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Trends in Obesity and Medical Expenditure among Women with Diabetes, 2008-2016: Differences by Race/Ethnicity

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Objectives: Diabetes results in $327 billion in medical expenditures annually, while obesity, a risk factor for type 2 diabetes, leads to more than $147 billion in expenditure annually. The aims of this study were: 1) to evaluate racial/ethnic trends in obesity and medical expenditures; and 2) to assess incremental medical expenditures among a nationally representative sample of women with diabetes.

Methods: Nine years of data (2008–2016) from the Medical Expenditure Panel Survey Full Year Consolidated File (unweighted = 11,755; weighted = 10,685,090) were used. The outcome variable was medical expenditure. The primary independent variable was race/ethnicity defined as non-Hispanic Black (NHB), Hispanic, or non-Hispanic White (NHW). Covariates included age, education, marital status, income, insurance, employment, region, comorbidity, and year. Cochran-Armitage tests determined statistical significance of trends in obesity and mean expenditure. Two-part modeling using Probit and gamma distribution was used to assess incremental medical expenditure. Data were clustered to 2008-2010, 2011-2013, 2014-2016.

Results: Trends in medical expenditures differed significantly between NHB and NHW women between 2008-2016 (P<.001). Hispanic women paid $1,291 less compared with NHW women, after adjusting for relevant covariates. There were no significant differences in obesity trends from 2008-2016 between NHB (P=.989) or Hispanic women with diabetes (P=.938) compared with NHW women with diabetes.

Conclusions: These findings suggest the need to further understand the factors associated with differences in trends for medical expenditures between NHB and NHW women with diabetes and incremental medical expenditures in Hispanic women with diabetes compared with NHW women with diabetes.

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Introduction

In the United States, diabetes affects more than 34 million people (or 10.5% of the population); approximately 12% of US women have diabetes.[1] Like diabetes, obesity continues to persist as a public health concern, with the prevalence of obesity in women reported as high as 40% since 2013-2014.[2] Diabetes is a major cause of morbidity and is associated with an increased risk of adverse complications such as heart disease, kidney disease, stroke, and blindness,[3] particularly among racial and ethnic minority women who have a higher prevalence of obesity, higher health care utilization, and increased medical expenditure.[1,4,5] Medical expenditures for people with diagnosed diabetes is 2.3 times higher than expenditures for people without diabetes[1,6,7]; per person costs associated with diabetes increased from $8,417 to $9,601 between 2010 and 2017.[1] Furthermore, total direct and indirect expenditures for diabetes in the United States have been estimated at $327 billion since 2017,[1] a significant 21% increase from the previous estimate of $245 billion in 2012.[6] Annual medical costs for obesity in the United States alone are estimated at $147 billion, with individuals having obesity spending approximately $1,429 more than individuals of normal weight.[8]

Obesity has been shown to independently increase the risk for incident diabetes, particularly the development of type 2 diabetes, which accounts for 98% of cases.[3,9-12] In a 1999-2002 NHANES survey, the prevalence of obesity among adults

with diagnosed diabetes in the United States was 54.8%.[13] Recent estimates show approximately 88% of adults with type 2 diabetes are considered overweight or obese.[14] It is an important modifiable risk factor of type 2 diabetes[1,3,15] as evidence shows modest and sustained weight loss is associated with improved fasting plasma glucose and glycemic control and a reduced need for diabetes medications.[16] In the same NHANES survey, the prevalence of obesity for adults with diabetes was 57.9%, 63.0%, and 59.5% for non-Hispanic White (NHW) adults, non-Hispanic Black (NHB) adults, and Mexican Americans, respectively,[13] suggesting significant differences in the prevalence and trends for both diabetes and obesity by race and ethnicity continue to persist.[17]

Though studies have assessed racial and ethnic differences in health care costs in adults with diabetes, differences in the relationship between obesity and medical expenditure in women with diabetes is yet to be examined. Therefore, this study aimed to evaluate racial and ethnic differences in trends in obesity and medical expenditure among women with diabetes and to evaluate the relationship between trends in obesity and medical expenditure by race and ethnicity among a nationally representative sample of women with diabetes in the United States.

Methods

Sample Population

Data from the Medical Expenditure Panel Survey (MEPS) full year consolidated data files were used for the analyses and included 9 years of data for the period 2008 to 2016, which was clustered into three time points: 2008 to 2010, 2011 to 2013, and 2014 to 2016. MEPS is a national research program administered by the Agency for Research and Quality in Health Care (AHRQ) that provides a wide range of deidentified information using a set of large-scale surveys aimed at families and individuals across the United States.[18] During in-person and household interviews, extensive data are collected on their demographic characteristics, use of medical services, health status and conditions, access to care, health utilization, satisfaction with care, source and payment changes, health expenditure and health insurance coverage, employment status, and income. The weighting of surveys of families and individuals in selected populations represents the US population due to its diverse survey structures and multistage probability examining approach. For this study, only women with diabetes were included in the analysis (unweighted = 11,755), which represents 10,685,090 women of the US population after appropriate weighting.

Outcome Variable

In order to analyze total health expenditures over time among women with diabetes, we used total health care expenditures from the years 2008 to 2016, which is derived from direct expenditures for each survey participant for health care, home health care, hospital/emergency visits and pharmacy.

Primary Independent Variable

To determine differences by race and ethnicity among women with diabetes, race/ethnicity was used as the primary independent predictor and was classified into three groups: non-Hispanic Black (NHB), Hispanic, and non-Hispanic White (NHW).

Covariates

Adjusting covariates included age, US region, marital status, education, insurance status, personal income, employment status, and comorbidities. Age and personal income were analyzed as continuous variables. Education level was dichotomized to 2 categories: less than bachelor's degree or bachelor's degree and above. Marital status was categorized as married, widowed, divorced, separated, and never married. Insurance coverage was categorized by those with any private, public only, or uninsured. Employment status was grouped as employed or unemployed/retired. Comorbidity count was calculated if any or more of the following comorbidities existed – cancer, cholesterol, hypertension, stroke, emphysema, coronary disease, angina, heart attack, joint pain, arthritis, asthma, and depression. The type and independent effect of each specific condition was not assessed in this analysis.

Statistical Analyses

Sample demographics of the study population were summarized with means and standard deviations for continuous measures and percentages for categorical variables. The trend analysis included identifying linear trends in obesity among women with diabetes and trends in mean medical expenditure among women with diabetes from 2008 to 2016 over 3 time points. Cochran-Armitage tests were

used to test the statistical significance of the trends. A two-part General Linear Model (GLM) using Probit and log transformation with gamma distribution was performed to compute incremental estimates of medical expenditure in women with diabetes who have a BMI≥30 compared with those with a BMI<30 and in NHB and Hispanic women compared with NHW women with diabetes. To assess the probability of having positive medical expenditure compared with zero expenditure, a Probit model was first performed, followed by the GLM with gamma family and log link to evaluate a state of having a positive medical expenditure among women with diabetes. Manning and Mullahy[19,20] recommend the two-part modeling method as the most frequently used method when handling and interpreting cost data to assess medical expenses. Unadjusted models were performed, and covariates were applied to the adjusted models. The interaction between BMI and race/ethnicity in incremental medical expenditures was evaluated. The interaction term was not significant, suggesting the relationship between BMI and race/ethnicity were independent; therefore, the interaction term was not included in the adjusted model. After the two-part model (Probit and GLM) was performed, post estimation margin commands were performed to calculate average marginal effects for incremental costs of medical expenditures. All statistical analyses were done using SAS 9.4 (SAS Institute) and STATA SE v.15.1 software. Appropriate weighting was used when adjusting for the complex sample designs in MEPS. An alpha of .05 was used as the threshold for the statistically significant level.

Results

Table 1 shows the sample demographics for women with diabetes by

Table 1. Unweighted sample demographics by race/ethnicity, 2008-2016, N=11,755

	NHW, n=4,509	NHB, n=3,719	Hispanic, n=3,527
Age, mean ± sd	62 ± 14.3	59 ± 14.2	57 ± 14.2
Personal income, mean ± sd	$24,119 ± $24,509	$19,587 ± $21,415	$14,169 ± $18,483
Education			
<Bachelor's	69.2%	75.6%	87.2%
≥Bachelor's	30.8%	24.4%	12.8%
Marital status			
Married	46.8%	27.4%	48.3%
Widowed	24.3%	23.9%	15.0%
Divorced	18.1%	19.5%	14.5%
Separated	2.4%	6.4%	6.6%
Never married	8.5%	22.8%	15.7%
Insurance coverage			
Any private	55.3%	40.3%	29.1%
Public only	39.2%	50.8%	49.9%
Uninsured	5.5%	8.8%	20.9%
Employment status			
Employed	29.4%	31.6%	31.4%
Unemployed/retired	70.6%	68.4%	68.6%
Region			
Northeast	16.8%	15.3%	16.2%
Midwest	28.7%	15.3%	8.6%
South	38.5%	63.3%	34.6%
West	16.0%	6.1%	40.7%
Total medical expenditure, mean ± sd	$13,538 ± $21,433	$12,107 ± $22,565	$8,795 ± $19,720
Comorbidity count, mean ± sd	4 ± 1.8	4 ± 1.7	3 ± 1.8
Year			
2008-2010	32.8%	31.3%	28.0%
2011-2013	33.0%	34.1%	34.5%
2014-2016	34.2%	34.6%	37.5%

NHW, non-Hispanic White; NHB, non-Hispanic Black; mean ± sd = mean ± standard deviation.

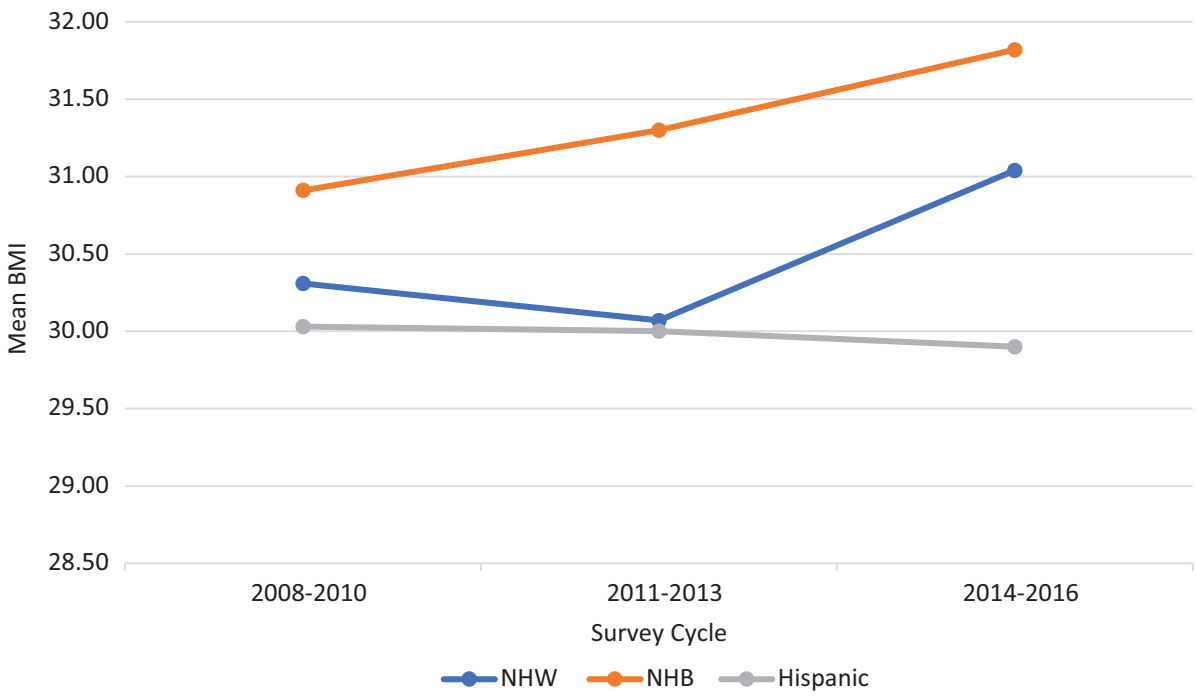

Figure 1. Unweighted obesity trend in women with diabetes by race/ethnicity, 2008-2016

race/ethnicity. The average age of the sample ranged from approximately 57 to 62 years of age with Hispanic women having the youngest mean age, and NHW women having the highest mean age. The average income for NHW women was approximately $24,119 compared with $19,587 for NHB women and $14,169 for Hispanic women. For each group of women, the majority had less than a bachelor's degree – approximately 69% of NHW women, 76% of NHB women, and 87% of Hispanic women. For NHW women, the majority (55%) had any private insurance, while the majority of NHB, and Hispanic women had public insurance at 51%, and 50%, respectively. Across all racial/ethnic groups, most women were unemployed/retired. The majority of NHW (39%) and NHB (63%) women reported living in the South region, whereas the majority of Hispanic (41%) women reported living in the West region. The mean total medical expenditure was $13,538 for NHW women, $12,107 for NHB women, and $8,795 for Hispanic women.

Figure 1 shows the linear trend in obesity for women with diabetes by race/ethnicity from 2008-2016. For NHW women, the mean BMI ranged from 30.3 ± 11.8 between 2008-2010 to 30.1 ± 12.2 between 2011-2013 to 31.0 ± 11.6 between 2014-2016. For NHB women, the mean BMI ranged from 30.9 ± 13.4 between 2008-2010 to 31.3 ± 11.3 between 2011-2013 to 31.8 ± 11.3 between 2014-2016. For Hispanic women, the mean BMI ranged from 30.0 ± 11.0 between 2008-2010 to 30.0 ± 11.4 between 2011-2013 to 29.9 ± 10.7 between 2014-2016. Cochrane-Armitage tests did not show significant differences for trends in obesity from 2008-2016 between NHB women (P=.989) or Hispanic women (P=.938) compared to NHW women.

Figure 2 shows the linear trend in mean medical expenditure for women with diabetes by race/ethnicity from 2008-2016. For NHW women, the mean medical expenditure ranged from $11,747 (95% CI: $10,907, $12,587) between 2008-2010 to $12,973 (95% CI: $11,869, $14,078) between 2011-2013 to $15,805 (95% CI: $14,563, $17,048) between 2014-2016. For NHB women, the mean medical expenditure ranged from $11,983 (95% CI: $10,741,

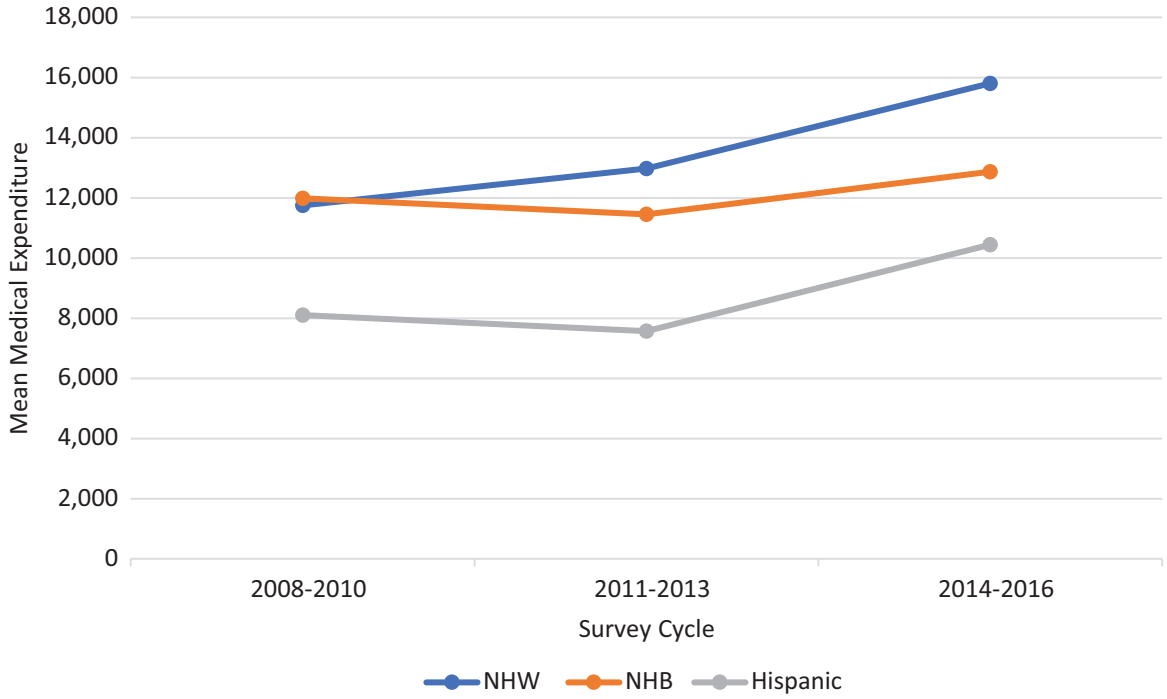

Figure 2. Unweighted mean medical expenditure trend in women with diabetes by race/ethnicity, 2008-2016

$13,225) between 2008-2010 to $11,449 (95% CI: $10,279, $12,619) between 2011-2013 to $12,868 (95% CI: $11,524, $14,211) between 2014-2016. For Hispanic women, the mean medical expenditure ranged from $8,099 (95% CI: $7,177, $9,021) between 2008-2010 to $7,568 (95% CI: $6,703, $8,433) between 2011-2013 to $10,442 (95% CI: $9,065, $11,818) between 2014-2016. Cochrane-Armitage test showed the trends in mean medical expenditure from 2008-2016 differed significantly between NHB women (P<.001) compared with NHW women, but it did not show significant differences for trends in mean medical expenditure between Hispanic women (P=.112) compared with NHW women during this same period.

Table 2 shows incremental medical expenditure for women with diabetes from 2008-2016. In the unadjusted model, NHB and Hispanic women were found to have statistically lower incremental medical expenditure compared with NHW women (NHB women: -$1,809 (95% CI: -$3,071, -$547), P<.01; Hispanic women: -$4,369 (95% CI: -$5,652, -$3,086), P<.001). After adjusting for relevant covariates, statistical significance for lower incremental medical expenditure for Hispanic women (-$1,291 [95% CI: -$2,215, -$366], P<.01) compared with NHW women persisted. There were no statistically significant differences in incremental medical expenditure between NHB and NHW women after adjusting for covariates. In addition, when assessing incremental medical expenditure by BMI≥30 vs BMI<30, there were no statistically significant differences.

Discussion

In this nationally representative sample of women with diabetes, significant differences by race and ethnicity were found for trends in medical expenditure and in incremental medical expenditure. First, compared with NHW women with diabetes, trends in mean medical expenditure differed significantly for NHB women with diabetes. Second, in the unadjusted analysis, NHB and Hispanic women with diabetes had significantly lower incremental medical expenditure compared with NHW women with

Table 2. Incremental medical expenditure for women with diabetes, 2008-2016

	Model 1, Estimate (95% CI)	Model 2, Estimate (95% CI)
Body mass index		
BMI ≥30	$861 (-$379, $2,100)	$3 (-$672, $679)
Race/ethnicity		
Non-Hispanic Black	-$1,809 (-$3,071, -$547)[b]	-$344 (-$1,096, $408)
Hispanic	-$4,369 (-$5,652, -$3,086)[a]	-$1,291 (-$2,215, -$366)[b]

Significance at a. P<.001; b. P<.01.
Reference groups: BMI<30 and NHW women with diabetes.
Model 1: unadjusted, year.
Model 2: adjusted for age, education, marital status, income, insurance coverage, employment status, region, comorbidity count, year.
95% CI, 95% confidence interval.

diabetes. After adjusting for relevant covariates, significantly lower incremental medical expenditure persisted for Hispanic women with diabetes compared with NHW women with diabetes. There were no significant differences in incremental medical expenditure between NHB and NHW women with diabetes, after adjusting for relevant covariates. Furthermore, there were no significant differences between groups in trends for obesity or when comparing incremental medical expenditure by BMI. Overall, these findings suggest a need for understanding the factors associated with differences in trends for medical expenditure in NHB women with diabetes compared with NHW women with diabetes and in incremental medical expenditure between Hispanic and NHW women with diabetes.

Our findings are supported by existing evidence indicating lower health care costs in racial and ethnic minorities with diabetes compared with Whites.[21-24] In this sample, Hispanic women with diabetes had lower incremental medical expenditure compared with NHW women with diabetes. Lower medical expenditure in racial and ethnic minorities has been attributed to lower health care utilization rates.[23,24] In a study to assess the relationship between being uninsured and race in health care utilization by rural minorities, insurance was found to be a factor associated with health care utilization despite place of residence, particularly among Hispanic and Asian individuals.[23] Similarly, in a study to examine gender and racial/ethnic differences in the role of economic access in health care utilization, public insurance such as Medicare was found to be instrumental in the services received by women and minorities.[24] In addition to lower utilization rates, complex, multilevel barriers to accessing care including demographic and socioeconomic factors have been shown to contribute to lower medical expenditure in racial and ethnic minorities.[25] However, in our study, despite controlling for sociodemographic covariates, racial and ethnic differences in medical expenditure persisted. This suggests there may be underlying factors that explain variations in medical expenditures beyond those controlled for in this study.

Though findings from previous studies comparing medical expenditure between NHB and NHW adults have shown mixed results, most studies provide evidence of lower expenditure in NHBs compared with NHWs.[23,26,27] Findings from our study showed trends in mean medical expenditure from 2008-2016 differed significantly between NHB women and NHW women with diabetes; however, there were no statistically significant differences between the two groups in incremental medical expenditure. According to work by Lee et al to assess racial and ethnic differences in diabetes care and health care use and costs, NHW adults had higher health care costs compared with both African American and Hispanic adults with diabetes.[17] In our study, however, there were no statistically significant differences in medical expenditure between NHB women and NHW women with diabetes, after adjusting for covariates. Evidence suggests additional research is warranted to understand the reasons why outcomes such as medical expenditure do not differ significantly between racial and ethnic groups, when trends in medical expenditure would suggest otherwise.[17]

Though studies have found racial and ethnic differences in the prevalence and incidence of obesity at specific time points among adults,[13,28,29] we found there were no significant

racial/ethnic differences in trends of obesity across groups. It is important to note, however, that despite the lack of statistically significant differences among the groups, there was an upward trend in BMI for NHB and NHW women with diabetes from 2011-2013 to 2014-2016; this was not true for Hispanic women where obesity was beginning to trend down. This observation underscores the need for additional research to understand the mechanisms associated with increasing obesity in NHB and NHW women with diabetes and the factors associated with lower incremental medical expenditure in Hispanic women with diabetes compared with NHW women. Finally, we did not find a significant interaction between obesity and race and ethnicity among women with diabetes suggesting the two are independent. This finding is supported by Ibe and Smith[4] suggesting diabetes among US women continues to increase independent of increasing BMI and other risk factors.

Study Limitations

The strengths of our study are the large sample size and use of a longitudinal study design, affording the ability to determine trends over time; however, there are study limitations that must be mentioned. First, there are potential confounding variables that were not accounted for in the analyses. For example, evidence shows lifestyle factors such as a sedentary lifestyle and poor dietary habits and unhealthy behaviors such as tobacco use and alcohol consumption independently and collectively predispose individuals to both obesity and diabetes.[1,3,16] In our analyses, we did not control for these variables, and they may have influenced the results. Second, data used in the analyses are based on self-report, which could introduce recall bias and social desirability bias of the type of diabetes diagnoses, comorbid conditions, and medical expenditure. However, given 98% of cases of diabetes are type 2 diabetes[1] and prior studies have used similar data to estimate chronic disease prevalence and expenditure estimates,[6,7] we believe the results of our study are reliable. Third, there is a pathophysiological relationship between obesity and type 2 diabetes ascribed to two factors: insulin resistance and insulin deficiency.[30] Furthermore, being obese inherently increases the risk for diabetes among women.[12] In our analyses, we did not account for the potential impact of insulin resistance in women with diabetes in this sample. We also did not account for diabetes severity in the analysis, which may have impacted the results. Fernandez et al[31] showed minority women have higher odds of having diabetes severity associated with complications compared with NHW women. Specifically, Hispanic and NHB women have 39% and 22% higher odds, respectively, of having severe diabetes compared with White women.[31] Understanding the severity of diabetes could prove useful in predicting direct healthcare costs and targeting interventions for prevention of complications.[32] Finally, given the design of the MEPS dataset, it does not include institutionalized individuals who may have higher prevalence of disease and higher medical expenditure.

Conclusions

The results of our study are important and provide new information on the relationship between race and ethnicity and obesity and medical expenditure in women with diabetes. In this nationally representative sample of women with diabetes, significant differences in trends in medical expenditure and incremental medical expenditure by race and ethnicity were found. Given these results, it is important for providers to assess and address factors that impact health care utilization for ethnic minority women with diabetes. Additionally, our findings on racial and ethnic trends in obesity suggest a need for effective obesity management interventions for women with diabetes across racial/ethnic groups. This is essential considering evidence that indicates weight loss in obese and overweight patients with diabetes is a useful strategy for improving glycemic control and reducing medical expenditure.[16,30,33]

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Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Williams, Lu, Akinboboye, Egede; Acquisition of data: Nagavally; Data analysis and interpretation: Williams, Lu, Zhou, Olukotun, Egede; Manuscript draft: Williams, Lu, Zhou, Akinboboye, Olukotun; Statistical expertise: Zhou, Nagavally, Egede; Acquisition of funding: Egede; Administrative: Williams, Lu, Akinboboye, Olukotun; Supervision: Williams, Lu, Egede

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