

## WOMEN'S SEXUAL HEALTH

## Assessment of the Association of Cannabis on Female Sexual Function With the Female Sexual Function Index



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## ABSTRACT

**Introduction:** Cannabis use has increased in the last decade, and the impact of cannabis on female sexual function remains unclear.

**Aim:** To assess the impact of frequency of use, chemovar (tetrahydrocannabinol, cannabidiol, or both) type, and method of consumption on female sexual function among cannabis users.

**Methods:** Adults who visited a single-partner cannabis dispensary's locations were invited to participate in an uncompensated, anonymous online survey October 20, 2019 and March 12, 2020. The survey assessed baseline demographics, health status, cannabis use habits as well as used the validated Female Sexual Function Index (FSFI) to assess sexual function.

**Main Outcome Measure:** The main outcomes of this study are the total FSFI score (sexual dysfunction cutoff <26.55) and subdomain scores including desire, arousal, lubrication, orgasm, satisfaction, and pain.

**Results:** A total of 452 women responded with the majority between the ages of 30–49 years (54.7%) and in a relationship or married (81.6%). Of them, 72.8% reported using cannabis more than 6 times per week, usually through smoking flower (46.7%). Women who reported more cannabis use, reported higher FSFI scores (29.0 vs 26.7 for lowest vs highest frequencies of reported use,  $P = .003$ ). Moreover, an increase in cannabis use frequency by one additional use per week was associated with an increase in total FSFI ( $\beta = 0.61$ ,  $P = .0004$ ) and subdomains including desire domain ( $P = .02$ ), arousal domain ( $P = .0002$ ), orgasm domain ( $P = .002$ ), and satisfaction domain ( $P = .003$ ). For each additional step of cannabis use intensity (ie, times per week), the odds of reporting female sexual dysfunction declined by 21% (odds ratio: 0.79, 95% confidence interval: 0.68–0.92,  $P = .002$ ). Method of consumption of cannabis and chemovar type did not consistently impact FSFI scores or odds of sexual dysfunction.

**Conclusion:** Increased frequency of marijuana use is associated with improved sexual function among female users, whereas chemovar type, method of consumption, and reason for use does not impact outcomes. **Kasman AM, Bhambhani HP, Wilson-King G, et al. Assessment of the Association of Cannabis on Female Sexual Function With the Female Sexual Function Index. Sex Med 2020;8:699–708.**

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**Key Words:** Cannabis; Marijuana; Female Sexual Function; Female Sexual Dysfunction; FSFI

## INTRODUCTION

The impact of cannabis use on sexual function is a matter of debate. An estimated 22.2 million people within the United States

use cannabis monthly, and there are more than a 100 million lifetime users.<sup>1–3</sup> There have been major policy changes governing cannabis use since the 1960s as calls for legalization began with

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medical legalization in 1996 by California followed by adult use in 2012 by Colorado and Washington State.<sup>4</sup> There are now 29 states, and the District of Columbia have legalized use of cannabis either for medical or adult use.<sup>5</sup> As legalization has become more prevalent and users have become more widespread, there is a need to better understand the systemic effects of cannabis.<sup>6</sup>

Cannabis' effect on sexual arousal and sex steroid hormones has been previously studied.<sup>7,8</sup> Women who use cannabis have reported increased sexual frequency and increased endocannabinoids have been associated with increased arousal; however, examination of sexual function with regard to cannabis has led to conflicting reports.<sup>7,9</sup> Prior studies have either examined sexual function using a mix of validated and non-validated instruments with varied results.<sup>10,11</sup> Although a few studies have found a positive dose-dependent effect on arousal and shown a positive effect with pleasure, these studies have been small and have not examined other domains of female sexual function such as lubrication, pain, and overall satisfaction.<sup>12</sup> Interestingly, a large Australian survey found that men who used cannabis were more likely to report impaired sexual function, whereas women cannabis users did not have higher rates of sexual dysfunction.<sup>13</sup> To date, no studies have examined female sexual function with a validated survey in a large sample size nor have examined the impact of the cannabis chemovar (categorization of a plant species based on chemical composition, eg, tetrahydrocannabinol [THC] or cannabidiol [CBD] dominant) or the method of consumption. Chemovar may be important as the receptors for THC and CBD are different, which may account for the psychoactive effects of THC compared with CBD.<sup>14</sup> Therefore, we sought to characterize the association between female sexual function and cannabis use by using a validated questionnaire (Female Sexual Function Index [FSFI]) using a U.S. population.

## METHODS

### Study Population

After institutional review board approval, adults who visited a single-partner cannabis dispensary were invited to participate in an uncompensated, anonymous online survey via a provided hyperlink or QR code upon purchase between October 20, 2019 and March 12, 2020. The partner dispensary was chosen based on a large customer base and willingness to distribute our survey. The survey was distributed throughout all locations of the partner dispensary.

### Survey Instruments

All participants were administered the same anonymous survey in the English language via the online survey platform Qualtrics (Provo, UT). Informed consent was waived given the online nature of the survey, and waiver of documentation was provided before proceeding with the survey. The first half of the survey queried participants for demographic information, past medical history, and adult drug use habits. After selection of sex, female

participants were directed to the validated FSFI. The FSFI is a validated 19-item survey instrument designed to assess female sexual function over the preceding 4 weeks.<sup>15</sup> It assesses 6 individual domains including desire, arousal, lubrication, orgasm, satisfaction, and pain. Each domain is scored via a Likert scale score from either 0–5 or 1–5 with a cutoff total score of 26.55 to define sexual dysfunction as per previous validation studies to define female sexual dysfunction.<sup>15,16</sup> To score, each domain sum is multiplied by a specific factor ratio and then summed to obtain the total FSFI score with a maximum of 36. As the FSFI was developed and validated in sexually active women, sexually inactive participants were excluded from the analysis.

### Covariates

Demographics collected included age, race, primary region of residence (international or per U.S. census divisions), and relationship status. Clinical variables were height, weight, number of visits to a primary care provider in the last 3 months, tobacco smoking history, and the presence/absence of 13 common chronic comorbidities within the United States (ie, hypertension, hypercholesterolemia, diabetes, heart disease, arthritis, lung disease, kidney disease, thyroid disease, cancer, neurologic disease, liver disease, depression, and anxiety).<sup>17</sup> Responses (yes/no) to these variables were collapsed to a single continuous variable, “total comorbidities” for the purpose of analysis. The complete distribution of these comorbidities can be found in [Supplemental Table 1](#).

Cannabis use variables included frequency of use within the last 4 weeks, method of consumption, primary cannabis chemovar (THC or CBD dominant), and reason for use. Options for frequency of use were never, 1–2 times per week, 3–5 times per week, and 6+ times per week. The frequency-response relationship was assessed in our regression analyses by converting this categorical variable to a continuous variable as follows: never users were assigned a value of 0; 1–2 times per week, a value of 1.5; 3–5 times per week, a value of 4; and 6+ times per week, a value of 6.1. These continuous variable values were chosen as the average weekly use frequency of their respective categorical variables. The options for method of consumption included smoking flower, edibles, smoking concentrates/extracts, tincture/oils, vaping, and other. 9 options were given for reason for use after performing a review of the literature: relax/unwind, improve mood, help with pain, help with sleep, help with stress, help with depression, glaucoma, nausea/loss of appetite, and neurologic condition.<sup>18</sup> The complete distribution of reason for use is illustrated in [Supplemental Table 1](#).

### Statistical Methods

Patient characteristics and survey responses were analyzed using descriptive statistics, including proportions, median, and mean  $\pm$  SD. Categorical variables were analyzed by the  $\chi^2$  test or Fisher's exact test as appropriate. Normally distributed continuous variables were analyzed by Student's t-test, whereas skewed continuous variables were analyzed by the Wilcoxon rank sum

**Table 1.** Cohort demographics and stratification by frequency of cannabis use

Characteristic	Overall	Frequency of cannabis use		P value
		≥3 times per wk	≤2 times per wk	
N	452	392	60	
Age, y Overall (range)	42 (20–79)			
<30	67 (14.8)	58 (14.8)	9 (15.0)	.23
30–39	117 (25.9)	101 (25.8)	16 (26.7)	
40–49	130 (28.8)	109 (27.8)	21 (35.0)	
50–59	81 (17.9)	76 (19.4)	5 (8.3)	
60+	55 (12.2)	47 (12.0)	8 (13.3)	
Race (%)				
Caucasian	337 (74.6)	300 (76.5)	37 (61.7)	.02*
Black/African	15 (3.3)	14 (3.6)	1 (1.7)	
Hispanic/Latino	55 (12.2)	45 (11.5)	10 (16.7)	
Other	45 (10.0)	33 (8.4)	12 (20.0)	
Region (%)				
West	159 (35.2)	130 (33.2)	29 (48.3)	.05*
International	96 (21.2)	87 (22.2)	9 (15.0)	
Midwest	34 (7.5)	27 (6.9)	7 (11.7)	
Northeast	81 (17.9)	74 (18.9)	7 (11.7)	
South	75 (16.6)	69 (17.6)	6 (10.0)	
Unknown	7 (1.5)	5 (1.3)	2 (3.3)	
Relationship status (%)				
Married	245 (54.2)	210 (53.6)	35 (58.3)	.59
In a relationship	124 (27.4)	111 (28.3)	13 (21.7)	
Single	79 (17.5)	67 (17.1)	12 (20.0)	
Education (%)				
4-y degree	130 (28.8)	118 (30.1)	12 (20.0)	.01*
2-y degree	67 (14.8)	58 (14.8)	9 (15.0)	
Doctorate	32 (7.1)	27 (6.9)	5 (8.3)	
High school or less	33 (7.3)	33 (8.4)	0 (0.0)	
Professional degree	108 (23.9)	84 (21.4)	24 (40.0)	
Some college	82 (18.1)	72 (18.4)	10 (16.7)	
Weight, lbs (mean [SD])	155.20 (37.44)	154.69 (37.73)	158.48 (35.54)	.47
Height, cm (mean [SD])	165.41 (6.97)	165.43 (6.88)	165.31 (7.54)	.91
PCP visits in last 3 mo (%)				
0	213 (47.1)	181 (46.2)	32 (53.3)	.59
1	170 (37.6)	150 (38.3)	20 (33.3)	
2+	69 (15.3)	61 (15.6)	8 (13.3)	
Cannabis use frequency (%)				
Never	7 (1.5)	0 (0.0)	7 (11.7)	<.001
1–2 times per wk	53 (11.7)	0 (0.0)	53 (88.3)	
3–5 times per wk	63 (13.9)	63 (16.1)	0 (0.0)	
6+ times per wk	329 (72.8)	329 (83.9)	0 (0.0)	
Tobacco use (%)				
Never smoker	203 (44.9)	167 (42.6)	36 (60.0)	.05*
Current smoker	59 (13.1)	56 (14.3)	3 (5.0)	
Former smoker	189 (41.8)	168 (42.9)	21 (35.0)	
Method of consumption (%)				
Smoking flower	211 (46.7)	193 (49.2)	18 (30.0)	<.001*
Edibles	50 (11.1)	38 (9.7)	12 (20.0)	
Other	22 (4.9)	15 (3.8)	7 (11.7)	
Smoking concentrates	24 (5.3)	23 (5.9)	1 (1.7)	

(continued)

Table 1. Continued

Characteristic	Overall	Frequency of cannabis use		P value
		≥3 times per wk	≤2 times per wk	
N	452	392	60	
Tincture or oils	69 (15.3)	56 (14.3)	13 (21.7)	
Vaping	73 (16.2)	67 (17.1)	6 (10.0)	
Primary reason for use (%)				
Medical	364 (80.5)	327 (83.4)	37 (61.7)	<.001*
Recreational	88 (19.5)	65 (16.6)	23 (38.3)	
Cannabinoid (%)				
THC dominant	208 (46.0)	189 (48.2)	19 (31.7)	<.001*
Both THC and CBD	192 (42.5)	168 (42.9)	24 (40.0)	
Only CBD dominant	49 (10.8)	35 (8.9)	14 (23.3)	
Total comorbidities (%)				
0	111 (24.6)	87 (22.2)	24 (40.0)	.004*
1	111 (24.6)	94 (24.0)	17 (28.3)	
2	123 (27.2)	110 (28.1)	13 (21.7)	
3+	107 (23.7)	101 (25.8)	6 (10.0)	
FSFI score (mean [SD])				
Total score	28.6 (5.44)	28.9 (5.30)	26.7 (5.98)	.003*
Desire score	3.74 (1.11)	3.8 (1.10)	3.5 (1.12)	.03*
Arousal score	4.7 (1.19)	4.8 (1.17)	4.3 (1.24)	.003*
Lubrication score	5.2 (1.19)	5.2 (1.15)	4.9 (1.43)	.09
Orgasm score	4.9 (1.35)	5.0 (1.32)	4.6 (1.48)	.01*
Satisfaction score	4.74 (1.34)	4.79 (1.32)	4.39 (1.42)	.03*
Pain score	5.27 (1.18)	5.30 (1.12)	5.06 (1.49)	.14

BMI = body mass index; CBD = cannabidiol; FSFI = female sexual function index; OR = odds ratio; PCP = primary care physician; SD = standard deviation; THC = tetrahydrocannabinol.

Comorbidities included hypertension, diabetes, heart disease, arthritis, lung disease, kidney disease, thyroid disease, hypercholesterolemia, cancer, neurologic disease, liver disease, depression, and anxiety.

Region represents primary residence.

\*Significant ( $P < .05$ ).

test. Multiple linear regression was used to identify factors associated with the overall FSFI score, as well as each FSFI domain. We used multivariable logistic regression to identify factors associated with female sexual dysfunction. In this analysis, female sexual dysfunction was defined as a FSFI score of less than 26.55.<sup>15</sup> All data were analyzed using R v3.5.3 (R Foundation for Statistical Computing, Vienna, Austria). The significance level for all statistical tests was set at  $<0.05$ , and all tests were 2 sided.

## RESULTS

Survey respondent demographics including age, race, relationship status, education, and cannabis use characteristics are outlined in Table 1. In total, 452 women completed the survey with the majority between the ages of 30–49 years (54.7%) and in a relationship or married (81.6%). Most participants were educated with either a 4 year or professional degree (52.7%) and had not seen their primary care physician within the last

3 months (47.1%). Of them, 72.8% reported using cannabis more than 6 times per week in the last 4 weeks, usually through smoking flower (46.7%). Overall, 118 women reported sexual dysfunction with a FSFI score of  $<26.55$ .

When stratified by frequency of use ( $\geq 3$  times per week vs  $< 3$  times per week), those who used more frequently had overall higher FSFI scores (28.9 vs 26.7,  $P = .003$ ) and had higher FSFI subdomain scores except for pain (5.3 vs 5.06,  $P = .14$ ). More frequent users tended to smoke flower (49.2% vs 30%) and vape (17.1% vs 10%), whereas less frequent users reported using edibles more commonly (20% vs 9.7%;  $P < .001$ ). In addition, the dominant cannabinoid chemovar that more frequent users reported was THC dominant (48.2% vs 31.7%) compared with CBD dominant (8.9% vs 23.3%,  $P < .001$ ). More frequent users had more comorbidities compared with less frequent users with 25.8% with 3 or more compared with 10% ( $P = .004$ ). The most common reason for cannabis use was to relax (81%) followed by relieve stress (74.1%) and help with sleep (73.9%; Supplemental Table 1).

**Table 2.** Linear regression models of female sexual function index scores and demographics, health status, and marijuana use habits

Characteristic	Total FSFI		Desire domain		Arousal domain		Lubrication domain		Orgasm domain		Satisfaction domain		Pain domain	
	$\beta$	P value	$\beta$	P value	$\beta$	P value	$\beta$	P value	$\beta$	P value	$\beta$	P value	$\beta$	P value
Age, y														
<30	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
30–39	–1.32	.12	–0.29	.11	–0.28	.14	–0.08	.69	–0.25	.24	–0.40	.06	–0.02	.91
40–49	–0.32	.71	–0.30	.10	–0.15	.42	–0.09	.62	0.11	.62	–0.08	.73	0.19	.31
50–59	–2.08	.03*	–0.54	.008*	–0.53	.01*	–0.57	.008*	–0.14	.57	–0.16	.51	–0.14	.50
60+	–1.32	.21	–0.48	.03*	–0.22	.34	–0.48	.04	0.29	.27	–0.22	.40	–0.21	.38
Race														
White	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Black	–1.06	.46	0.02	.94	–0.26	.40	–0.03	.93	–0.58	.10	–0.40	.27	0.18	.56
Hispanic	0.69	.42	0.45	.01*	0.22	.25	0.19	.30	–0.09	.68	–0.11	.62	0.02	.90
Other	–2.12	.02*	–0.21	.27	–0.51	.01*	–0.33	.10	–0.70	.002*	–0.22	.33	–0.16	.42
Relationship status														
Married/in a relationship	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Single	0.86	.21	0.23	.12	0.43	.005*	0.24	.12	0.06	.71	–0.19	.28	0.09	.57
Region														
West	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
International	–0.18	.82	0.00	.99	–0.08	.63	0.10	.54	–0.05	.80	–0.11	.57	–0.04	.80
Midwest	1.87	.07	0.16	.46	0.37	.09	0.41	.07	0.48	.06	0.51	.05*	–0.06	.78
Northeast	–0.33	.66	–0.05	.77	–0.10	.53	–0.02	.89	–0.04	.82	–0.19	.31	0.07	.66
South	0.79	.30	0.03	.87	–0.03	.85	0.36	.03*	0.00	.99	0.11	.56	0.32	.05*
BMI														
Normal	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Underweight	–2.91	.11	–0.01	.97	–0.53	.19	–1.14	.01	–0.63	.17	–0.33	.48	–0.28	.49
Overweight	0.34	.59	0.03	.82	0.08	.59	0.08	.55	0.02	.91	–0.05	.73	0.19	.18
Obese	0.16	.85	0.02	.91	0.06	.75	0.12	.52	0.10	.63	–0.21	.33	0.06	.73
Extremely obese	0.43	.65	–0.08	.68	0.06	.76	0.01	.95	0.39	.11	–0.04	.88	0.09	.67
Tobacco use														
Never	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Current	0.92	.27	0.14	.42	0.17	.36	0.17	.37	0.25	.25	0.06	.79	0.14	.45
Former	–0.01	.98	0.12	.31	–0.04	.76	0.09	.46	–0.08	.59	–0.15	.29	0.04	.77
PCP visits in last 3 mo														
0.00	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
1.00	–0.91	.12	–0.23	.07	–0.14	.28	–0.12	.38	–0.11	.47	–0.24	.11	–0.02	.88
2+	–0.62	.43	–0.06	.71	–0.10	.58	–0.17	.32	–0.06	.78	–0.03	.87	–0.10	.57

(continued)

Table 2. Continued

Characteristic	Total FSFI		Desire domain		Arousal domain		Lubrication domain		Orgasm domain		Satisfaction domain		Pain domain	
	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value	$\beta$	<i>P</i> value
Cannabis use frequency (continuous)	0.61	.0004*	0.09	.02*	0.14	.0002*	0.07	.08	0.14	.002*	0.13	.003*	0.05	.20
Method of consumption														
Smoking flower	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Edibles	-0.59	.51	-0.11	.55	-0.11	.59	-0.19	.34	-0.08	.73	-0.01	.98	-0.10	.60
Other	-1.22	.36	-0.03	.90	-0.10	.72	0.11	.71	-0.15	.66	-0.36	.27	-0.68	.02*
Smoking concentrates	-1.67	.16	-0.23	.36	-0.06	.82	-0.28	.29	-0.59	.05	-0.30	.32	-0.28	.41
Tincture or oils	-0.09	.91	-0.04	.82	0.19	.30	-0.12	.53	0.09	.67	-0.25	.23	0.04	.85
Vaping	0.04	.96	-0.13	.44	-0.06	.70	0.19	.27	-0.03	.89	-0.11	.58	0.18	.30
Primary reason for use														
Medical	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Recreational	1.03	.15	0.22	.14	0.21	.18	0.01	.93	0.27	.13	0.29	.11	0.03	.83
Cannabinoid														
THC dominant	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
Both THC and CBD	0.32	.57	0.06	.61	0.11	.39	0.15	.24	0.21	.14	0.06	.69	-0.26	.03*
CBD dominant	0.28	.77	0.09	.66	-0.07	.74	0.15	.50	0.21	.40	0.01	.96	-0.10	.64
Total comorbidities (continuous)	-0.44	.04*	-0.03	.44	-0.05	.33	-0.08	.08	-0.11	.04*	-0.09	.09	-0.08	.07

BMI = body mass index; CBD = cannabidiol; FSFI = female sexual function index; OR = odds ratio; PCP = primary care physician; THC = tetrahydrocannabinol.

Comorbidities included hypertension, diabetes, heart disease, arthritis, lung disease, kidney disease, thyroid disease, hypercholesterolemia, cancer, neurologic disease, liver disease, depression, and anxiety. Region represents primary residence.

\*Significant ( $P < .05$ )

**Table 3.** Multivariable logistic regression identifying factors associated with female sexual dysfunction (FSFI total < 26.55)

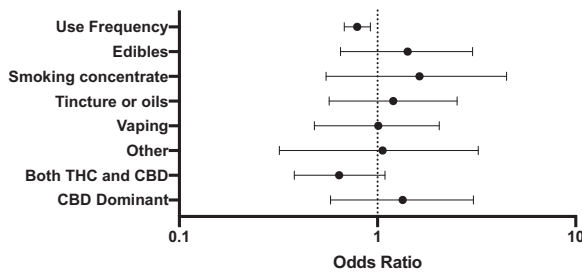
Characteristic	OR (95% CI)	P value
<b>Age, y</b>		
<30	Ref	
30–39	1.65 (0.73–3.77)	.22
40–49	0.85 (0.37–2.02)	.71
50–59	1.76 (0.73–4.38)	.21
60+	1.28 (0.48–3.42)	.62
<b>Race</b>		
White	Ref	
Black	2.52 (0.69–8.3)	.14
Hispanic	0.51 (0.20–1.19)	.14
Other	1.71 (0.78–3.67)	.17
<b>Relationship status</b>		
Married/relationship	Ref	
Single	0.66 (0.33–1.27)	.23
Unknown	1.01 (0.05–9.08)	1.00
<b>Region</b>		
West	Ref	
International	0.66 (0.32–1.35)	.27
Midwest	0.36 (0.12–0.95)	.05
Northeast	0.63 (0.31–1.24)	.19
South	0.71 (0.36–1.40)	.34
<b>BMI</b>		
Normal	Ref	
Underweight	2.45 (0.43–11.85)	.28
Overweight	1.04 (0.57–1.85)	.91
Obese	0.94 (0.43–1.99)	.87
Extremely obese	1.12 (0.47–2.53)	.79
<b>Tobacco use</b>		
Never	Ref	
Current	0.48 (0.18–1.16)	.12
Former	1.04 (0.63–1.70)	.88
<b>PCP visits in last 3 mo</b>		
0	Ref	
1	1.33 (0.78–2.29)	.30
2+	0.99 (0.47–2.03)	.99
Cannabis use frequency (continuous)	0.79 (0.68–0.92)	.002*
<b>Method of consumption</b>		
Smoking flower	Ref	
Edibles	1.42 (0.65–3.02)	.37
Other	1.06 (0.32–3.22)	.92
Smoking concentrates	1.63 (0.55–4.48)	.35
Tincture or oils	1.2 (0.57–2.52)	.62
Vaping	1.01 (0.48–2.05)	.99
<b>Cannabinoid</b>		
THC dominant	Ref	
Both THC and CBD	0.64 (0.38–1.09)	.10
CBD dominant	1.34 (0.58–3.05)	.49
Total comorbidities (continuous)	1.26 (1.05–1.52)	.02*

BMI = body mass index; CBD = cannabidiol; FSFI = female sexual function index; OR = odds ratio; PCP = primary care physician; THC = tetrahydrocannabinol.

Comorbidities included hypertension, diabetes, heart disease, arthritis, lung disease, kidney disease, thyroid disease, hypercholesterolemia, cancer, neurologic disease, liver disease, depression, and anxiety.

Region represents primary residence.

\*Significant ( $P < .05$ )



**Figure 1.** Forest plot demonstrating results of multivariable logistic regression with regard, to factors associated with female sexual dysfunction (FSFI total < 26.55). CBD = cannabidiol; FSFI = female sexual function index; THC = tetrahydrocannabinol.

Demographics, health status (eg, body mass index, primary care provider visits, tobacco use), and cannabis use and methods were assessed in relation to total FSFI and FSFI subdomains using linear regression (Table 2). Women older than the age of 50 years were more likely to have lower total FSFI scores (25.04 vs 27.12,  $P = .03$ ) as were those who had more comorbidities (26.68 vs 27.12,  $P = .02$ ). An increase in cannabis use frequency by one additional use per week was associated with an increase in total FSFI ( $\beta = 0.61$ ,  $SE = 0.17$ ,  $P = .0004$ ) and subdomains including desire domain ( $\beta = 0.09$ ,  $SE = 0.04$ ,  $P = .02$ ), arousal domain ( $\beta = 0.14$ ,  $SE = 0.04$ ,  $P = .0002$ ), orgasm domain ( $\beta = 0.14$ ,  $SE = 0.04$ ,  $P = .002$ ), and satisfaction domain ( $\beta = 0.13$ ,  $SE = 0.04$ ,  $P = .003$ ). The method of consumption, cannabis chemovar, or primary reason for consumption did not consistently impact FSFI scores.

The odds of female sexual dysfunction, as defined by a FSFI total score less than 26.55, were assessed using logistic regression (Table 3). For each additional step of cannabis use intensity (ie, times per week), the odds of reporting female sexual dysfunction declined by 21% (odds ratio [OR]: 0.79, 95% confidence interval [CI]: 0.68–0.92,  $P = .002$ ). In addition, having more comorbidities was associated with higher odds of sexual dysfunction (OR: 1.26, 95% CI: 1.05–1.52,  $P = .02$ ). The methods of use and chemovar type were not associated with odds of developing sexual dysfunction (Figure 1).

## DISCUSSION

To our knowledge, this study is the first to use a validated questionnaire to assess the association between female sexual function and aspects of cannabis use including frequency, chemovar, and indication. In this survey of more than 400 women, we found a dose response relationship between increased frequency of cannabis use and reduced odds of female sexual dysfunction. In addition, while the increase in index scores was small (and possible below clinical significance for some domains), increased cannabis use was associated with improved sexual desire, arousal, orgasm, and overall satisfaction as well as overall improved FSFI scores as compared with less frequent users. Older women and those with more comorbidities tended to have

more sexual dysfunction. Importantly, our study did not find an association between cannabis chemovar (eg, THC vs CBD dominant), reason for cannabis use, and female sexual function.

As cannabis use has been shown to be associated with increased sexual frequency in the United States, it is possible this may cause positive effects on sexual experiences.<sup>7</sup> Much of the research focusing on sexual function and experiences with regard to cannabis began in the 1970s and 1980s. Cannabis' potential positive effect on female sexual function was noted as early as 1970 by Tart<sup>19</sup> who sought to describe the common experiences of cannabis users. He noted in interviews with college students that orgasms are improved, arousal increases, and "sexual feelings are much stronger" leading to more satisfaction. Although this was a small, non-controlled qualitative study without detailed cannabis use characterization, it was suggestive of cannabis' positive effect on female sexual function and is consistent with the current report. In a similar interview-based study with 37 female cannabis, the authors found that frequent users (>5 times per week) reported increased sexual pleasure, orgasms, satisfaction, and intimacy compared with less frequent users (<5 times per week).<sup>20</sup> However, this observation did not reach statistical significance. However, in interviews in 84 graduate students, of which 18 were female students, heavy users of cannabis tended to report more positive sexual experiences (ie, pleasure and intensity of orgasm) compared with lower intensity users.<sup>21</sup> These findings are similar to those by Koff<sup>22</sup> who, in a survey of 128 women, found that users of cannabis tended to enjoy sexual activity more than non-users. Interestingly, unlike most studies, he assessed if method of consumption had any impact on sexual experiences (eg, method of smoking and ingestion), and similar to the findings reported here, found no impact. However, the issue with these early studies has been that they represent a small, select sample size, and use non-validated questionnaires in an interview format.

More recently, researchers have used survey instruments to examine the effect of cannabis on female sexual function. However, many of these studies still do not use validated instruments or use sets of individual questions from them resulting in inconsistent findings. Johnson et al<sup>23</sup> surveyed 1,801 women asking specifically about sexual dysfunction and substance use. Although there was no significant increase in sexual dysfunction among cannabis users (10% of the survey respondents), inhibited orgasm (OR: 1.76, 95% CI: 1.12–2.74) and dyspareunia (OR: 1.69, 95% CI: 1.13–2.55) were more common among female cannabis users. This is in contrast to the present study that found orgasm to be improved in more frequent users, whereas pain during sexual activity was unaffected. In contrast, Lynn et al<sup>10</sup> surveyed 373 women (127 users of cannabis) and reported that frequent users had improved orgasms (OR: 2.10, 95% CI: 1.01–4.44). Other realms of sexual function, such as satisfaction, sex drive, lubrication, and dyspareunia, were not impacted by either use vs not or frequency of use. An Australian survey of 8,650 men and women, of which 754 reported cannabis use, found no association between



cannabis use and sexual dysfunction in women when comparing users vs non-users as well as frequency of use.<sup>13</sup> While sexual dysfunction was assessed, a validated questionnaire was not used to obtain composite scores. In contrast to these studies, Johnson et al,<sup>23</sup> who asked questions specifically about female sexual dysfunction, found that cannabis use was associated with inhibited orgasm in a survey of more than 1,500 women.

The exact mechanisms by which cannabis may increase sexual function in women is unknown. The endocannabinoid system has been postulated to be involved in female sexual function, and prior studies have demonstrated that increased amounts of endogenous cannabinoids such as arachidonoyl ethanolamide and 2-arachidonoylglycerol are associated with increased sexual arousal.<sup>9</sup> Exogenous use may similarly lead to activation of the endocannabinoid system leading to increased sexual function as we found here. As many patients use cannabis to reduce anxiety, it is possible that a reduction in anxiety associated with a sexual encounter could improve experiences and lead to improved satisfaction, orgasm, and desire.<sup>24</sup> Similarly, THC can alter the perception of time which may prolong the feelings of sexual pleasure.<sup>25</sup> Finally, CB1, a cannabinoid receptor, has been found in serotonergic neurons that secretes the neurotransmitter serotonin, which plays a role in female sexual function thus activation of CB1 may lead to increased sexual function.<sup>12</sup>

Several limitations of the present study warrant mention. Our cohort of women was derived from a population of cannabis users who made a purchase at a single-partner cannabis dispensary during a specific time period that may represent a unique subset of cannabis users especially as prior reports show lower prevalence of cannabis use in the general population introducing possible selection bias. In addition, while respondents had purchased a product at the partner dispensary, the specific locations from which respondents purchased their product is unknown. However, the population was geographically diverse and was not representative of only 1 region within the United States. Any survey distributed in such a manner is subject to volunteer and recall bias. Although respondents were asked about chemovar, it is possible some respondents did not know the dominant chemovar in the product they purchased thus altering the results. In addition, while frequency was assessed the exact dosage of product (eg, milligrams of THC), duration of use or chronicity is unknown. The impact of frequency of use on sexual function was compared by dichotomizing less frequent and more frequent users with no comparison to a non-user control group. It is possible that inclusion of a non-user population may alter the findings. In addition, we cannot exclude the possibility of causation in that more frequent female cannabis users happen to have higher FSFI scores rather than causal relationship. Although the multi-variable linear regression was adjusted for available factors, residual confounders may exist that were not examined and therefore alter the results. While the FSFI is the most commonly used female sexual function survey, it is not the only one (eg, Sexual Quotient-Female and Golombok Rust Inventory of Sexual Satisfaction), and use of another validated survey may yield differing results.

Although the FSFI cutoff of 26.55 for female sexual dysfunction has been validated and was examined here in associated with frequency of cannabis use, the clinical significance in FSFI subdomain scores is unknown. Although other aspects of sexuality were not assessed, such as vaginismus, this would be a potential area for future study.<sup>26</sup> Finally, while the survey assessed cannabis use within the last 4 weeks, it did not differentiate between chronic and new users.

Our results demonstrate that increasing frequency of cannabis use is associated with improved sexual function and is associated with increased satisfaction, orgasm, and sexual desire. Neither, the method of consumption nor the type of cannabis consumed impacted sexual function. The mechanism underlying these findings requires clarification as does whether acute or chronic use of cannabis has an impact on sexual function. Whether the endocannabinoid system represents a viable target of therapy through cannabis for female sexual dysfunction requires future prospective studies though any therapy has to be balanced with the potential negative consequences of cannabis use.

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## SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.esxm.2020.06.009>.