75, 1.10 | .93 | .78, 1.11 |
| Foreign-born | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Educational attainment | | | | | | | | | | | | | | | | |
| <HS | 1.19 | .75, 1.89 | 1.22 | .77, 1.92 | 1.32 | .87, 2.01 | 1.23 | .79, 1.94 | 1.03 | .57, 1.84 | 1.09 | .68, 1.82 | 1.00 | .55, 1.83 | 1.00 | .54, 1.82 |
| ≥HS | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Health insurance | | | | | | | | | | | | | | | | |
| Insured | 1.22 | .48, 3.11 | 1.22 | .48, 3.09 | 1.21 | .48, 3.10 | 1.25 | .53, 3.08 | .40 | .23, .70 | .40 | .23, .70 | .39 | .22, .69 | .40 | .22, .70 |
| Uninsured | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| BMI | | | | | | | | | | | | | | | | |
| Normal | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Overweight | 1.18 | .69, 2.02 | 1.17 | .69, 2.01 | 1.17 | .69, 2.01 | 1.18 | .69, 2.01 | 1.73 | .92, 3.22 | 1.66 | .90, 3.10 | 1.67 | .90, 3.09 | 1.67 | .90, 3.10 |
| Obese | 1.91 | 1.18, 3.09 | 1.89 | 1.16, 3.07 | 1.91 | 1.18, 3.10 | 1.93 | 1.20, 3.11 | 4.41 | 2.41, 8.09 | 4.35 | 2.38, 7.96 | 4.30 | 2.34, 7.90 | 4.31 | 2.34, 7.93 |
| Racial discrimination | | | | | | | | | | | | | | | | |
| Yes | | | 1.07 | .56, 2.06 | | | 1.10 | .46, 2.17 | | | .871. | .51, 1.46 | | | .89 | .53, 1.49 |
| No | | | 1.00 | | | | 1.00 | | | | 1.00 | | | | 1.00 | |
| Depressive symptoms | | | | | | | | | | | | | | | | |
| <3 | | | | | 1.00 | | 1.00 | | | | | | 1.00 | | 1.00 | |
| ≥3 | | | | | .77 | .47, 1.26 | .78 | .47, 1.26 | | | | | 1.18 | .75, 1.87 | 1.19 | .76, 1.87 |

[a] Blank cells in each row indicate the variable corresponding to the row was not included in the specific model.
[b] Analyses for both outcome undiagnosed diabetes and poor glycemic control are restricted to diabetic respondents ($n$=1,132) with biomarker-based criterion of diabetes.
[c] Model 1 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, and BMI.
[d] Model 2 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, and racial discrimination.
[e] Model 3 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, and depressive symptoms.
[f] Model 4 adjusts for race/ethnicity, age, sex, nativity, educational attainment, health insurance, BMI, racial discrimination, and depressive symptoms.

evaluate the influence of these factors on accuracy of self-report and elevated diabetes risk. However, the results of this study should be interpreted in light of the following limitations. Due to the cross-sectional design of the study, we are unable to establish whether modifiable factors (eg, depressive symptoms or discrimination) causally affect each of our outcomes. However, to the extent that reverse causation is unlikely (diabetes does not cause race) and most of our findings indicate that social risk factors were independent of disease status, self-report of diagnosis, or control, this should not change major inferences from the study. HbA1c was considered the reference standard for verifying self-reports. Although HbA1c is increasingly used to screen and diagnose type 2 diabetes in the clinical setting, further follow-up tests are typically used for confirmation. We may have misclassified individuals who controlled diabetes solely by lifestyle modification. However, we do not think that this would have considerably altered the direction or magnitude of the results. The small sample sizes within specific subgroups, particularly among Whites and Hispanics who reported discrimination, may have resulted in imprecise estimates. Our analyses did not differentiate between incident and prevalent diabetes. Most importantly, many of the social categories we used, including race/ethnicity, are heterogeneous. For example, US Hispanics are highly diverse, and there is some evidence of important health differences based on country of origin. However, we did not have data to fully explore this heterogeneity.

While previous studies compared the accuracy of self-reported diabetes to biomarker-based criterion of diabetes or confirmed clinical medical diagnosis of diabetes assessed demographic characteristics such as age, sex, and educational attainment level, studies examining accuracy by race/ethnicity or nativity are limited. We demonstrated that self-reported diabetes corresponds well with the newly recommended guidelines of using HbA1c to diagnose diabetes. In the United States, where diabetes prevalence is increasing and outcomes are consistently patterned by race/ethnicity and nativity, elucidating factors contributing to differential diagnosis, risk, and control by race/ethnicity can inform potential modifications to delivery of care and help develop patient-centered interventions to improve diabetes recognition and management.

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