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High Prevalence of Undiagnosed Hyperglycemia in Low-Income Overweight and Obese Hispanic Women in Oregon

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Abstract

Background Overweight Hispanic women are at high risk for type 2 diabetes. A clinical diagnosis of hyperglycemia is often necessary to access interventions. We examined the prevalence of undiagnosed hyperglycemia among a group of low-income overweight or obese Hispanic women, who were receiving care at a Federally Qualified Health Center (FQHC).

Methods Among 196 overweight or obese Hispanic women (mean age 44 ± 10 years, mean weight 86.8 ± 16.5 kg, mean body mass index [BMI] 36.5 ± 6.4 kg/m^2) enrolled in a randomized clinical weight-loss trial, we compared A1C and fasting blood glucose (FBG) obtained at baseline with women's existing diabetes and prediabetes diagnoses in the medical record.

Results According to the information in participants' medical records, 36% (70/196) had diagnosed diabetes, 20% (39/196) had a diagnosis of prediabetes, and the remaining 44% (87/196) had neither diagnosis. Among participants without a diagnosis of diabetes or prediabetes during the baseline screening for our study, 63% (55/87) had at least one test in the prediabetes range (baseline A1C and FBG were in prediabetes range for 39 and 55 participants, respectively), and 13% (11/87) had at least one test in the diabetic range (baseline A1C and FBG values in diabetes range for 3 and 11 participants, respectively).

Discussion We found substantial prevalence of undiagnosed hyperglycemia among a sample of overweight and obese Hispanic women. It is possible that limited awareness of diabetes risk may be a barrier to patient compliance with screening recommendations.

Keywords Hispanic · Hyperglycemia · Diagnosis · Women's health · Underdiagnosis

Introduction

In the USA, rates of type 2 diabetes and prediabetes among adult Hispanics are disproportionately high compared with those of non-Hispanic whites [1], with prevalence more than two times higher among Hispanics [2]. Among individuals with prediabetes, Hispanics have a higher conversion rate to type 2 diabetes than non-Hispanic whites, [3] and among individuals with diabetes, Hispanics are less likely than non-Hispanic whites to meet hemoglobin A1C (A1C) recommended levels [4]. These trends are particularly troubling for Hispanic women, whose rates of obesity and diabetes and prediabetes have increased dramatically in the past 15 years [5, 6], and whose estimated lifetime risk of developing diabetes is the highest of all ethnic/gender groups in the USA [7]. Because excess body weight is an independent risk factor for type 2 diabetes, the American Diabetes Association (ADA) [8], the American Association of Clinical Endocrinologists [9], and the United States Preventive Services Task Force (USPSTF) [10] currently recommend screening for diabetes in all overweight or obese adults.

Data from the National Health and Nutrition Examination Survey (NHANES), which combines interviews and A1C, FBG, and 2-h plasma glucose (PG) tests, have shown a 10% prevalence rate of undiagnosed diabetes among Hispanic individuals, with a 35% prevalence rate of undiagnosed prediabetes [11]. The NHANES data are aggregate data for Hispanic

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individuals with and without health insurance, and of all levels of household income, and therefore may not represent rates of undiagnosed hyperglycemia among those at highest risk: low-income overweight or obese Hispanic women obtaining medical care at a safety net clinic.

Our study's objective was to examine the prevalence of hyperglycemia, as determined by A1C and FBG levels, among a group of overweight and obese Hispanic women receiving care at a Federally Qualified Health Center (FQHC), some of whom had diagnoses of prediabetes or diabetes recorded in the electronic medical record (EMR), and some of whom did not have a recorded diagnosis of either diabetes or prediabetes. We also compared these patients on age, BMI, and waist circumference.

Methods

Participants

This study was conducted with participants enrolled in a randomized pragmatic trial testing the efficacy of a weight-loss intervention targeting overweight and obese adult Hispanic women. Data used for the current analysis were collected at the baseline visit, prior to randomization. The study was conducted at the Virginia Garcia Memorial Health Center (VGMHC), an FQHC in Hillsboro, OR. Nearly 98% of VGMHC patients live in poverty (earning less than 200% of the federal poverty level) and approximately 60% of patients are Hispanic. Approximately 71% of patients are covered by Medicaid, Medicare, Oregon Health Plan, or private insurance. Services are provided on a sliding-scale basis and no one is turned away for inability to pay.

Eligibility criteria were age ≥ 18 years, Spanish-speaking Hispanic, female, body mass index (BMI) ≥ 27 kg/m^2, diagnosed with type 2 diabetes or prediabetes per International Classification of Diseases (ICD)-9 codes and/or inclusion of the diagnoses on patients' problem lists, or considered to be at risk for type 2 diabetes due to metabolic syndrome, high blood pressure, family history of diabetes, or history of gestational diabetes; and have had a clinic appointment in the last 18 months. Participants were excluded if they were treated for cancer in the past 2 years (excluding non-melanoma skin cancers), had conditions that require limitation of physical activity or that would be contraindicated for the DASH diet patterns, were on weight-loss medication currently or within the past 6 months, were currently or recently (< 12 months) pregnant or breastfeeding, or were planning pregnancy in the next 18 months.

We generated a list of potentially eligible patients from the EMR who met the inclusion criteria. We also recruited participants via posters placed in clinic exam rooms and through direct physician referral (see Fig. 1). From the EMR data pull, we identified 711 potentially eligible patients. We mailed these patients a recruitment letter, in Spanish, which described the study and invited them to call the study recruitment line. Whether in response to recruitment letters, posters, or physician referral, individuals who called the study line were contacted by telephone within the next 48 h, received a description of the study and, if interested, were invited to attend a group information session at the clinic. Bilingual study staff made at least three attempts via telephone to reach all eligible patients who did not respond to the recruitment letter.

During the information sessions, we explained the study and answered questions. Following confirmation of eligibility, interested patients provided written consent ($n = 208$) and were scheduled for a baseline data collection visit at the clinic after a 12-h fast. As shown in Fig. 1, eight consented participants did not attend the baseline data collection visit, and two more declined to participate in the study, with 200 participants completing the baseline clinic visit. During this visit, weight and height were recorded, and FBG and A1C were obtained as described below. All consented participants were cleared by their primary care provider at VGMHC for participation in this study. All study materials and procedures were approved by the Kaiser Permanente Northwest (KPNW) and VGMHC Institutional Review Boards.

Data Collection

During the baseline data collection visit, weight was measured using a standard protocol, with participants in light indoor clothes without shoes, and determined to the nearest 0.1 kg by a calibrated digital scale. Height was measured to the nearest 0.1 cm using a calibrated, wall-mounted stadiometer. Waist circumference was measured to the nearest 0.5 cm at the midpoint between the lower rib and the iliac crest using a Linen non-stretch tape measure with a tension device to provide a constant tension during measurement. Fasting blood glucose (FBG) was measured from capillary blood using a OneTouch Ultra blood glucose monitoring system (LifeScan, Inc., Milpitas, CA). A1C was measured from capillary blood using an A1CNow+ device (Bayer HealthCare LLC, Sunnyvale, CA), an FDA-approved and National Glycohemoglobin Standardization Program–certified instrument that accurately measures A1C in point-of-care settings [12]. Scales were recalibrated every 6 months. Blood testing devices were tested for quality control daily and recalibrated quarterly.

Measures

The study used the ADA's classification of A1C and FBG values indicative of type 2 diabetes and prediabetes as follows:

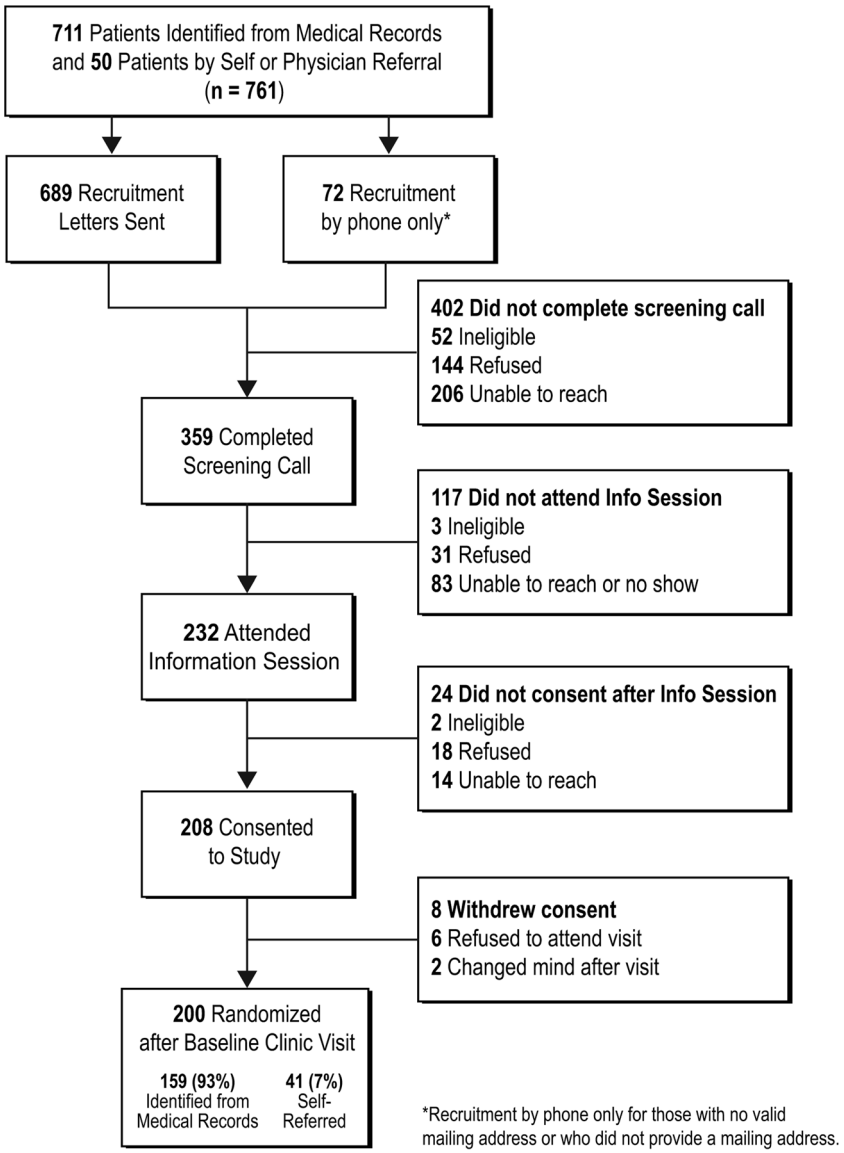

Fig. 1 Recruited participants

Normal range: FBG < 100 mg/dL; A1C < 5.7% (< 39 mmol/mol).
Prediabetes range: FBG 100–125 mg/dL; A1C 5.7–6.4% (39–47 mmol/mol).
Diabetes range: FBG ≥ 126 mg/dL; A1C ≥ 6.5% (≥ 48 mmol/mol).

Analysis

We created three groups based on a combination of A1C or FBG test results and EMR diagnosis: (1) diagnosed with diabetes or prediabetes in the EMR and having abnormal A1C or FBG results, (2) undiagnosed with diabetes or prediabetes in the EMR and having abnormal A1C or FBG results, and (3) undiagnosed with diabetes or prediabetes in the EMR and presenting normal A1C or FBG results. These groups were compared on age, BMI, waist circumference, and test results using a one-way ANOVA. Significant omnibus tests were followed up with post hoc tests using Scheffe adjustments for multiple comparisons to determine which pairs of groups differed from each other. All inferential tests were conducted at a two-tailed alpha level of .05.

The correspondence of the information in the EMR for enrolled study participants regarding diagnosis of diabetes, prediabetes, or neither diagnoses with the ADA classification based on FBG and A1C results was examined using cross-tabulation. The specific focus was on the degree of discordance in which there was an absence of diagnosed hyperglycemia in the EMR but an ADA classification of hyperglycemia based on A1C and FBG results.

Results

Four participants had incomplete FBG or A1C test results. Complete data were available for 196 participants (mean ± SD age = 44 ± 10 years, weight = 86.8 ± 16.5 kg, BMI = 36.5 ± 6.4 kg/m^2, waist circumference = 115 cm ± 13.6 cm, A1C = 6.5 ± 1.5% [47.7 ± 15.9 mmol/mol], FBG = 134.6 ± 44.9 mg/dL [7.5 ± 2.9 mmol/L]). Data for four participants who were missing either FBG or A1C test results from the baseline screening were not included in the analyses.

Data from the EMR showed that out of 196 participants, 70 (36%; 70/196) had a diagnosis of type 2 diabetes, 39 (20%, 39/196) had a diagnosis of prediabetes, and 87 participants (44%, 87/196) had no diagnoses of either type 2 diabetes or prediabetes. Table 1 presents the comparisons of participants, grouped by diagnoses and FBG and A1C values, on age, BMI, waist circumference, and glycemic levels. Groups differed significantly on age, FBG, and A1C ($p < .001$). Scheffe post hoc tests indicated that participants with a diabetes or prediabetes diagnosis were older ($M = 47.2$ years) than those without a diagnosis but with abnormal FBG/A1C values ($M = 40.4$ years), and than those with no diagnosis and normal FBG/A1C values ($M = 35.0$). Undiagnosed participants with abnormal FBG/A1C values were also older than those undiagnosed who presented normal values. As expected, participants with a diagnosis of prediabetes or diabetes had significantly higher FBG ($M = 154.6$ mg/dL) and A1C ($M = 54.9$ mmol/mol and 7.2%) levels than undiagnosed participants who had abnormal FBG ($M = 113.1$ mg/dL) and A1C ($M = 39.4$ mmol/mol and 5.8%) values and than undiagnosed participants with normal FBG ($M = 93.3$ mg/dL) and A1C ($M = 34.5$ mmol/mol and 5.3%) levels. No significant group differences were found in BMI and waist circumference.

Table 2 presents the cross-tabulation of patients whose EMR noted either a diagnosis of prediabetes or no diagnoses, and the mean A1C and FBG values stratified by normal, prediabetes, and diabetes ranges using the same definitions used by the ADA and by the NHANES study (i.e., for prediabetes: HbA1C ≥ 5.7% < 6.5%, fasting plasma glucose [FPG] ≥ 100 mg/dL < 126 mg/dL; for diabetes: HbA1C ≥ 6.5%, FPG ≥ 126 mg/dL). Among the 87 participants with no diagnoses of diabetes or prediabetes, 45 (52%, 45/87) had A1C values in the normal range, 39 (45%, 39/87) had A1C values in the prediabetes range, and 3 (3%, 3/87) had A1C values in the diabetes range. Among the same participants with no diagnoses, 21 (24%, 21/87) had FBG concentrations in the normal range (< 100 mg/dL), 55 (63%, 55/87) had concentrations in the prediabetes range (100–125 mg/dL), and 11 (13%, 11/87) had concentrations in the diabetes range (≥ 126 mg/dL). In sum, data from our study suggest that nearly half of our participants had undiagnosed hyperglycemia, with 45–63% potentially having undiagnosed prediabetes, and 3–13% potentially having undiagnosed diabetes.

Closer examination of a subset of medical records revealed that even among those participants for whom a diagnosis of some type of hyperglycemia was recorded, the diagnosis was not necessarily accurate or up to date. Of the 39 participants who had a diagnosis of prediabetes, the EMR showed that two of them (5%, 2/39) had A1C values in the diabetes range, and nine (23%, 9/39) had FBG concentrations in the diabetes range. Additional examination revealed that two participants with a prediabetes diagnosis had both A1C and FBG in the diabetes range (including FBG > 200 mg/dL) and could therefore be clinically classified as having type 2 diabetes [13].

Table 1 Comparison of age, BMI, waist circumference, FBG, and A1C values of participants the presence or absence of a diabetes or prediabetes diagnosis on their EMR, and their A1C or FBG results

Variables	Entire cohort $N = 196$	Diagnosed with diabetes or prediabetes $N = 109$	Undiagnosed and abnormal FBG/A1C values $N = 72$	Undiagnosed and normal FBG/A1C $N = 15$	p value*
Age (years)	44 (10)	47.2 (9.7)**	40.4 (8.5)**	35.0 (10.6)**	< .001
BMI (kg/m^2)	36.5 (6.4)	37.0 (6.4)	36.4 (6.8)	33.8 (5.5)	.21
Waist circumference (cm)	115 (13.5)	116.0 (12.9)	115.6 (14.5)	111.2 (13.8)	.44
FBG (mg/dL)	134.6 (44.9)	154.6 (50.7)*	113.1 (13.3)	93.3 (5.0)	< .001
A1C (mmol/mol)	47.7 (15.9)	54.9 (17.9)*	39.4 (4.4)	34.5 (2.7)	< .001
A1c (percent)	6.5 (1.5)	7.2 (1.6)*	5.8 (0.4)	5.3 (0.2)	< .001

Abnormal values: FBG ≥ 100; A1C ≥ 5.7%, or A1C ≥ 39 mmol/mol

*p value from a one-way ANOVA comparison across the three diagnosis categories; all values are reported as mean (SD)

Comparisons based on Scheffe's post hoc test: **Indicates significant differences between all three groups. *Indicates that the group diagnosed with diabetes/prediabetes significantly differs from the two groups without diagnoses

Table 2 Cross-tabulation of participants with a prediabetes diagnosis or without a diagnosis of diabetes or prediabetes in the EMR with baseline A1C and fasting blood glucose values[a]

	Units	No diagnosis of type 2 diabetes or prediabetes $n = 87$ (44%)		Diagnosis of prediabetes $n = 39$ (20%)	
		n (%)	Mean ± SD	n (%)	Mean ± SD
A1C					
Normal range	mmol/mol	45 (52)	35.3 ± 2.6	7 (18)	35.5 ± 1.5
	%		5.4 ± 0.2		5.4 ± 0.1
Pre-diabetic range	mmol/mol	39 (45)	41.4 ± 2.4	30 (77)	41.1 ± 1.9
	%		5.9 ± 0.2		5.9 ± 0.2
Diabetic range	mmol/mol	3 (3)	50.5 ± 4.1	2 (5)	77.6 ± 39.4
	%		6.8 ± 0.4		9.3 ± 3.6
Fasting blood glucose					
Normal range	mmol/L	21 (24)	5.2 ± 0.3	5 (13)	5.4 ± 0.2
	mg/dL		93.6 ± 4.5		96.6 ± 3.2
Pre-diabetic range	mmol/L	55 (63)	6.1 ± 0.4	25 (64)	6.2 ± 0.3
	mg/dL		110.5 ± 7.2		111.7 ± 5.8
Diabetic range	mmol/L	11 (13)	7.6 ± 0.7	9 (23)	8.3 ± 2.2
	mg/dL		136.1 ± 11.7		149.3 ± 39.0

[a] A1C and FBG values are stratified based on the American Diabetes Association's classification as follows: *Normal range*, FBG < 100 mg/dL; A1C < 5.7% (< 39 mmol/mol). *Prediabetes range*, FBP 100–125 mg/dL; A1C 5.7–6.4% (39–47 mmol/mol). *Diabetic range*, FBG ≥ 126 mg/dL; A1C ≥ 6.5% (≥ 48 mmol/mol)

Discussion

Our finding that participants with diagnosed diabetes or prediabetes were older than undiagnosed participants with both normal and abnormal-range A1C and FBG is not surprising given the well-documented findings of higher prevalence of hyperglycemia in older adults [14]. It would be expected for diagnosed individuals to have more elevated FBG and A1C values than participants with no diagnoses, particularly because one of the comparison groups (i.e., those undiagnosed and who presented normal FBG and A1C values) by definition had no evidence of hyperglycemia.

More interestingly, we found that among 87 low-income Hispanic women without a diagnosis of either prediabetes or diabetes in the medical chart, 42 (48%) had baseline A1C values in the prediabetes or diabetes range, and 66 (76%) had baseline FBG values in the prediabetes or prediabetes range. Similarly, among the 39 women with a diagnosis of prediabetes, 2 (5%) had A1C values in the diabetes range, and 9 (23%) had FBG values in the diabetes range. Such undiagnosed hyperglycemia among this population is concerning, as unmanaged hyperglycemia can lead to serious complications. A diagnosis of prediabetes or type 2 diabetes is often necessary to trigger behavioral or pharmacological interventions that might prevent, delay, or control diabetes, and reduce morbidity and mortality from the illness. The ADA recommends testing for diabetes or prediabetes for all overweight or obese Hispanic adults even if they are under age 45, the point at which screening is recommended for all asymptomatic adults [13]. Similarly, while the USPSTF recommends screening for all 40- to 70-year-old adults with BMI ≥ 25 kg/m^2, it suggests that for Hispanic individuals screening should be considered at earlier ages or lower BMI [15]. The results of our study suggest that many Hispanic women may not receive the recommended screening, although the reasons for this were beyond the scope of this study.

The prevalence of undiagnosed hyperglycemia in our cohort is higher than that seen in the National Health and Nutrition Examination Survey (NHANES). Through interviews, along with the assessment of A1C, FBG, and 2-h plasma glucose (PG), NHANES has found a 10% prevalence rate for undiagnosed diabetes among Hispanic individuals, with a 35% prevalence rate for undiagnosed prediabetes [11]. A recent examination of 1999–2014 NHANES data has shown that detection of undiagnosed type 2 diabetes improved, although improvements in detection of undiagnosed type 2 diabetes were generally limited to non-Hispanic white adults (from 3.2% during 1999–2002 to 2.2% during 2011–2014), and for adults in the highest income categories (declining from 2.4% during 1999–2002 to 1.5% during 2011–2014). However, during 199–2002 versus 2011–2014, undiagnosed diabetes among Mexican Americans increased from 3.7 to 6% [16].

Several limitations in the present study should be noted. Given that our study is part of a pragmatic clinical trial, screening was conducted with point-of-care instruments, which are not recommended by the ADA for diagnosing diabetes [13]. Nevertheless, the use of capillary blood for

detecting unrecognized diabetes in clinical settings has been reported to be strongly correlated with standard laboratory measures [17]. Also, FBG and A1C were only tested at one point in time, and the study did not include conducting the recommended confirmatory testing necessary to make a diagnosis of diabetes. However, even without a confirmatory test, a diagnosis of hyperglycemia can be a gateway to preventive services such as referrals to diabetes education programs, or dietary or weight-loss counseling, all of which are first-line treatment in diabetes prevention and management.

Secondly, presented data are restricted to a relatively narrow range of demographic characteristics, i.e., all low-income adult Spanish-speaking Hispanic women with a BMI of 27 kg/m^2 or above and enrolled in a diabetes risk reduction intervention. These data are therefore not representative of Hispanic individuals or clinic patients in general.

Given the potential to inhibit progression of prediabetes and reduce the complications of diabetes, improving screening rates, especially among high-risk populations, is a public health priority. Results from the current study underscore the need for early detection, education, and referral of at-risk individuals to diabetes prevention or diabetes management programs. Adherence to ADA and USPSTF screening recommendations [8, 15] is critical to reduce the impact of diabetes in Hispanic populations. It is beyond the scope of the study to determine the reasons why some participants had not been identified as hyperglycemic in the EMR, but we have several hypotheses. Although it is the clinic's protocol to adhere to ADA screening recommendations, financial or time constraints, or inadequate understanding of the importance of diabetes screening, may have prevented patients from completing screening for which they have been referred. Although the clinic had some medical record systems automatically notify health care providers when patients meet guideline criteria for specific screenings (e.g., flagging all women aged 50–74 for biennial mammography screening), this type of flagging cannot be relied upon when race or ethnicity is part of the criteria, as this data is often not systematically or reliably collected. Questions regarding race and ethnicity are often not well understood by Hispanic immigrants, many of whom have never before encountered this particular demographic question, thus these patients may elect not to provide this information at intake, and clinic staff may feel uncomfortable asking them [18]. As a result, particularly for patients of Hispanic origin, ethnic and racial data are often missing and cannot be used to generate provider notifications regarding recommended screenings.

Our study did not query whether participants without a diagnosis of diabetes or prediabetes had been referred for screening and had not complied with this medical recommendation, and if so, why they had not done so. While this important aspect of self-care was out of the scope of this study, in past studies, patient limited understanding of diabetes has emerged as a barrier to inadequate patient diabetes control [19, 20], whereas having good communication with medical providers was positively associated with diabetes self-management. Future research should explore patients' perceptions of barriers to screening and other diabetes-related self-care behaviors.

Conclusions

Screening may be particularly important for Hispanic individuals because rates of knowledge about diabetes, risk factors, and prevention practices tend to be lower for this population relative to other groups [21–23]. Health care providers can play a key role in combating the impact of diabetes among Hispanic individuals. Given the burden of diabetes in an already vulnerable population, we recommend that physicians emphasize the importance of diabetes screening among overweight or obese Hispanic women.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in this study involving human subject protection were conducted in accordance with the ethical standards of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), and the Kaiser Permanente Northwest and Virginia Garcia Memorial Health Center Institutional Review Boards, and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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