



Original Research Article

Validity of Type 2 Diabetes Self-Reports among Black and White Church Going Adults

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ABSTRACT

Background: There is a paucity of research evaluating the accuracy of type 2 diabetes (DM2) self-reports compared to laboratory measures for Blacks and Whites.

Objectives: The authors cross-sectionally compared DM2 self-reports to hemoglobin A1c (HbA1c), fasting plasma glucose (FPG), and a diabetes medication inventory order to evaluate the accuracy of self-reports to laboratory measures.

Methods: Data was collected as part of a community-based prospective cohort study of Black and White Seventh-day Adventist adults. Confirmed DM2 was defined as HbA1c \geq 6.5% or FPG \geq 126 mg/dL or use of hypoglycemic medications.

Results: There were 50 (12.7%) out of 394 participants with self-reported DM2. Blacks (19.6%, $n = 31$) reported significantly higher rates of DM2 compared to Whites (8.1%, $n = 19$). Detection of undiagnosed DM2 within the total sample population ranged from 2.3% to 6.7% with higher rates of undiagnosed DM2 for Blacks (2.4% to 11.0%) compared to Whites (2.3% to 4.1%). The sensitivity of self-reported DM2 ranged from 65.2% to 80.5% and the specificity ranged from 95.2% to 97.9%, depending on the diagnostic criteria.

Conclusions: Our findings add to the evidence that self-report is a relatively valid method for assessing DM2 with no observed ethnic differences.

Keywords: type 2 diabetes, self-report, Blacks, Whites, undiagnosed

INTRODUCTION

Investigators often utilize self-report measures when studying type 2 diabetes (DM2).^[1-3] Although there are advantages of self-report measures like low-cost and convenience, the specificity and sensitivity of self-reports when compared to laboratory measures like hemoglobin A1c (Hb1Ac) and

fasting plasma glucose (FPG) can vary by study and sample populations.^[4-7] From a public health perspective, it is important to determine the number of individuals with DM2 so that the at-risk population can be effectively targeted. It is estimated that 57 million U.S. adults have either pre-diabetes or diabetes.^[8] Diabetes overall is the fifth

leading cause of death by disease with approximately 1.9 million people newly diagnosed each year. Furthermore, Harris et al. found significant ethnic differences in rates of diabetes. [9] Non-Hispanic Blacks had 1.6 times the rate of diabetes of non-Hispanic Whites.

Although there have been studies on accuracy of DM2 self-report, [10,11] the quality of self-report and the degree of underreporting for Blacks have not been well described. El Fakiri, Bruijnzeels, and Hoes found no ethnic difference in DM2 self-report in their study of Dutch, Turkish, Surinamese, and other first generation ethnic minorities residing in two Dutch cities. [12]

However, their sample was recruited from primary care centers with patients that were at risk for cardiovascular disease. There is a need to examine self-report accuracy in a community sample that subscribes to healthier lifestyle choices whose DM2 rate may differ from an at risk population. In addition, given the ethnic disparity in DM2 rates, it is important to assess whether self-reports of DM2 are equally valid for different ethnic groups.

Given the paucity of research evaluating the accuracy of DM2 self-reports for Blacks and Whites, we compared DM2 self-reports to concurrent HbA1c, FPG, and hypoglycemic diabetes medication reports in Seventh-day Adventist church-going adults who participated in a community-based prospective cohort study. Adventists have many religiously based health behavior recommendations such as regular exercise, healthy diet, and abstaining from smoking or alcohol consumption. [13] These recommendations have been found to reduce morbidity and mortality as well as to promote a higher quality of life. [14-16] The combination of positive health behaviors observed in Adventists make them an optimal population to study ethnic differences in rates of DM2 self-report

accuracy as several other confounding variables are removed in this group. Thus, our study objectives were to examine the validity of self-reported DM2 among Seventh-day Adventist adults and evaluate whether there was any discrepancy in validity or prevalence of DM2 between Blacks and Whites.

MATERIALS AND METHODS

Participants and Procedures

Data for this study were collected in 2006-7 as part of the Biological Manifestations of Religion Substudy (BioMRS), which is part of the Adventist Health Study-2 (AHS-2), a longitudinal cohort study on diet and cancer as well as the Biopsychosocial Religion and Health Study (BRHS) where investigators examined the influence of religion/spirituality on health outcomes in a random sample of the AHS-2 who lived within a 60-mile radius of the university campus. [17,18] The Institutional Review Board at Loma Linda University approved the study and participants signed written, informed consent to participate. They completed a 20-page questionnaire assessing stress, physical, and mental health as well as a medication inventory and provided fasting blood samples to determine FPG and HbA1c.

For validation of self-reported DM2, we restricted the population to participants without missing data on DM2 self-report, FPG, and HbA1c. The other inclusion criterion was being either Black (African American, Caribbean Black, biracial) or White ethnicity. There were no statistically significant differences in demographic measures (age, gender, ethnicity, education, socioeconomic status), health behaviors (smoking history, body mass index, reported diabetes medication use), or laboratory measures (FPG, HbA1c) between the 78

participants who were excluded and the 394 who were included in the study.

Measures

Definition of self-reported type 2 diabetes.

Study participants were asked whether they were “*ever diagnosed with diabetes mellitus (type II adult onset) by a physician.*” If they answered “yes”, they were coded as having self-reported DM2; if they said “no” they were coded as not self-reporting DM2. Participants who did not answer this question were excluded from the analyses.

Reference definitions of type 2 diabetes.

Fasting plasma glucose and HbA1c were measured from eight-hour fasting blood samples. Fasting plasma glucose was assessed with the Cholestech LDX Analyzer. HbA1c was assessed from frozen fasting blood samples with a Cholestech GDX Analyzer. Diagnostic criteria for DM2 were defined using FPG \geq 126 mg/dL and/or HbA1c \geq 6.5% (American Diabetes Association; ADA, 2014). Participants who also reported the use of the following hypoglycemic diabetes medications were also identified as having DM2: Metformin (Glucophage), Glyburide, Glipizide, and Insulin. Three DM2 reference definitions were examined: (a) HbA1c \geq 6.5% and/or hypoglycemic diabetes medication; (b) FPG \geq 126 mg/dL and/or hypoglycemic diabetes medication; (c) HbA1c \geq 6.5%, FPG \geq 126 mg/dL, and/or reported use of hypoglycemic diabetes medication.

Type 2 diabetes diagnostic criteria include: HbA1c \geq 6.5%, or FPG \geq 126 mg/dL, or two-hour plasma glucose \geq 200 mg/dL, or if the person is symptomatic for hyperglycemia with a random plasma glucose \geq 200 mg/dL. [19] Of note, HbA1c measures the average blood glucose in the past three months, while FPG evaluates glucose levels after 8-hour fasting period.

Data Analysis

There are several important definitions to consider in determining the validity like true positive, true negative, false positive, and false negatives. True positives are participants who reported DM2 and diagnostically have DM2. True negatives refer to participants who did not report DM2 and are without DM2. False positives (type I error) are participants who self-report DM2 but diagnostically did not have DM2. False negatives refer to participants who reported no DM2 when in fact are diagnostically diabetic. This is also known as a type II error.

Self-reported diabetes was compared to each of the reference definitions of DM2 to determine sensitivity (probability of identifying true positives) and specificity (probability of diagnosing true negatives). Positive predictive value (PPV) was calculated by dividing the number of true positives/(true positives + false positives). Negative predictive value (NPV) was defined as true negatives/(true negative + false negatives).

Agreements between self-report diagnosis and medication inventories, HbA1C, and FPG were calculated using kappa statistics [20] with kappa value of < 0.40 indicative of poor to fair agreement, 0.41 to 0.60 as moderate agreement, 0.61 to 0.80 as substantial agreement, and 0.81 to 1.00 as excellent agreement. Baseline comparisons between those with versus without reported DM2 and Blacks versus Whites on demographic and clinical characteristics were assessed using *t*-tests for continuous variables and χ^2 for categorical variables. Analyses were performed using IBM SPSS-20 with *p*-value of <0.05 as the determinant of statistical significance.

RESULTS

The final sample consisted of 154 males (39.1%) and 240 females (60.9%)

with a mean age of 68.8 ($SD = 11.9$) and an age range of 36 to 96 years. Most participants were White, had little to no difficulties meeting expenses in the past year (91.1%, $n = 362$), were overweight, and within normal range in blood glucose measures, FPG < 126 mg/dL ($n = 368$, 93.4%) and HbA1c < 6.5% ($n = 345$, 87.6%). There were also a significant number of participants who met diagnostic criteria for pre-diabetes: FPG 100– 125 mg/dL ($n = 74$, 18.8%) and HbA1c 5.7– 6.4% ($n = 199$, 50.5%). Other demographic and laboratory characteristics of participants are shown in Table 1 along with comparisons between those with and without self-reported DM2. There were 50 (12.7%) participants with self-reported DM2. As shown in Table 2, depending on the diagnostic criteria the sensitivity of self-reported DM2 ranged from 65.2% to 80.5% and the specificity ranged from 95.2% to 97.9%.

Baseline differences between Blacks (40.1%, $n = 158$) and Whites (59.9%, $n = 236$) were also assessed. There were no significant differences in FPG and difficulty meeting expenses. Whites (71.9 years, $SD =$

12.0) on average were older than Blacks (64.5 years, $SD = 10.4$), $t(392) = 7.4$, $p < 0.001$. There were a higher percentage of Black females (68.4%, $n = 108$) compared to White females (55.9%, $n = 132$), $\chi^2(1, N = 394) = 6.1$, $p = 0.013$; and a greater number of Whites (52.1%, $n = 123$) with graduate degrees than Blacks (23.5%, $n = 37$), $\chi^2(3, N = 394) = 58.4$, $p < 0.001$. Blacks (19.6%, $n = 31$) reported higher rates of smoking history compared to Whites (8.1%, $n = 19$), $\chi^2(1, N = 394) = 11.4$, $p = 0.001$.

While both Blacks and Whites were on average within the overweight BMI (kg/m^2) category (25– 29.9), Blacks (29.8, $SD = 7.2$) had higher BMIs compared to Whites (25.9, $SD = 4.8$), $t(392) = 4.0$, $p < 0.001$. In fact, 75.9% of Blacks ($n = 120$) compared 50.8% of Whites ($n = 120$) had BMI ≥ 25 . Similar elevated rates were also observed for HbA1c values in Blacks (6.0%, $SD = 0.8$) versus Whites (5.8%, $SD = 0.4$), $t(392) = 4.3$, $p < 0.001$. There were 34 (21.5%) Blacks compared to 15 (6.4%) Whites with elevated HbA1c $\geq 6.5\%$, $\chi^2(1, N = 394) = 20.0$, $p < 0.001$.

Table 1. Characteristics of 394 Participants With and Without Self-Report Type 2 Diabetes

| | All Participants | | Self-Report Type 2 Diabetes | | | | p-value |
|-------------------------------------|------------------|-------------|-----------------------------|-------------|--------------|--------------|---------|
| | n(%) | Mean (SD) | No (n = 344) | | Yes (n = 50) | | |
| | | | n(%) | Mean (SD) | n(%) | Mean (SD) | |
| Age (years) | | 68.8 (11.9) | | 68.5 (12.1) | | 72.0 (10.5) | 0.06 |
| Female | 240 (60.9) | | 212 (61.6) | | 28 (56.0) | | 0.40 |
| White | 236 (59.9) | | 217 (63.1) | | 19 (38.0) | | 0.001 |
| <i>Level of education</i> | | | | | | | 0.101 |
| Trade, high school or less | 28 (7.1) | | 21 (6.1) | | 7 (14.0) | | |
| Associate's or some college | 115 (29.2) | | 96 (27.9) | | 19 (38.0) | | |
| Bachelor's degree | 91 (23.1) | | 86 (25.0) | | 5 (10.0) | | |
| Graduate degree | 160 (40.6) | | 141 (41.0) | | 19 (38.0) | | |
| Low socioeconomic status | 32 (8.1) | | 24 (7.0) | | 8 (16.0) | | 0.029 |
| No history of smoking | 50 (12.7) | | 35 (10.2) | | 15 (30.0) | | <0.001 |
| Body mass index (kg/m^2) | | 27.5 (6.2) | | 27.1 (6.1) | | 29.7 (6.1) | 0.006 |
| Hemoglobin A1c (%) | | 5.9 (0.6) | | 5.8 (0.4) | | 6.8 (1.2) | <0.001 |
| Fasting plasma glucose (mg/dL) | | 95.0 (19.9) | | 91.2 (13.0) | | 120.6 (35.0) | <0.001 |
| Hypoglycemic medication | 25 (6.3) | | 0 (0) | | 25 (50.0) | | <0.001 |

Notes. History of smoking = Reported history of regular cigarette, cigar, or pipe smoking. Hypoglycemic diabetes medications include Metformin (Glucophage), Glyburide, Glipizide, and Insulin. Low socioeconomic status referred to the number of participants who reported *somewhat, fairly, and very difficult* meeting expenses basic needs in the last year.

Blacks (19.6%, $n = 31$) self-reported significantly higher rates of DM2 compared to Whites (8.1%, $n = 19$). In regards to undiagnosed DM2 (false negative) within the total sample population ($n = 394$), it ranged from 2.0% to 5.8% depending on reference definition. There was a higher rate of undiagnosed DM2 for Blacks (2.4% to

11.0%) compared to Whites (2.3% to 4.1%). False positive (self-reported DM2 but had normal glucose measures) may be conceptualized as glycemic control. For those who reported DM2, 17 (34%) had FPG <126 mg/dL and 19 (38.0%) had HbA1c < 6.5%, indicative of good glycemic control.

Table 2. Validation of Self-Reported^a Type 2 Diabetes Status by Ethnicity

| Diagnostic Criteria ^b | Sensitivity % (95% CI) | Specificity % (95% CI) | Predictive Value | |
|---|---------------------------|---------------------------|------------------------|----------------------|
| | | | Negative % (95% CI) | Positive (95% CI) |
| <i>All Participants</i> | | | | |
| Hemoglobin A1c $\geq 6.5\%$ | 68.4 (55.5 – 79.0) | 96.7 (94.3 – 98.2) | 32.6 (22.3 – 47.9) | 21.0 (11.4 – 38.5) |
| Fasting plasma glucose ≥ 126 mg/dL | 80.5 (66.0 – 89.8) | 95.2 (92.4 – 97.0) | 20.5 (11.0 – 38.2) | 16.7 (10.3 – 27.2) |
| Both | 65.2 (53.1 – 75.5) | 97.9 (95.7 – 99.0) | 35.6 (25.6 – 49.5) | 30.5 (14.4 – 64.9) |
| <i>Blacks</i> | | | | |
| Hemoglobin A1c $\geq 6.5\%$ | 65.8 (49.9 – 78.8) | 95.0 (89.5 – 97.7) | 36.0 (23.1 – 56.1) | 13.2 (5.8 – 29.7) |
| Fasting plasma glucose ≥ 126 mg/dL | 87.0 (67.9 – 95.5) | 91.9 (86.0 – 95.4) | 14.2 (4.9 – 40.8) | 10.7 (5.9 – 19.2) |
| Both | 65.0 (49.5 – 77.9) | 95.8 (90.5 – 98.2) | 36.5 (23.9 – 55.8) | 15.3 (6.3 – 37.3) |
| <i>Whites</i> | | | | |
| Hemoglobin A1c $\geq 6.5\%$ | 73.7 (51.2 – 88.2) | 97.7 (94.7 – 99.0) | 26.9 (12.7 – 57.2) | 32.0 (12.9 – 79.2) |
| Fasting plasma glucose ≥ 126 mg/dL | 72.2 (49.1 – 87.5) | 97.3 (94.1 – 98.7) | 28.6 (13.6 – 60.2) | 26.2 (11.3 – 60.8) |
| Both | 65.4 (46.2 – 80.6) | 99.1 (96.6 – 99.7) | 34.9 (20.6 – 59.3) | 68.7 (16.8 – 280.5) |

Notes.^aSelf-reported type 2 diabetes (total $n = 394$, self-reported diabetes $n = 50$) was defined as “yes” if participants answered “yes” to “ever diagnosed with diabetes mellitus (Type II adult onset) by a physician?”

^bDiagnostic criteria include laboratory measures and/or use of hypoglycemic diabetes medications Metformin (Glucophage), Glyburide, Glipizide, and Insulin.

DISCUSSION

Our findings add to the evidence that self-report is a relatively valid method of assessing of DM2 in both Blacks and Whites. Depending on the reference definition, sensitivity ranged from 65.2% to 80.5% and specificity ranged from 95.2% to 97.9% for all participants. These rates are indicative of substantial to excellent agreement between self-report and DM2 reference definitions. FPG was more sensitive compared to other criterion; however, it was the lowest in specificity, PPV, and NPV. This could be attributed to the difference in plasma glucose measurement period between HbA1c (3 months) and FPG (8 hours). Utilizing HbA1c, FPG, and medication inventory together yielded the highest specificity, PPV, and NPV.

The specificity was highest for both Blacks and Whites when the diagnostic

criterion included all three measures (FPG, HbA1c, and medication) as predicted. The results from our study were consistent with other confirmatory studies of DM2 self-report. [10,21,22] However, most prior studies did not evaluate validity by ethnicity. In addition, other studies often relied upon a single source of diagnostic criteria while we examined three independently and in combination: HbA1c, FPG, and a hypoglycemic diabetes medication inventory allowing us to conclude that self-reported DM2 is a valid measure.

In this older, community sample of Adventist adults, the detection of undiagnosed DM2 was low. As expected and consistent with the literature, [23,24] there were higher rates of undiagnosed DM2 as well as diagnosed DM2 in Blacks than Whites. These ethnic differences in the prevalence of diagnosed and undiagnosed DM2 were also noted in a recent National

Health and Nutrition Examination Survey (NHANES) study.^[25] The participants in the NHANES study were younger, had higher BMI, and had slightly higher FPG than the participants in our sample. In the NHANES study, glycemic control was defined as HbA1c > 7.0%. All participants in this study had better glycemic control compared to the NHANES sample population, which exemplified the healthier nature of the Adventists compared to the general population. For this BioMRS study population, only 26.0% of self-identified DM2 had poor glycemic control (HbA1c > 7.0%). Similar rates of poor glycemic control were observed for Blacks (29.9%) and Whites (21.1%), and, these rates were significantly lower than the glycemic control in the NHANES population where 48.0% and 43.0% reported poor glycemic control respectively.

The strengths of our study included the validation of self-reports through multiple reference definitions and the comparative analysis of Blacks and Whites in an older, community based sample. Study limitations included possibly less generalizability of the findings given that we only examined Seventh-day Adventists who have a healthier lifestyle than the general U.S. population. Perhaps with their knowledge of diabetes status and/or reported medication use, some participants made positive changes in reducing their glucose levels.

CONCLUSION

In conclusion, findings indicate that self-report is an acceptable and valid assessment of DM2 in this community-based sample. Higher rates of diagnosed and undiagnosed DM2 were observed in Blacks compared to Whites. Of note, this sample population had better glycemic control compared to the general population and future studies can help identify the

mechanisms within the Seventh-day Adventist population that contribute to less diabetes and better diabetes management.

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