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Diabetes Mellitus and Sexual Function in Middle-Aged and Older Women

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Abstract

Objective—Diabetes mellitus is an established risk factor for sexual dysfunction in men, but its effect on female sexual function is poorly understood. We examined the relationship of diabetes to sexual function in middle-aged and older women.

Methods—Sexual function was examined in a cross-sectional cohort of ethnically-diverse women aged 40 to 80 years using self-administered questionnaires. Multivariable regression models compared self-reported sexual desire, frequency of sexual activity, overall sexual satisfaction, and specific sexual problems (difficulty with lubrication, arousal, orgasm, or pain) among insulin-treated diabetic, noninsulin-treated diabetic, and nondiabetic women. Additional models assessed relationships between diabetic end-organ complications (heart disease, stroke, renal dysfunction, and peripheral neuropathy) and sexual function.

Results—Among the 2,270 participants, mean±SD age was 55±9.2 years, 1,006 (44.4%) were non-Latina white, 486 (21.4%) had diabetes, and 139 (6.1%) were taking insulin. Compared to 19.3% of non-diabetic women, 34.9% of insulin-treated diabetic women (adjusted OR[95%CI]=2.04[1.32–3.15] and 26.0% of non-insulin-treated diabetic women (adjusted OR[95%CI]=1.42[1.03–1.94]) reported low overall sexual satisfaction. Among sexually active women, insulin-treated diabetic women were more likely to report problems with lubrication (OR[95%CI]=2.37[1.35–4.16]) and orgasm (OR[95%CI]=1.80[1.01–3.20]) than nondiabetic women. Among all diabetic women, end-organ complications such as heart disease, stroke, renal dysfunction, and peripheral neuropathy were associated with decreased sexual function in at least one domain.

Conclusions—Compared to nondiabetic women, diabetic women are more likely to report low overall sexual satisfaction. Insulin-treated diabetic women also appear at higher risk for problems

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such as difficulty with lubrication and orgasm. Prevention of end-organ complications may be important in preserving sexual activity and function in diabetic women.

INTRODUCTION

Diabetes mellitus is a common chronic condition in the United States, with an estimated lifetime risk of 32.8% in men and 38.5% in women (1). Among men, diabetes is a recognized risk factor for sexual dysfunction, with prior research documenting an over threefold increased risk of erectile dysfunction in diabetic versus nondiabetic men (2). Among women, the effect of diabetes on sexual function is poorly understood, with very little research examining whether rates of sexual activity or sexual dysfunction differ in diabetic versus nondiabetic women or identifying risk factors for sexual dysfunction in diabetic women (3).

Diabetes has the potential to affect sexual function in women through a variety of mechanisms, including vascular changes in the urogenital tissues affecting genital lubrication and neuropathy-mediated alterations in genital arousal response. Women's interest in, satisfaction with, and ability to participate in sexual activity may be influenced globally by the effect of diabetes on their overall health, physical and mental functioning, and interpersonal relationships (4). Additionally, sexual function may be adversely affected by diabetes medications or other health interventions directed at monitoring or treating this chronic disease (5,6).

To examine the relationship of diabetes to sexual function in middle-aged and older women, we evaluated sexual activity, desire, satisfaction, and problems in a racially/ethnically-diverse, population-based cohort of 2,270 women aged 40 to 80 years, including 486 women with diabetes. Among diabetic women, we also examined associations between diabetic medication use, end-organ complications, and other markers of disease severity to sexual activity and function.

MATERIALS AND METHODS

Study Population

We conducted an ancillary study to the Reproductive Risks of Incontinence Study at Kaiser 2 (RRISK2), a cross-sectional cohort study of risk factors for urinary tract dysfunction in middle-aged and older women. Between January, 2003, and January, 2008, women were recruited from Kaiser Permanente Northern California (KPNC), an integrated health care delivery system serving approximately 25% to 30% of the northern California population. To be eligible for this cohort, women had to be between the ages of 40 and 80 years, to have been enrolled in Kaiser since age 24, and to have had at least half their childbirths at a Kaiser facility, but were not required to have any symptoms or history of genitourinary dysfunction (7). Women of non-white race/ethnicity were recruited to achieve a target race/ethnicity composition of 20% African-American, 20% Latina, 20% Asian, and 40% non-Latina white.

To achieve a diabetes prevalence of at least 20% in the overall cohort, women were also oversampled from the Northern California Kaiser Permanente Diabetes Registry, a database of KPNC patients that is updated annually through active surveillance of pharmacy, laboratory, and medical records. Prior studies have indicated that the registry has a sensitivity of 96% and a false-positive rate of 2% (8). Women who self-reported as having diabetes but were not listed in the diabetes registry were still classified as being diabetic if they met the following criteria normally used for registry inclusion: 1) use of a diabetes glycemic control medication, or 2) fasting blood sugar of 126 mg/dL or greater in the KPNC

database. Although autoantibody data were not collected systematically to provide a definitive determination of type 1 versus type 2 diabetes, only 7 participants (less than 2% of all diabetic women) reported that they were diagnosed with diabetes before the age of 30 and started on insulin at the time of diagnosis, suggesting that the vast majority of participants had type 2 diabetes. The final RRISK2 cohort consisted of 2,270 women aged 40 to 80 years, including 486 with diabetes.

Data Collection

Demographic characteristics, medical and gynecological history, medication use, and health-related habits were assessed in all participants using self-administered questionnaires as well as in-person interviews conducted either at a KPNC clinic or in participants' homes. Height and weight were measured by trained personnel at study visits for calculation of body mass index (BMI). Diabetic participants were also asked to contribute blood samples for measurement of serum creatinine and hemoglobin A1c (HbA1c).

Among participants with diabetes, specific diabetic end-organ complications were identified using questionnaire measures, physical examination, and/or laboratory studies. Specifically, heart disease and stroke were assessed by asking women, "Has a doctor, nurse, or other health care provider ever told you that you have any of the following conditions: 1) Heart attack (MI), angina, or other heart disease? 2) Stroke?" Peripheral neuropathy was assessed using the validated Michigan Neuropathy Screening Instrument (MNSI) instrument, which incorporates both self-reported symptom data and interviewer-administered physical examination of the lower extremities (foot inspection, vibration sensation, reflex testing, and monofilament testing); scores of 2 or greater are indicative of peripheral neuropathy (9). Renal function was examined by estimating glomerular filtration rate (GFR) from serum creatinine levels and participant age and weight using the Cockcroft-Gault equation; participants with a GFR <90 were considered to have at least stage 1 renal dysfunction.

Sexual activity and function were assessed using structured-item measures (see the Appendix at http://links.lww.com/xxx) derived from the validated Female Sexual Function Index (FSFI) (10) and previously administered in other large women's health studies (11,12,13). To ensure confidentiality, participants completed questions in private and submitted them to study personnel in sealed envelopes at their study visit. For this study, sexual activity was defined inclusively as "any activity that is arousing to you, including masturbation." Women were first asked to indicate whether they had had any sexual activity in the past 3 months, and, if so, the frequency of that activity.

Participants' sexual desire or interest, overall sexual satisfaction, and sexual problems were assessed through structured FSFI items that were adapted to assess sexual function in the 3 months before each visit. Women's level of sexual desire and overall sexual satisfaction were assessed in all participants regardless of sexual activity, whereas specific sexual problems (i.e., low level of arousal, difficulty with lubrication, difficulty achieving orgasm, and pain/discomfort during vaginal intercourse) were assessed only among women who reported some sexual activity in the past 3 months. To assess women's perception of the effect of their physical health on sexual function, all participants were additionally asked "how much has your physical health limited your sexual activity?" with response options ranging from "not at all" to "extremely."

Statistical Analyses

For the purposes of analysis, participants were categorized into one of three diabetes status groups based on whether they had diabetes, and, if so, whether they were using insulin: (1) insulin-treated diabetic women, (2) non-insulin-treated diabetic women, and (3) non-diabetic

women. These categories were chosen *a priori* based on the recognition that insulin use is a widely-recognized indicator of diabetes severity and also represents a higher level of disease management burden that can interfere with day-to-day functioning and quality of life. Differences in the demographic and clinical characteristics of participants in these three categories were examined using chi-square tests for categorical variables and analysis of covariance for continuous variables. Next, we described the distribution of less than monthly sexual activity, less than moderate sexual desire, and less than moderate sexual satisfaction among women in each diabetes status category. Among women reporting at least some sexual activity in the past 3 months, the prevalence of specific sexual problems such as low or very low arousal, at least moderate difficulty with lubrication, at least moderate difficulty with orgasm, or at least moderate pain with vaginal intercourse were also examined among women in each diabetes status category. Differences in the distribution of these sexual function outcomes among women in different diabetes status categories were examined using chi-square tests.

Our initial multivariable logistic regression models compared sexual function outcomes among: (1) insulin-treated diabetic versus nondiabetic women, and (2) noninsulin-treated diabetic versus nondiabetic women, adjusting for a core set of other factors with potential to influence sexual function (i.e., age, race/ethnicity, marital/relationship status, menopausal status, history of sex with men or women, body mass index, hysterectomy and oophorectomy, selective serotonin reuptake inhibitor [SSRI] use, and estrogen use.) While models examining frequency of sexual activity, desire, and satisfaction included all women, models examining specific sexual problems were confined to sexually active women, and additionally controlled for frequency of sexual activity.

Subsequent analyses used multivariable logistic regression to examine independent associations between diabetes-related end-organ complications and sexual function outcomes in all diabetic participants, again controlling for potential confounders. Sexual activity, desire, and satisfaction outcomes were examined in all diabetic participants, while specific problems with lubrication, arousal, orgasm, or pain were examined in sexually active diabetic women only. Finally, multivariable logistic regression models were developed to examine relationships between HbA1c and sexual function outcomes, adjusting for potential confounders. In these analyses, women with HbA1c levels 6.0 to 6.9, 7 to 7.9, and ≥8.0 were compared to women with levels < 6.0 as the reference group. All analyses were performed using SAS statistical software Version 9.1 (SAS Institute, NC). All study procedures were approved the institutional review boards of both the University of California San Francisco and the Kaiser Foundation Research Institute.

RESULTS

Of the 2,270 participants, 139 (6.1%) were insulin-treated diabetic, 347 (15.3%) were non-insulin-treated diabetic, and 1,784 (78.6%) were non-diabetic women (Table 1). Mean (±SD) age was 55 (±9.2) years, 1,006 (44.4%) were non-Latina white, 443 (19.5%) were African-American, 401 (17.7%) were Latina, 401 (17.7%) were Asian, and 18 (0.8%) were Native American. Age, race/ethnicity, marital/relationship status, parity, oophorectomy history, oral glycemic medication use, SSRI and estrogen use, alcohol use, and BMI differed significantly by diabetes status (Table 1). Of the diabetic participants, insulin-treated women tended to have more heart disease and peripheral neuropathy as well as higher HbA1c levels compared to non-insulin-treated women.

Overall, 63.7% of participants reported some sexual activity in the past 3 months. Of the 807 women who reported no sexual activity in the past 3 months, 271 (33.6%) indicated that lack of a partner and 224 (27.7%) indicated that partner health problems contributed to their

sexual inactivity. The proportion of sexually inactive women reporting partner-related issues did not differ by diabetes status (*P* for heterogeneity > .05).

Insulin-treated diabetic women were less likely to report at least monthly sexual activity compared to either non-insulin-treated diabetic women or non-diabetic women (Table 2). Insulin-treated diabetic women were also more likely to report low sexual desire and satisfaction compared to non-insulin-treated diabetic women or non-diabetic women. Among sexually active participants, problems with lubrication were also more common in insulin-treated diabetic women compared to non-diabetic women (Table 2).

In multivariable analysis adjusting for age, race, marital/relationship status, history of sex with men, women or both, parity, menopausal status, BMI, hysterectomy, oophorectomy, SSRI use, and estrogen use, the odds of reporting low overall sexual satisfaction were over two-fold higher in insulin treated diabetic women, and over 40% higher in non-insulin treated diabetic women, compared to non-diabetic women (Table 3). However, no significant differences in sexual desire or frequency of sexual activity by diabetes status were observed.

Among sexually active women, insulin-treated diabetic women were also more than twice as likely to report difficulty with lubrication and 80% more likely to report difficulty achieving orgasm compared to non-diabetic women, after adjusting for the same demographic and clinical factors (Table 3). No significant associations between diabetes status and other types of sexual problems (difficulty with arousal or pain/discomfort during intercourse) were detected in multivariable analyses.

When asked if their physical health limited their sexual activity, insulin-treated diabetic women were more likely than non-diabetic women to report that their health limited their sexual activity “quite a bit” or “extremely,” in multivariable analysis (OR[95%CI] = 2.29[1.49–3.51]). However, non-insulin-treated diabetic women were not substantially more likely than non-diabetic women to feel that their health limited their sexual activity (OR[95% CI]= 1.29 [0.92–1.78]).

Among all diabetic women (n = 486), the most common diabetic end-organ complication was peripheral neuropathy as measured by MNSI score (60.9%), followed by renal dysfunction (39.5%), heart disease (13.4%), and stroke (6.4%). In multivariable analyses, diabetic women were more likely to report less than monthly sexual activity if they had heart disease, renal dysfunction, or peripheral neuropathy (Table 4). Diabetic women with a history of stroke were more likely to report low overall sexual satisfaction than those without a stroke history. Diabetic women with peripheral neuropathy were also more likely to report less than monthly sexual activity, lower sexual desire, and limitation of sexual activity by physical health, compared to those without neuropathy. Among sexually active diabetic women, no significant associations between specific diabetic end-organ complications and sexual problems such as difficulty with arousal, lubrication, orgasm, or pain with intercourse were observed in adjusted models (Table 4). There were also no significant associations between number of years since diabetes diagnosis and sexual function, after adjustment for end-organ complications (*P* > .05 for all).

Of the diabetic participants, 62 (13.0%) had a HbA1c level less than 6.0%, 159 (33.4%) had a HbA1c level of 6.0% to 6.9%, 135 (28.4%) had a HbA1c level of 7.0% to 7.9%, and 120 (25.2%) had a HbA1c level of 8.0% or higher. In multivariable analyses, diabetic women with a HbA1c level of 8.0% or higher were less likely to report low sexual satisfaction (OR [95%CI] = 0.36 [0.16–0.80]), compared to diabetic women with a HbA1c level less than 6.0%. No other associations between HbA1c and sexual function were detected.

DISCUSSION

In this cohort of ethnically-diverse middle-aged and older women, diabetic and non-diabetic women reported similar levels of sexual desire and frequency of sexual activity, after adjustment for other demographic and clinical factors. However, both insulin-treated and non-insulin-treated diabetic women were significantly more likely to report low overall sexual satisfaction compared to non-diabetic women, and problems with lubrication and orgasm were more common among insulin-treated diabetic women compared to non-diabetic women. These findings suggest that while many diabetic women are interested and engaged in sexual activity, diabetes is associated with a markedly decreased sexual quality of life in women, either through complications of the disease itself or through utilization of treatments.

Our study also found that diabetic women with end-organ complications such as peripheral neuropathy, renal dysfunction, stroke and heart disease were more likely to report decreased sexual activity or lower sexual satisfaction than diabetic women without these complications. These findings suggest that diabetic end-organ complications may play an important role in decreasing women's sexual quality of life, and that raise the possibility that prevention of diabetic complications may be helpful in preventing sexual dysfunction in women with diabetes.

To date, there has been very limited study of the effect of diabetes on female sexual function, with prior research tending to rely upon small numbers of participants (14,15,16,17), lack non-diabetic controls (16), use unidimensional measures of sexual function (16,18), or focus on referral or other narrow populations (15,16,17,18,20,21,22). While a few previous studies have pointed to worse overall sexual function among diabetic women (15,19,21),our study underlines the importance of distinguishing between different aspects of female sexual function when evaluating the burden of this disease. Based on this research, diabetes and its complications appear to have a much greater impact on sexual problems such as lubrication and orgasm as opposed to sexual desire or subjective arousal. Furthermore, our study indicates that the adverse effects of diabetes on sexual function may be concentrated in women taking insulin, an apparently high-risk group for developing sexual problems.

One unexpected finding was that diabetic women with HbA1c levels of 8.0% or greater in this cohort tended to report higher overall sexual satisfaction compared to those with lower HbA1c, independent of clinical characteristics such as BMI, medication use, or duration of diabetes. One possible explanation for this finding is that it reflects unmeasured differences in attitudes, expectations, or approaches to sexual activity among diabetic women with better versus worse glycemic control. Diabetic women who were less motivated or interested in checking and controlling their blood sugars may have placed more priority on sexual activity and/or function in their daily lives, resulting in higher reports of sexual satisfaction. Alternatively, diabetic women with worse glycemic control may have had lower expectations about sexual activity in the setting of their poorly controlled disease, with the paradoxical result that they retained a stronger subjective sense of sexual satisfaction in spite of experiencing the same sexual difficulties. Differences in impulse control and other unmeasured personality factors could also have influenced both glycemic control and sexual satisfaction in diabetic participants.

This study benefits from a large and ethnically-diverse sample of women, multidimensional measures of sexual function and problems, and assessment of a large number of disease-specific factors with the potential to influence sexual function, including laboratory data on HbA1c level and kidney function. However, several limitations to this research should be

recognized. First, this was a cross-sectional study, and we were unable to examine longitudinal change in sexual activity and function over time or provide definitive evidence of causal relationships. Future studies should address whether poor diabetes control over time or de novo incidence of diabetic complications is associated with progression of sexual dysfunction in diabetic women. Second, although our measures were derived from previously validated questionnaires and have been used successfully in other women's health studies, they were adapted for the purposes of this research without being re-subjected to detailed psychometric testing. Additionally, the majority of diabetic participants were believed to have type 2 diabetes, which is consistent with national statistics showing that the vast majority of adult diabetic patients have type 2 diabetes, especially in older populations. This may limit the generalizability of our findings to women with type 1 diabetes. Lastly, some diabetic complications (heart disease, stroke) were assessed exclusively by self-report, and validation through clinical evaluation may be helpful to confirm these findings. Additionally, our power to detect associations between some diabetic complications (e.g., stroke) and sexual function outcomes was partly limited by the relatively small number of events.

Several previous studies have suggested that psychological factors such as depression play a role in sexual dysfunction among diabetic women (15,19,21,23,24,25). Because detailed depression measures were not administered in our cohort, our study did not assess depression as a mediator of the impact of diabetes on female sexual function. However, our multivariable models did adjust for SSRI medication use, given their known propensity to worse sexual function, and found that relationships between diabetes and sexual function were independent of SSRI therapy.

In summary, in this large cohort of ethnically-diverse women, we found that diabetic women did not differ significantly from non-diabetic women with regard to interest and engagement in sexual activity, but did report lower levels of sexual satisfaction and more problems with lubrication and orgasm during sex, particularly if they were taking insulin. End-organ complications such as heart disease, stroke, neuropathy, and renal dysfunction were associated with decreased sexual activity or decreased sexual satisfaction among diabetic women. Based on this research, clinicians may want to consider actively assessing for sexual problems in diabetic women, particularly those taking insulin, and counsel diabetic women that prevention of end-organ complications may be important in preserving their sexual function.

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Table 1

Demographic and Clinical Characteristics of Participants by Diabetes Status

Characteristic	Insulin-Treated Diabetic (n=139)	Noninsulin-Treated Diabetic (n=347)	Nondiabetic (n=1784)	*P* *
Age in years, mean (±SD)	55.9 (±9.1)	56.0 (±8.6)	54.7 (±9.3)	.006
Race/ethnicity†, No. (%)				.02
Caucasian	64 (46.0)	130 (37.8)	812 (45.5)	
African American	29 (20.9)	73 (21.1)	341 (19.1)	
Asian or Pacific Islander	15 (10.8)	66 (19.0)	320 (17.9)	
Latina	29 (20.9)	77 (22.2)	295 (16.5)	
Native American or Other	2 (1.4)	0 (0.0)	16 (0.9)	
Relationship history, No. (%)				
Married or living as married	84 (60.9)	223 (64.3)	1236 (69.3)	.03
Sexually active with men only	131 (97.0)	322 (92.8)	1696 (95.7)	.12
Parity				.028
Nulliparous	17 (12.3)	54 (15.6)	335 (18.8)	
1to 2 births	62 (44.9)	167 (48.3)	762 (42.8)	
3 or more births	59 (42.8)	125 (36.1)	684 (38.4)	
Gynecologic history, n (%)				
Postmenopausal‡	113 (81.3)	254 (73.2)	1284 (72.0)	.06
Prior hysterectomy	96 (69.1)	260 (74.9)	1381 (77.4)	.06
Bilateral oophorectomy	16 (11.5)	27 (7.8)	72 (4.0)	<.001
Current medication use, n (%)				
Oral glycemic agent use	131 (94.2)	261 (75.2)	--------	<.001
Oral or transdermal estrogen use	13 (9.4)	29 (8.4)	224 (12.6)	.06
Selective serotonin reuptake inhibitor use	21 (15.1)	41 (11.8)	144 (8.1)	.003
Health related habits and body mass index				
Currently smoking, n (%)	14 (10.1)	29 (8.4)	128 (7.2)	.38
One or more alcoholic drink per week, n (%)	7 (5.1)	45 (13.0)	542 (30.4)	<.001
Body mass index in kg/m^2, mean (±SD)	35.2 (±8.8)	33.3 (±7.4)	28.2 (±6.8)	<.001
Diabetic end-organ complications, n (%)				
Heart disease§	34 (24.5%)	31 (8.9%)	--------	<.001

Characteristic	Insulin-Treated Diabetic (n=139)	Noninsulin-Treated Diabetic (n=347)	Nondiabetic (n=1784)	*P* *
Stroke§	10 (7.2%)	21 (6.1%)	--------	.64
Renal dysfunction□	62 (45.3%)	130 (38.1%)	--------	.15
Peripheral neuropathy¶	112 (80.6%)	184 (58.6%)	--------	<.001
Hemoglobin A1C, n (%)				
Less than 6.0%	12 (8.8%)	50 (14.7%)	--------	
6.0 to 6.9%	34 (24.8%)	125 (36.9%)	--------	.004
7.0 to 7.9%	46 (33.6%)	89 (26.3%)	--------	
8.0% or greater	45 (32.8%)	75 (22.1%)	--------	
Self-reported years since diabetes diagnosis, mean (±SD)	15.8 (±11.1)	7.4 (±6.0)	-------	<.001

SD, standard deviation.

Data were missing for one participant for race or ethnicity, one for relationship status, five for parity, 15 for history of sexual activity with men compared with women, one for number of alcoholic drinks per week, 15 for body mass index, and 35 for years since diabetes diagnosis.

** P* for heterogeneity derived from chi-square or analysis of variance tests, as appropriate.

† Race or ethnicity information was assessed by asking women to self-identify as non-Latina white, Latina or Hispanic, African American or black, Asian or Pacific Islander, Native American, or other.

‡ Women were considered postmenopausal if they reported no natural menses in at least 1 year.

§ Assessed by asking, “Has a doctor, nurse, or other health care provider ever told you that you have: 1) Heart attack (MI), angina, or other heart disease? 2) Stroke?”

□ Defined as a glomerular filtration rate less than 90 as estimated by the Cockcroft-Gault equation.

¶ Defined as a Michigan Neuropathy Screening Instrument score of 2 or higher.

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Table 2

Sexual Activity and Functioning Among Participants by Diabetes Status

Sexual Function Outcomes Assessed in All Participants	Insulin-Treated Diabetic (n = 139)	Noninsulin-Treated Diabetic (n = 347)	Nondiabetic (n = 1784)	*P* *	*P* †
Less than monthly sexual activity	82 (61.2)	199 (58.0)	839 (48.0)	.003	<.001
Low sexual desire‡	83 (61.9)	201 (58.3)	928 (52.5)	.04	.05
Low sexual satisfaction§	38 (34.9)	75 (26.0)	304 (19.3)	<.001	.009
Sexual function outcomes assessed in sexually active participants only	**Insulin-treated diabetic (n = 69)**	**Non-insulin-treated diabetic (n = 189)**	**Non-diabetic (n = 1160)**	***P****	***P*** †
Low level of sexual arousal□	15 (20.8)	31 (16.2)	183 (15.8)	.26	.88
Difficulty with lubrication¶	24 (33.8)	34 (17.8)	220 (19.1)	.003	.66
Difficulty with orgasm//	19 (26.4)	32 (16.8)	207 (18.0)	.08	.69
Pain/discomfort with intercourse#	12 (19.4)	21 (12.9)	150 (14.8)	.33	.52

Data are n (%)

*P for difference between insulin-treated diabetic and nondiabetic women, derived from chi-square tests

†P for difference between noninsulin-treated diabetic and nondiabetic women, derived from chi-square tests

‡Women were considered to have “low sexual desire” if they reported that their level of sexual desire or interest was low, very low, or none.

§Women were considered to have “low sexual satisfaction” if they reported their overall level of sexual satisfaction was moderately dissatisfied or very dissatisfied.

□Women were considered to have “low sexual arousal” if they reported their level of sexual arousal during sexual activity was low, very low or none.

¶Women were considered to have “difficulty with lubrication” if they reported it was difficult, very difficult, extremely difficult or impossible to become lubricated during sexual activity.

//Women were considered to have difficulty with orgasm if they reported that was difficult, very difficult, extremely difficult, or impossible to reach orgasm during sexual stimulation or intercourse.

#Women were considered to have pain or discomfort with intercourse if they reported their level of discomfort or pain during or following vaginal penetration was moderate, high, or very high.

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Table 3

Multivariable Associations between Diabetes Status and Sexual Activity and Functioning Among Participants

	Less Than Monthly Sexual Activity		Low Sexual Desire*		Low Sexual Satisfaction†		Low Level of Sexual Arousal‡		Difficulty With Lubrication§		Difficulty With Orgasm‖		Pain or Discomfort With Intercourse¶	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Insulin-treated diabetic compared with nondiabetic	1.27 (0.85–1.91)	.25	1.17 (0.79–1.72)	.43	2.04 (1.32–3.15)	.001	1.19 (0.62-2.29)	0.6	2.37 (1.35-4.16)	0.003	1.80 (1.01-3.20)	0.05	1.52 (0.76-3.06)	0.24
Noninsulin-treated diabetic compared with nondiabetic	1.21 (0.92–1.58)	.17	1.09 (0.85–1.42)	.49	1.42 (1.03–1.94)	.03	1.09 (0.67-1.67)	0.82	1.01 (0.65-1.58)	0.97	1.02 (0.65-1.58)	0.94	0.95 (0.56-1.62)	0.85

OR, odds ratio; CI, confidence interval.

Odds ratios and confidence intervals derived from logistic regression models, adjusted for age, race or ethnicity, relationship status, history of sex with men, women or both, parity, menopause status, hysterectomy, oophorectomy, body mass index, selective serotonin reuptake inhibitor use, and estrogen use.

Separate models were developed for each sexual function outcome. Less than monthly sexual activity, low sexual desire, and low sexual satisfaction were assessed in all participants regardless of sexual activity status, whereas low level of sexual arousal, difficulty with lubrication, difficulty with orgasm, and pain or discomfort with intercourse were assessed only in women reporting some sexual activity in the past 3 months.

*Women were considered to have low sexual desire if they reported that their level of sexual desire or interest was low, very low, or none.

†Women were considered to have “low sexual satisfaction” if they reported their overall level of sexual satisfaction was moderately dissatisfied or very dissatisfied.

‡Women were considered to have “low sexual arousal” if they reported their level of sexual arousal during sexual activity was low, very low, or none.

§Women were considered to have “difficulty with lubrication” if they reported it was difficult, very difficult, extremely difficult, or impossible to become lubricated during sexual activity.

‖Women were considered to have “difficulty with orgasm” if they reported that it was difficult, very difficult, extremely difficult, or impossible to reach orgasm during sexual stimulation or intercourse.

¶Women were considered to have pain or discomfort with intercourse if they reported their level of discomfort or pain during or after vaginal penetration was moderate, high, or very high.

Table 4

Multivariable Associations Between Diabetic End-Organ Complications and Sexual Activity and Functioning Among Participants with Diabetes

Complication	Less Than Monthly Sexual		Low Sexual Desire*		Low Sexual Satisfaction†		Low Level of Sexual Arousal¶		Difficulty with lubrication#		Difficulty with orgasm**		Pain/discomfort with intercourse††	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Heart disease‡	2.42 (1.17–4.98)	.02	1.96 (0.99–3.87)	.05	1.19 (0.59–2.40)	.62	1.97 (0.63– 6.22)	.25	2.12 (0.77-5.86)	0.15	0.97 (0.28-3.36)	0.96	2.53 (0.73-8.78)	0.14
Stroke‡	2.72 (0.81–9.10)	.11	1.49 (0.55–4.06)	.43	3.32 (1.08–10.21)	.04	2.12 (0.47– 9.63)	.33	0.33 (0.03-3.34)	0.35	0.81 (0.11-5.88)	0.83	NA	
Renal dysfunction§	2.06 (1.16–3.67)	.01	1.07 (0.62–1.84)	.80	0.90 (0.51–1.60)	.73	1.32 (0.52– 3.33)	0.55	0.95 (0.41-2.21)	0.91	0.75 (0.29-1.91)	0.54	0.91 (0.30-2.77)	0.87
Peripheral neuropathy//	1.73 (1.08–2.78)	.02	1.57 (1.00–2.47)	.05	1.16 (0.72–1.97)	.55	1.31 (0.58– 2.99)	0.52	1.31 (0.63-2.74)	0.47	1.17 (0.53-2.56)	0.7	0.76 (0.30-1.96)	0.57

OR, odds ratio; CI, confidence interval.

Odds ratios and confidence intervals were derived from multivariable logistic regression models that evaluated each sexual function outcome separately, adjusting for age, race or ethnicity, relationship status, history of sex with men, women or both, parity, menopause status, hysterectomy, oophorectomy, body mass index, selective serotonin reuptake inhibitor and estrogen use, and duration of diabetes.

Less than monthly sexual activity, low sexual desire, and low sexual satisfaction were assessed in all diabetic participants regardless of sexual activity status, whereas low level of sexual arousal, difficulty with lubrication, difficulty with orgasm, and pain or discomfort with intercourse were assessed only in diabetic women reporting some sexual activity in the past 3 months.

*Women were considered to have low sexual desire if they reported that their level of sexual desire or interest was low, very low, or none.

†Women were considered to have low sexual satisfaction if they reported their overall level of sexual satisfaction was moderately dissatisfied or very dissatisfied.

‡Assessed by asking participants, “Has a doctor, nurse, or other health care provider ever told you that you have: 1) Heart attack (MI), angina, or other heart disease? 2) Stroke?”

§Defined as a glomerular filtration rate lower than 90, estimated by the Cockcroft-Gault equation.

//Defined as a Michigan Neuropathy Screening Instrument score of 2 or higher.

¶Women were considered to have low sexual arousal if they reported their level of sexual arousal during sexual activity was low, very low, or none.

#Women were considered to have difficulty with lubrication if they reported it was difficult, very difficult, extremely difficult, or impossible to become lubricated during sexual activity.

**Women were considered to have difficulty with orgasm if they reported that is was difficult, very difficult, extremely difficult, or impossible to reach orgasm during sexual stimulation or intercourse.

††Women were considered to have pain or discomfort with intercourse if they reported their level of discomfort or pain during or following vaginal penetration was moderate, high, or very high.