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ORIGINAL ARTICLE

Gender Differences in Composite Control of Cardiovascular Risk Factors Among Patients with Type 2 Diabetes

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Abstract

Objective: Disparities in outcomes for cardiovascular disease (CVD) exist between men and women with type 2 diabetes mellitus (T2DM). We examined gender differences in composite control of cardiovascular risk factors in a sample of adults with T2DM.

Subjects and Methods: This was a cross-sectional study of 680 people recruited from three primary care settings. Primary outcomes were individual and composite control of CVD risk factors. Control of individual risk outcomes was defined as glycosylated hemoglobin A1c (HbA1c) level of $<7\%$, blood pressure (BP) of $<130/80$ mm Hg, and low-density lipoprotein (LDL) cholesterol level of <100 mg/dL. Composite control was defined as having all three outcomes under control simultaneously. Linear and logistic regression models were used to assess differences in individual means and individual and composite outcomes control between men and women, while adjusting for relevant covariates.

Results: Men made up 56% of the sample, approximately 67% were non-Hispanic black, and 78% made less than $35,000 annually. Unadjusted mean systolic BP (134 mm Hg vs. 130 mm Hg, $P=0.005$) and LDL cholesterol (99.7 mg/dL vs. 87.6 mg/dL, $P<0.001$) levels were significantly higher in women than in men. Adjusted linear regression showed mean diastolic BP ($\beta=3.09$; 95% confidence interval 0.56, 5.63) was significantly higher in women. Overall, 12.4% of the sample had composite control, and women had poorer composite control compared with men (5.9% vs. 17.3%). Adjusted logistic models showed that men were significantly more likely to have composite risk factor control (odds ratio 2.90; 95% confidence interval 1.37, 6.13) compared with women.

Conclusions: In this sample of adults with T2DM, women had significantly lower composite control compared with men, when adjusting for relevant confounders. It is imperative that women are informed about CVD risk factors, educated on how to reduce them, and aggressively treated to avoid adverse outcomes. Additional research involving women is needed to explore and reduce disparities in CVD risk between men and women with T2DM.

Introduction

Having a diagnosis of type 2 diabetes mellitus (T2DM) significantly increases the risk of developing cardiovascular disease (CVD) and dying when CVD is present.[1–3] CVD results from multiple risk factors, including but not limited to diabetes, hyperlipidemia, and hypertension.[1,4,5] It is associated with heart failure, stroke, and myocardial infarction[4] and is the primary cause of death and disability among people with diabetes.[1] Compared with the general population, the risk of death from CVD is two to four times higher among adults with diabetes.[2,4,6]

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Yang et al.[7] reported a prevalence trend of less than 1% in 2003–2008 to 3.3% in 2009 for ideal cardiovascular health within the general population. For individuals more adversely impacted by diabetes, there is likely a disproportionate representation in certain population subgroups, including racial/ethnic minorities and women.[1,8–10] A review of the literature shows that men with T2DM often have better cardiovascular risk profiles and outcomes compared with women with T2DM.[11–24] Women with diabetes have a three- to fivefold higher risk of developing CVD, and men have a two- to threefold higher risk compared with their respective counterparts without diabetes.[2,10,11,14–17,25–27] Regardless, both men and women living with diabetes can lower their risk of CVD by adjusting modifiable factors below specific thresholds such as glycosylated hemoglobin A1c (HbA1c) level <7%, blood pressure (BP) <130/80 mm Hg, and low-density lipoprotein (LDL) cholesterol level <100 mg/dL.[27] In addition, it is imperative that clinicians provide consistent care, so the differences in CVD and diabetes outcomes observed between men and women are not perpetuated.

Compared with epidemiological studies on CVD, less attention is given to examining whether disparities in CVD risk management create gender differences among an already high-risk population like those with diabetes. Although differences exist between men and women with T2DM regarding CVD occurrence, gender differences in composite control of cardiovascular risk factors are less understood. In this study, we examined the gender differences in multiple CVD risk factor control in adults with type 2 diabetes seen in diverse clinical settings, including an academic medical center, a Veterans Affairs (VA) Medical Center, and a federally qualified health center in the southeastern United States. Based on evidence in the current literature that women with diabetes have a higher risk of developing CVD, we hypothesized that adult women with T2DM would have poorer composite control of CVD risk factors compared with men in a diverse primary care sample.

Research Design and Methods

Research design

This study was conducted as a part of a larger project funded by the National Institutes of Health/National Institute of Diabetes and Digestive and Kidney Diseases. Using a cross-sectional research design, participants were randomly invited and recruited to complete a self-report survey yielding data relevant to gender differences in cardiovascular risk factor control.

Sample characteristics

Patients with a diagnosis of T2DM were recruited from three primary care clinics in the southeastern United States: a general internal medicine clinic at an academic institution (university clinic), a primary care clinic of a VA Medical Center, and an indigent clinic of a federally qualified health center. Patients eligible for the study were adult males and females, 18 years of age and older, any race/ethnicity, having a diagnosis of T2DM, willing to complete survey instruments, and receiving care at one of the aforementioned clinics. Patients were ineligible if they did not speak English, were deemed cognitively impaired, or were too ill to participate, as determined while interacting with the research assistants. Patients diagnosed with type 1 diabetes or gestational diabetes was also excluded from the study. The Institutional Review Board of our institution approved the study. All demographic characteristics collected and reported here were based on self-report.

Recruitment

Patients were recruited between May 2011 and August 2011. Research assistants reviewed the daily electronic clinic roster (based on ICD-9 codes) to identify eligible patients. With an approved script, they subsequently approached patients waiting to be seen by the clinician and provided a brief description of the study. Research assistants abstracted data on most recent BP and laboratory values from patients' charts to assess multiple outcomes.

Outcomes of risk factor control

The primary outcomes were individual and composite control of multiple CVD risk outcomes. Control of individual diabetes-related risk outcomes was defined as HbA1c level of <7%, BP of <130/80 mm Hg, and LDL cholesterol level of <100 mg/dL. Composite control was defined as having all three outcomes under control simultaneously. These parameters are in concordance with the 2012 American Diabetes Association clinical guidelines.[28]

Variables and instruments: demographics

Demographic variables collected for this study included age, gender, race/ethnicity, marital status, educational level, employment status, annual income level, and health insurance.[29] Age was grouped into three categories: <50 years, 50–64 years, and 65+years. Gender was dichotomized into two groups: male and female. Race/ethnicity was based on self-report and included non-Hispanic whites, non-Hispanic blacks, Hispanics, and ''other.'' Marital status was married or not married. Educational level was categorized as less than high school graduate, high school graduate, college graduate, or postgraduate degree. Employment status was unemployed or employed. Four income categories were defined: <$9,999, $10,000–$19,000, $20,000–$34,999, and ≥$35,000+. Health insurance was divided into three groups: private, government (Medicare, Medicaid, and Tricare), or uninsured. Health status, a self-reported item, was adopted from the 2010 Behavioral Risk Factor Surveillance Survey and measured as same/better or worse in comparison with the 12 months prior to completing the survey. The assumption of normality was met for all variables; thus, the use of parametric tests was allowed.

Statistical analyses

We performed three main types of analyses. First, we calculated sample percentages for each demographic variable based on gender using the χ^2 test. Second, we calculated unadjusted mean scores for HbA1c, systolic BP (SBP), diastolic BP (DBP), and LDL cholesterol and compared differences by gender using the *t* test. Third, linear and logistic regression models were used to assess individual mean scores and individual and composite outcomes control, respectively, between men and women, while adjusting for

relevant covariates including age, race/ethnicity, marital status, education, employment, insurance, income, health status, and clinic site. The primary dependent variable for both the linear and logistic models was gender. All variables were included in the models because each was conceptually related to the outcome of interest or were statistically significant in bivariate analyses. A two-tailed α of 0.05 was used to assess for significance. All analyses were performed using STATA version 12.0 software[30] (StataCorp, College Station, TX).

Results

Table 1 shows the sample demographics by gender for this population of adults with T2DM. Men and non-Hispanic blacks composed more than half of the sample. Fifty-seven percent of the men were non-Hispanic blacks, whereas 80% of the women were non-Hispanic blacks. The majority of the sample was middle-aged and older (>50 years), and twice as many women as men were younger than 50 years of age. More than twice as many men were married than women. The majority of men and women had at least a high school education, were unemployed, and were covered by government insurance. Nearly 36% of the sample made less than $10,000 annually, although a significantly higher proportion of men than women were in the highest income levels. Sixty percent made <$20,000, and 78% made less than $35,000 annually. Most participants rated their health status as the same or better than last year; there was no significant statistical

Table 1. Sample Demographics by Gender for Adults with Type 2 Diabetes

	All (n = *680*)	*Men* (n = *383*)	*Women* (n = *297*)	P *value*
Age (years)				0.002[a]
< 50	16.6	12.3	22.2	
50–64	44.9	47.8	41.1	
65 +	38.5	39.9	36.7	
Race/ethnicity				<0.001[a]
Non-Hispanic white	32.9	42.6	20.5	
Non-Hispanic black	67.1	57.4	79.5	
Marital status				<0.001[a]
Married	40.5	52.1	25.6	
Not married	59.5	47.9	74.4	
Educational level				<0.001[a]
Less than HS graduate	23.9	18.2	31.4	
HS graduate	34.7	33.8	35.8	
Some college/college graduate	33.6	38.3	27.7	
Postgraduate degree	7.8	9.7	5.1	
Employment status				0.364
Unemployed	76.2	77.5	74.5	
Employed	23.8	22.5	25.5	
Health insurance				0.398
Uninsured	18.0	17.0	19.3	
Private	15.5	14.4	17.0	
Government insurance	66.5	68.6	63.7	
Annual income level				<0.001[a]
≤ $9,999	35.4	23.5	50.3	
$10,000–$19,000	25.5	25.1	26.1	
$20,000–$34,900	16.6	21.2	10.8	
≥ $35,000	22.5	30.2	12.8	
Health status				0.802
Same/better	72.0	71.6	72.5	
Worse	28.0	28.4	27.5	
Gender by clinic site				
University clinic	38.4	22.9	66.4	<0.001[a]
VAMC primary care clinic	35.3	61.0	2.5	
FQHC clinic	26.4	16.1	65.6	
Outcome by gender				<0.001[a]
HbA1c < 7%	38.4	40.5	35.6	
BP < 130/80 mm Hg	45.1	61.6	36.6	
LDL-C < 100 mg/dL	64.9	71.1	56.9	
Composite control	12.4	17.3	5.9	

All numbers represent percentages.

[a]Statistically significant difference, $P < 0.05$.

BP, blood pressure; FQHC, federally qualified health center; HbA1c, glycosylated hemoglobin A1c; HS, high school; LDL-C, low-density lipoprotein cholesterol; VAMC, Veterans Affairs Medical Center.

Table 2. Gender Differences in Unadjusted Mean Scores for Outcomes of Adults with Type 2 Diabetes

	All	*Men*	*Women*	P *value*
Glycosylated hemoglobin A1c (%)	7.8 ± 1.9	7.8 ± 1.9	7.9 ± 1.9	0.744
Blood pressure (mm Hg)				
Systolic	131.0 ± 20.3	130.0 ± 20.1	134.0 ± 20.3	0.005[a]
Diastolic	73.7 ± 12.8	73.4 ± 12.8	74.1 ± 12.8	0.498
Low-density lipoprotein cholesterol (mg/dL)	92.9 ± 35.2	87.6 ± 32.0	99.7 ± 38.1	< 0.001[a]

Data are mean ± SD values.
[a]Statistically significant, $P < 0.05$.

difference for health status by gender. Employment and type of insurance were also not statistically different by gender.

Significant differences were observed by site and by outcome between men and women. Men made up the majority of the sample from the VA Medical Center; the other two sites had more women participants than men. A greater percentage of men than women had better glycemic, BP, and cholesterol control, overall across all three sites. Approximately 12% of the sample had composite control, with more men having simultaneous control of all three outcomes compared with women.

Table 2 shows gender differences in unadjusted mean scores for multiple CVD risk outcomes. Unadjusted mean SBP and LDL cholesterol levels were significantly higher in women. There were no significant differences in unadjusted HbA1c or DBP mean scores by gender.

Table 3 shows unadjusted and adjusted linear regression models for multiple CVD risk outcomes between men and women. Adjusted linear regression showed that mean DBP levels were significantly higher in women. However, adjusted HbA1c, SBP, and LDL cholesterol were not significantly different by gender.

Table 4 shows logistic regression models (unadjusted and adjusted) for control of multiple CVD risk outcomes by gender. In unadjusted analysis, men were more likely to have composite control compared with women. The results persisted even after adjusting for relevant confounders. Glycemic control, BP control, and lipid control were not significantly different by gender when adjusting for covariates.

Discussion

In this sample of adults with T2DM, women had significantly poorer composite control of CVD risk outcomes compared with men, adjusting for relevant confounding factors. In unadjusted analyses, women had higher mean SBP and LDL cholesterol levels compared with men. However, after adjusting for relevant confounders, differences in SBP and LDL cholesterol between the two groups no longer persisted; instead, mean DBP levels emerged as being significantly higher in women than men. In unadjusted logistic models, women were more likely to have lower levels of BP, LDL cholesterol, and composite control compared with men. In adjusted logistic analyses, however, there were no statistically significant differences in HbA1c, BP, or LDL cholesterol control by gender. There was, however, a statistically significant difference by gender in composite control, with women having poorer control of multiple CVD risk outcomes simultaneously. Although a definitive cause cannot be identified based on our study design and findings, it is possible that this observed gender difference in CVD risk might be due to suboptimal control of multiple risk factors in women. In addition, these findings suggest that composite control should be a goal in the management and care of patients, especially women, with T2DM to decrease risk of poor CVD outcomes.

Our findings are supported by evidence from previous studies evaluating gender differences in CVD risk factor control for patients with T2DM. In this sample, we found women to have poorer composite control compared with men. Our study also found that only 12.4% of the sample has good composite control, and women are less likely to have good composite control compared with men (5.9% vs. 17.3%, respectively). This is similar to the findings of Homko et al.,[8] who found that women were less likely to achieve HbA1c, BP, and LDL cholesterol targets simultaneously compared with men. In a cross-sectional analysis of 8,775 patients with T2DM attending outpatient clinics in Croatia, researchers

Table 3. Unadjusted and Adjusted Linear Regression Models for Outcomes Between Men and Women

	Unadjusted model		*Adjusted model*	
Outcome	*Coefficient (95% CI)*	P *value*	*Coefficient (95% CI)*	P *value*
Mean HbA1c	−0.05 (−0.35, 0.25)	0.744	0.22 (−0.18, 0.62)	0.271
Mean SBP	−4.48 (−7.60, −1.36)	0.005[a]	0.29 (−4.02,4.60)	0.895
Mean DBP	−0.68 (−2.65, 1.29)	0.498	3.09 (0.56, 5.63)	0.017[a]
Mean LDL-C	−12.0 (−17.46, −6.55)	< 0.001[a]	−6.04 (−13.65, 1.56)	0.119

The model was adjusted for age, race/ethnicity, marital status, employment, insurance, education, income, health status, and clinic site. The reference group was women.
[a]Statistically significant, $P < 0.05$.
CI, confidence interval; DBP, diastolic blood pressure; HbA1c, glycosylated hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure.

Table 4. Logistic Regression Models (Unadjusted and Adjusted) for Outcomes Control by Gender and Controlling for Covariates

	Unadjusted		*Adjusted*	
Outcome	*Odds ratio (95% CI)*	P *value*	*Odds ratio (95% CI)*	P *value*
HbA1c <7%	1.23 (0.89, 1.70)	0.207	1.38 (0.88, 2.20)	0.161
BP <130/80 mm Hg	1.84 (1.35, 2.53)	<0.001[a]	1.22 (0.78, 1.92)	0.388
LDL-C <100 mg/dL	1.86 (1.34, 2.59)	<0.001[a]	1.35 (0.84, 2.17)	0.210
Composite control[b]	3.30 (1.89, 5.78)	<0.001[a]	2.90 (1.37, 6.13)	0.005[a]

The model was adjusted for age, race/ethnicity, marital status, employment, insurance, education, income, health status, and clinic site. The reference group was women.

[a]Statistically significant, $P < 0.05$.

[b]Composite control is defined as having all three outcomes under control simultaneously.

BP, blood pressure; CI, confidence interval; HbA1c, glycosylated hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

found women to have higher mean levels of HbA1c, SBP, and LDL cholesterol compared with men, resulting in poorer control of modifiable cardiovascular risk factors for women with T2DM compared with men with the same diagnosis.[23]

More evidence is needed to determine why gender differences in CVD risk factor control continue, and some postulate that this difference may be due to variances in clinical practice. In a systematic review of gender differences related to treatment of CVD, there was a 20% significant difference in cardiovascular-related outcomes by gender[31] such that women demonstrated more adverse outcomes in the majority of the studies reviewed. Several studies suggest that this difference may be due to significantly better medical management in men with diabetes compared with women.[14,17,19,24,27] Additionally, evidence demonstrates a variance in clinical practice such that women are less likely to receive treatment for modifiable risk factors and that when they are treated, they are done so less aggressively.[14,32] Women are less likely to be (1) prescribed necessary medications such as aspirin, statins, and antihypertensive agents, (2) use the medications when prescribed, and (3) meet treatment goals of therapy.[14,32,33] Furthermore, research suggests that gender differences in the blood levels of glucose and lipids, for example, contribute to the physiologic reasons for disparities in CVD risk between men and women.[14,32] The examination of treatment disparities between men and women for CVD and associated risk factors, as well as the behaviors of clinicians, warrants immediate consideration.

Researchers concluded there is a dire need for more large-scale clinical trials or meta-analyses concerning CVD in women. These findings suggest that, despite the existence of specified treatment goals and guidelines for better control, disparities between men and women still persist. Female patients must be educated on modifiable risk factors and made aware of their individual risk profiles for developing CVD. They must be empowered to adopt healthier lifestyles and behaviors such as adhering to prescribed medication regimens to achieve improved outcomes.

In this sample, there were more women than men and a higher percentage of non-Hispanic black women compared with white women. Additionally, fewer women in this sample were married and achieved higher levels of education. It is alarming that almost 90% of the women made less than $35,000 annually. Given these characteristics and a demonstrated lack of composite control for women in this sample, future research must seek to understand the major factors contributing to poorer risk profiles in women compared with men and in women of other racial and ethnic backgrounds.

With regard to glycemic control, diabetes presents a more significant risk for CVD among women,[14] and women have poorer cardiovascular risk profiles and outcomes compared with men. In this sample, we did not find any significant differences in glycemic control by gender when adjusting for relevant confounding factors; the reasons for this are not apparent. Therefore, future studies are needed to evaluate this disparity. Subsequent studies should focus on the influence other factors (like knowledge, attitudes, beliefs and perceptions, medication adherence, quality of care, access to care and availability of resources, self-management, and social support) impart on the differences observed in the management of patients with diabetes.

There are study limitations that must be mentioned. First, cross-sectional studies are limited in being able to draw causal associations. Second, there are potential confounders that were not controlled for, including diabetes knowledge, self-management practices, medication adherence, co-morbidity burden, and social support. Additionally, we did not have information on the duration of diabetes or the medications used to treat diabetes or hypertension; therefore, we are unable to substantiate gender differences based on these factors. Finally, evidence supports the notion that a high triglyceride level is an independent risk factor for coronary heart disease, particularly in women.[18,26] In our analyses, we did not account for the impact that other cholesterol subfractions (e.g., triglycerides, high-density lipoprotein, apolipoproteins) may have conferred to the women in this sample.

The results of our study are important and provide new information about gender differences in composite control of cardiovascular risk factors among patients with T2DM. In this sample of adults, women had significantly worse composite CVD risk factor control compared with men after adjusting for relevant confounding factors. These results point to the need for more research on composite CVD risk factor control in women with diabetes. Future research must focus on understanding the potential mediators causing gender differences in control. It is imperative that women are informed about CVD risk factors, educated on how to reduce them, and aggressively treated to avoid adverse outcomes.

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Author Disclosure Statement

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