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Perceptions, prevalence, and patterns of cannabis use among cancer patients treated at 12 NCI-Designated Cancer Centers

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Abstract

Background: The legal climate for cannabis use has dramatically changed with an increasing number of states passing legislation legalizing access for medical and recreational use. Among cancer patients, cannabis is often used to ameliorate adverse effects of cancer treatment. Data are limited on the extent and type of use among cancer patients during treatment and the perceived benefits and harms. This multicenter survey was conducted to assess the use of cannabis among cancer patients residing in states with varied legal access to cannabis.

Methods: A total of 12 NCI-Designated Cancer Centers, across states with varied cannabis-access legal status, conducted surveys with a core questionnaire to assess cannabis use among recently diagnosed cancer patients. Data were collected between September 2021 and August 2023 and pooled across 12 cancer centers. Frequencies and 95% confidence intervals for core survey measures were calculated, and weighted estimates are presented for the 10 sites that drew probability samples.

Results: Overall reported cannabis use since cancer diagnosis among survey respondents was 32.9% (weighted), which varied slightly by state legalization status. The most common perceived benefits of use were for pain, sleep, stress and anxiety, and treatment side effects. Reported perceived risks were less common and included inability to drive, difficulty concentrating, lung damage, addiction, and impact on employment. A majority reported feeling comfortable speaking to health-care providers though, overall, only 21.5% reported having done so. Among those who used cannabis since diagnosis, the most common modes were eating in food, smoking,

and pills or tinctures, and the most common reasons were for sleep disturbance, followed by pain and stress and anxiety with 60%-68% reporting improved symptoms with use.

Conclusion: This geographically diverse survey demonstrates that patients use cannabis regardless of its legal status. Addressing knowledge gaps concerning benefits and harms of cannabis use during cancer treatment is critical to enhance patient-provider communication.

Evidence of cannabis use, including for medicinal purposes, comes from archaeological evidence and early written records dating as early as 1500 BCE (1). In the late 19th century, the *Lancet* published an article by J. Russel Reynolds, describing the use of “cannabis indica,” noting, in his experience, effectiveness in treating “senile insomnia,” dysmenorrhea, and some types of painful neuropathy (1,2). These early reports also highlighted the challenges of dosing and limiting the toxic side effects, including dysphoria, that remain relevant today. The legal climate around cannabis use changed in the 1900s and, because of strict control along with its classification as a schedule I drug in the United States (ie, drugs, substances, or chemicals with no currently accepted medical use and high potential for abuse) (3), research into potential medicinal application of cannabis and its potential benefits and harms was severely restricted.

The legal landscape for cannabis and cannabinoids use has dramatically changed over the past decade (4). Although cannabis remains classified as a schedule I drug, as of November 8, 2023, a total of 39 states and the District of Columbia have passed legislation for the legal use of cannabis for medical conditions, and 24 states and the District of Columbia have fully legalized cannabis for medical and adult nonmedical use (5,6). One common use of medical cannabis has been to manage chemotherapy-related symptoms such as nausea and vomiting. Recognizing the benefit of cannabis for chemotherapy-associated nausea and vomiting, the drug Marinol (dronabinol), a synthetic cannabinoid, was developed and approved by the US Food and Drug Administration in 1985 (7) and classified as a schedule II drug, which must be prescribed by a health-care provider. With state legalization of cannabis, a wide variety of cannabis products, with varying potency, cannabinoid constituents and ratios, and methods of delivery are more readily available to consumers, including cancer patients.

Cancer patients use cannabis and cannabinoids during treatment for a variety of symptoms beyond nausea, including pain, sleep disturbance, and anxiety (8-13). Several surveys estimate that one-quarter of cancer patients use cannabis and cannabinoids for symptom management during their treatment (8-11,13,14). Given the rapidly changing availability of a wide variety of products and modes of delivery, there remains a significant gap in knowledge about the extent and type of use among cancer patients during treatment and the perceived benefits and harms.

The current survey was undertaken to assess the use of cannabis products among cancer patients residing in states with varied legal access to cannabis. Common elements of the survey conducted by 12 National Cancer Institute (NCI)-Designated Cancer Centers across the United States included current and past use of cannabis, mode of use, reasons for use, perception of harms and benefits, and health-care provider recommendations regarding use. We present a summary of the results of the survey taking into consideration the legal status of the state of residence of the cancer patients.

Methods

A total of 12 NCI-Designated Cancer Centers were awarded supplemental funding to conduct surveys assessing cannabis use

among recently diagnosed cancer patients. Cancer centers responded to a call for administrative supplements, and applications were administratively reviewed by NCI. Selected sites were in states with varied legal status for medical and recreational cannabis use at the time of the survey. The 12 cancer centers independently received approval from their institutional review boards and collected data from September 2021 to August 2023. Eligible participants were patients diagnosed with cancer who were undergoing treatment or recently completed cancer treatment and who resided in their respective cancer center’s catchment area (see Figure 1).

Cancer centers were responsible for sampling patients within their catchment area with the goal of 1000 completed surveys. Centers were asked to recruit patients who were currently undergoing treatment or who had completed treatment within the past 2 years. Enrolled patients were diagnosed and treated between January 2017 and December 2020. Cancer centers used a variety of methods to recruit patients, including invitations sent through mail, email, phone calls, text messages, and electronic medical record-based messaging. In addition, a combination of web-based, telephone, and paper-based surveys were used across cancer centers (see Table 1).

For this survey, the terms *cannabis* and *cannabinoids* refer to any marijuana, cannabis concentrates, edibles, lotions, ointments, tinctures containing cannabis, cannabidiol-only products, pharmaceutical or prescription cannabinoids (eg, dronabinol, nabilone), and other products made with cannabis. A set of common core measures (15) were developed by NCI and approved by the centers and administered by each site. The core questions assessed current and past use of cannabis, modes of use, reasons for use, perception of harms and benefits, and health-care provider recommendations regarding use. De-identified data were sent to the coordinating center for cleaning and weighting.

Characteristics of the sample and past and current use of cannabis were assessed for respondents whose data were pooled from the 12 sites (n = 13 180). Respondents were characterized by state-level legalization status. We assigned 3 state-level legalization statuses for cannabis use (fully legal, legal for medical use, and fully illegal) to all respondents in the pooled dataset based on the state where the respondent lived at the time of cancer diagnosis. The “legal for medical use” category included the states where cannabis use was legalized for medical purposes and decriminalized and the states where cannabis use was legalized for medical purposes and not decriminalized. The “fully illegal” category included states where cannabis use was not legalized for medical purposes regardless of the decriminalization status. The legalization status for respondents who refused to report where they lived at the time of cancer diagnosis or were not asked this question was imputed using the location of the cancer center (Case Western, Fred Hutchinson, Memorial Sloan Kettering, Oregon Health and Science University Knight Cancer Institute, San Diego Moores, and Minnesota Masonic Cancer Centers did not have the variable “residence at diagnosis”). For example, the legalization status of the 8 respondents who refused to answer in the Abramson Cancer Center’s data was set

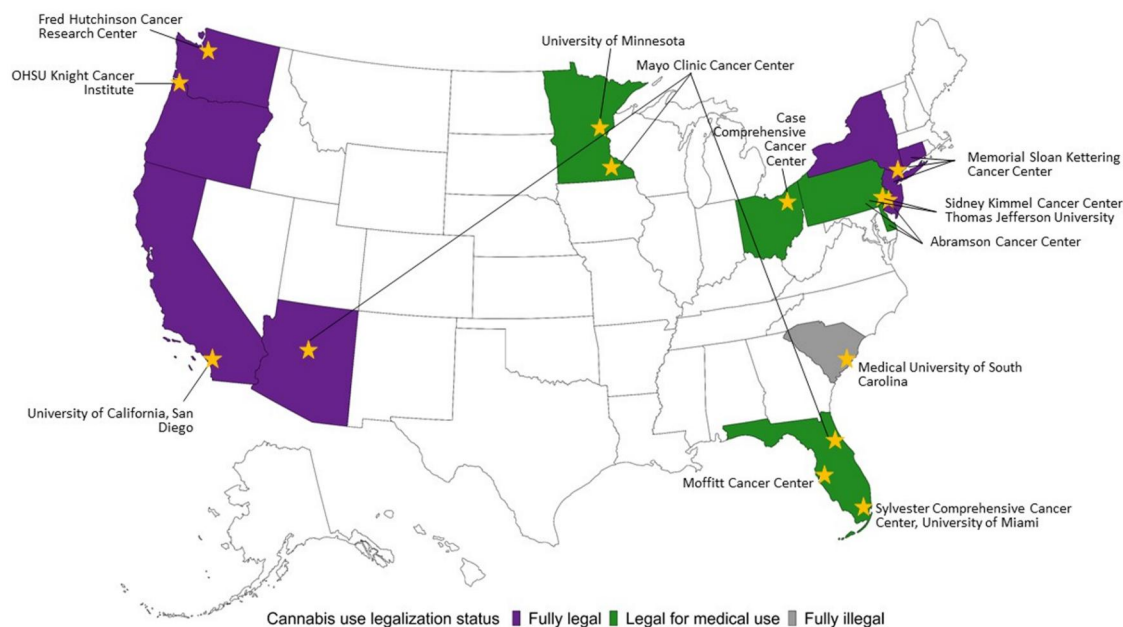


Figure 1. Map of NCI-Designated Cancer Center sites and state legalization status (2023). NCI = National Cancer Institute; OSHU = Oregon Health and Science University.

as legal for medical use, which is the legalization status in Pennsylvania.

Analyses regarding perceived benefits and risks of cannabis use and communication with health-care providers about use were conducted only among respondents from the 10 cancer centers that used probability sampling methods ($n = 12\,614$). Weighting was conducted for those sites from patient lists defining their catchment area with some stratifying the sample by cancer type, sex, race and ethnicity, or a combination of demographic variables (see Table 1). Survey weights were calculated accounting for patients' probability of selection and patient non-response. Prior to weighting, using available patient-level data (eg, cancer type, sex, age, race and ethnicity, and marital status), nonresponse analysis was conducted within each cancer center. A multidimensional ranking approach to adjust the weights to sum to the cancer centers population of interest separately for each cancer center was implemented.

Weighted estimates and 95% confidence intervals for the core survey measures were calculated and presented for the 10 sites that drew probability samples, accounting for the complex survey design. The 10 sites that drew probability samples had a sample size of 12 614 respondents, which, with sampling weights applied, represent a population of 118 712 cancer patients across all catchment areas (see Supplementary Table 1, available online).

Analyses for prevalence and patterns of cannabis use, including frequency and duration, mode, reasons for use, and perceived therapeutic benefit of use, were conducted only among those who used cannabis since diagnosis and included only those sites that used probability sampling methods ($n = 4163$). We conducted Pearson χ^2 tests for categorical variables and t tests for continuous variables. To compare the core measures by the state-level legalization status, we built multivariable logistic regression models and computed model-based estimates for the respondents' reported cannabis use and the percentages of various patterns of cannabis use by legalization status, adjusted by categorical age, sex at birth, and race and ethnicity. We used an alpha of 0.05 to calculate 95% confidence intervals and statistical

significance for all analyses. All data cleaning and analyses were performed in SAS version 9.4.

Results

Demographic description of respondents and cannabis use

For the 12 cancer centers combined, 13 180 cancer patients responded to the survey from a base population of 69 970 patients (Table 1). Among the 10 sites that drew probability samples, 12 614 responded to surveys for an overall response rate of 18%.

Table 2 describes the characteristics of all survey respondents according to whether they used cannabis before and/or after the diagnosis of cancer or never used. The median age of respondents was 65 years, ranging from 19 to 100 years. More than one-half of respondents were female, and the majority were White and college graduates or higher. There was representation from patients living in states across the spectrum of state cannabis policies governing use, including fully legal (39.8%), legalized for medical use (52.1%), and fully illegal (8.1%). Breast and prostate were the most frequently reported cancer types. Current treatment status was not reported for 19% of respondents; 18% reported being actively treated with either hormonal therapy, chemotherapy, immunotherapy, radiation, or a combination of therapies. Approximately one-quarter of patients used cannabis prior to diagnosis only (no use after diagnosis), and a similar percent reported use before and after diagnosis; 6% reported use since diagnosis only (not prior to diagnosis), and 38% reported never using cannabis. Respondents who reported using cannabis at any time before or after diagnosis differed from respondents who reported never using cannabis by all demographic characteristics and state policies governing cannabis use.

Perceptions and beliefs about cannabis use among cancer patients

Regardless of past or current cannabis use, 88.5% of cancer patients sampled reported perceiving any benefit related to

Table 1. Sample size and sampling methods

NCI-Designated Cancer Center	Knight Cancer Institute, Oregon Health and Science University										Total
	Abramson	Case	Hutchinson	Hollings, Medical University of South Carolina	Mayo Clinic	Memorial Sloan-Kettering	Moffit	Sidney Kimmel	Sylvester, University of Miami	Moore's, University of California San Diego	
Location surveyed ^a	DE, PA, NJ	OH	WA	SC	AZ, FL, MN	CT, NY, NJ	FL	OR	FL	CA	MN
Legal status of area surveyed	PA: mixed (medical and not decriminalized); NJ: fully legal (medical and decriminalized)	Mixed (medical and decriminalized)	Fully legal (medical and decriminalized)	Fully illegal (no medical and not decriminalized)	FL: mixed (medical but not decriminalized); MN: mixed (medical and decriminalized); AZ: fully legal (medical and decriminalized)	NY: fully legal (medical and decriminalized); NJ: fully legal (medical and decriminalized)	Mixed (medical and not decriminalized)	Fully legal (medical and not decriminalized)	Mixed (medical and not decriminalized)	Fully legal (medical and decriminalized)	Mixed (medical and decriminalized)
No. sampled ^b	5808	—	10 723	7749	10 000	3837	9043	3807	—	6849	2062
No. responded	1054	334	1539	1036	2304	1258	1592	534	232	954	775
Response rate, % ^b	18.1	—	14.4	13.4	23.0	32.8	17.6	14.0	—	13.9	37.6
Prevalence of use since diagnosis	33.4	32.2	41.3	28.4	23.1	30.8	46.9	54.9	44.7	31.6	20.9
	(30.5 to 36.2)	(27.0 to 37.8)	(38.8 to 43.8)	(25.6 to 31.1)	(21.4 to 24.9)	(28.2 to 33.4)	(44.5 to 49.4)	(50.6 to 59.2)	(38.1 to 51.4)	(28.5 to 34.7)	(17.9 to 23.9)
	12 centers	—	41.0	26.0	23.8	29.4	44.4	55.0	—	30.4	25.3
	Weighted, 31.2	—	(38.5 to 43.6)	(23.3 to 28.9)	(22.1 to 25.6)	(26.5 to 32.5)	(41.9 to 46.9)	(50.7 to 59.3)	—	(27.3 to 33.7)	(21.3 to 29.7)
Survey administration	Web survey	Web survey or paper survey	Web survey or telephone survey	Web survey or telephone survey	Web survey	Web survey	Web survey	Web survey or paper survey	Web survey or paper survey	Web survey	Paper survey
Sampling method	Stratified random sampling	Convenience sampling	All eligible patients are sampled	Simple random sampling	Stratified random sampling	Stratified random sampling	All eligible patients are sampled	Stratified random sampling	Convenience sampling	All eligible patients are sampled	Stratified random sampling

^a The state of residence was imputed based on the location of the cancer center if missing. Em dashes are for Case and Miami that didn't conduct probability sampling (convenience sampling) and therefore no response is required for No. sampled and response rate, and data are not weighted. AZ = Arizona; CA = California; CT = Connecticut; DE = Delaware; FL = Florida; MN = Minnesota; NJ = New Jersey; NY = New York; OH = Ohio; PA = Pennsylvania; SC = South Carolina; WA = Washington.

^b Sample size, response rate, and weighted estimate of the convenience sample of Miami and Case Western Cancer Center were not applicable.

Table 2. Characteristics of sample, 12 sites unweighted data

Characteristic	Total No. (%)	Cannabis use before diagnosis only No. (%)	Cannabis use since cancer diagnosis only No. (%)	Cannabis use before and since diagnosis No. (%)	Never used No. (%)	P _{unweighted} , 12 centers		
						Only before vs never used	Only since vs never used	Before and after vs never used
All respondents, No., row %	13 180	3461 (26.3)	831 (6.3)	3507 (26.6)	5063 (38.4)			
Age, y								
Median (range)	64.53 (19-100)	65.55 (20-94)	60.02 (22-90)	61.07 (19-92)	66.97 (19-100)	<.0001	<.0001	<.0001
Younger than 50	2148 (16.3)	413 (11.9)	221 (26.6)	848 (24.2)	646 (12.8)	<.0001	<.0001	<.0001
50-64	3935 (29.9)	1102 (31.8)	266 (32.0)	1186 (33.8)	1350 (26.7)			
65 and older	6624 (50.3)	1867 (53.9)	321 (38.6)	1385 (39.5)	2931 (57.9)			
Missing	473 (3.6)	79 (2.3)	23 (2.8)	88 (2.5)	136 (2.7)			
Sex								
Male	5791 (43.9)	1678 (48.5)	275 (33.1)	1624 (46.3)	2147 (42.4)	<.0001	<.0001	.0001
Female	7054 (53.5)	1754 (50.7)	544 (65.5)	1829 (52.2)	2861 (56.5)			
Unknown or missing	335 (2.5)	29 (0.8)	12 (1.4)	54 (1.5)	55 (1.1)			
Race and ethnicity								
Asian and Pacific Islander	344 (2.6)	67 (1.9)	32 (3.9)	52 (1.5)	189 (3.7)			
Black	788 (6.0)	167 (4.8)	62 (7.5)	208 (5.9)	342 (6.8)			
Hispanic	667 (5.1)	133 (3.8)	79 (9.5)	184 (5.2)	261 (5.2)			
Other	338 (2.6)	95 (2.7)	19 (2.3)	117 (3.3)	103 (2.0)	<.0001	<.0001	<.0001
Unknown or missing	427 (3.2)	55 (1.6)	23 (2.8)	72 (2.1)	91 (1.8)			
White	10616 (80.5)	2944 (85.1)	616 (74.1)	2874 (82.0)	4077 (80.5)			
Education								
High school graduate or less	2278 (17.3)	481 (13.9)	144 (17.3)	543 (15.5)	1084 (21.4)	<.0001	<.0001	<.0001
Some college	2233 (16.9)	611 (17.7)	119 (14.3)	631 (18.0)	849 (16.8)			
College graduate	3475 (26.4)	1000 (28.9)	193 (23.2)	938 (26.7)	1302 (25.7)			
Postgraduate	3201 (24.3)	956 (27.6)	172 (20.7)	767 (21.9)	1279 (25.3)			
Unknown or missing	1993 (15.1)	413 (11.9)	203 (24.4)	628 (17.9)	549 (10.8)			
State cannabis policy								
Fully legal	5248 (39.8)	1496 (43.2)	260 (31.3)	1589 (45.3)	1751 (34.6)	<.0001	.0377	<.0001
Legalized for medical use	6865 (52.1)	1645 (47.5)	510 (61.4)	1676 (47.8)	2871 (56.7)			
Fully illegal	1067 (8.1)	320 (9.2)	61 (7.3)	242 (6.9)	441 (8.7)			
Type of cancer								
Brain	226 (1.7)	42 (1.2)	24 (2.9)	77 (2.2)	74 (1.5)			
Breast	2757 (20.9)	710 (20.5)	185 (22.3)	631 (18.0)	1172 (23.1)			
Colorectal	628 (4.8)	152 (4.4)	46 (5.5)	182 (5.2)	234 (4.6)			
Gastrointestinal	387 (2.9)	86 (2.5)	31 (3.7)	117 (3.3)	146 (2.9)			
Liver and gall bladder	217 (1.6)	38 (1.1)	21 (2.5)	71 (2.0)	81 (1.6)			
Pancreas	188 (1.4)	36 (1.0)	14 (1.7)	62 (1.8)	68 (1.3)			
Oropharyngeal	285 (2.2)	90 (2.6)	11 (1.3)	91 (2.6)	85 (1.7)			
Lung	824 (6.3)	244 (7.1)	66 (7.9)	220 (6.3)	281 (5.6)			
Melanoma	714 (5.4)	203 (5.9)	26 (3.1)	146 (4.2)	324 (6.4)			
Prostate	1717 (13.0)	546 (15.8)	50 (6.0)	371 (10.6)	704 (13.9)			
Gynecological	520 (3.9)	125 (3.6)	32 (3.9)	136 (3.9)	223 (4.4)			
Kidney	453 (3.4)	116 (3.4)	22 (2.6)	122 (3.5)	184 (3.6)			
Bladder	362 (2.7)	109 (3.1)	16 (1.9)	75 (2.1)	362 (3.0)			
Thyroid	291 (2.2)	63 (1.8)	22 (2.6)	77 (2.2)	125 (2.5)			
Lymphoma	561 (4.3)	151 (4.4)	31 (3.7)	154 (4.4)	225 (4.4)			
Myeloma	221 (1.7)	50 (1.4)	25 (3.0)	54 (1.5)	90 (1.8)			
Leukemia	317 (2.4)	65 (1.9)	27 (3.2)	77 (2.2)	141 (2.8)			
Other	2354 (17.9)	595 (17.2)	182 (21.9)	658 (18.8)	877 (17.3)			
Not reported	1275 (9.7)	318 (9.2)	80 (9.6)	406 (11.6)	408 (8.1)			

(continued)

Table 2. (continued)

Characteristic	Total No. (%)	Cannabis use before diagnosis only			Cannabis use since cancer diagnosis only		Cannabis use before and since diagnosis		P _{unweighted} , 12 centers		
		No. (%)			No. (%)		No. (%)		Only before vs never used	Only since vs never used	Before and after vs never used
		No.	(%)		No.	(%)	No.	(%)			
Cancer treatment status											
Hormonal only	612 (4.6)	154 (4.4)		33 (4.0)	163 (4.6)	226 (4.5)					
Active	160 (26.1)	48 (31.2)		2 (6.1)	44 (27.0)	62 (27.4)					
Completed	75 (12.3)	18 (11.7)		8 (24.2)	22 (13.5)	27 (11.9)					
Not reported	377 (61.6)	88 (57.1)		23 (69.7)	97 (59.5)	137 (60.6)					
Chemotherapy only	1288 (9.8)	273 (7.9)		111 (13.4)	372 (10.6)	508 (10.0)					
Active	229 (17.8)	42 (15.4)		21 (18.9)	73 (19.6)	91 (17.9)					
Completed	569 (44.2)	116 (42.5)		46 (41.4)	196 (52.7)	208 (40.9)					
Not reported	490 (38.0)	115 (42.1)		44 (39.6)	103 (27.7)	209 (41.1)					
Immunotherapy only	549 (4.2)	154 (4.4)		46 (5.5)	157 (4.5)	186 (3.7)					
Active	92 (16.8)	29 (18.8)		6 (13.0)	22 (14.0)	35 (18.8)					
Completed	288 (52.5)	81 (52.6)		28 (60.9)	100 (63.7)	77 (41.4)					
Not reported	169 (30.8)	44 (28.6)		12 (26.1)	35 (22.3)	74 (39.8)					
Radiation only	1760 (13.4)	460 (13.3)		119 (14.3)	452 (12.9)	686 (13.5)					
Active	61 (3.5)	18 (3.9)		5 (4.2)	10 (2.2)	27 (3.9)					
Completed	1075 (61.1)	288 (62.6)		75 (63.0)	304 (67.3)	396 (57.7)					
Not reported	624 (35.5)	154 (33.5)		39 (32.8)	138 (30.5)	263 (38.3)					
More than 1 treatment	3828 (29.0)	1015 (29.3)		260 (31.3)	1002 (28.6)	1510 (29.8)					
Active ^a	1614 (42.2)	473 (46.6)		101 (38.8)	472 (47.1)	556 (36.8)					
Completed ^a	1209 (31.6)	319 (31.4)		81 (31.2)	338 (33.7)	465 (30.8)					
Not reported	1005 (26.3)	223 (22.0)		78 (30.0)	192 (19.2)	489 (32.4)					
Not reported ^b	2492 (18.9)	637 (18.4)		152 (18.3)	760 (21.7)	837 (16.5)					

^a Considered active if at least 1 of the treatments is active.

^b Questions related to cancer treatment were not asked in the survey by Sylvester Cancer Center (University of Miami), Memorial Sloan Kettering Cancer Center, and Knight Cancer Institute, Oregon Health and Science University Cancer Center.

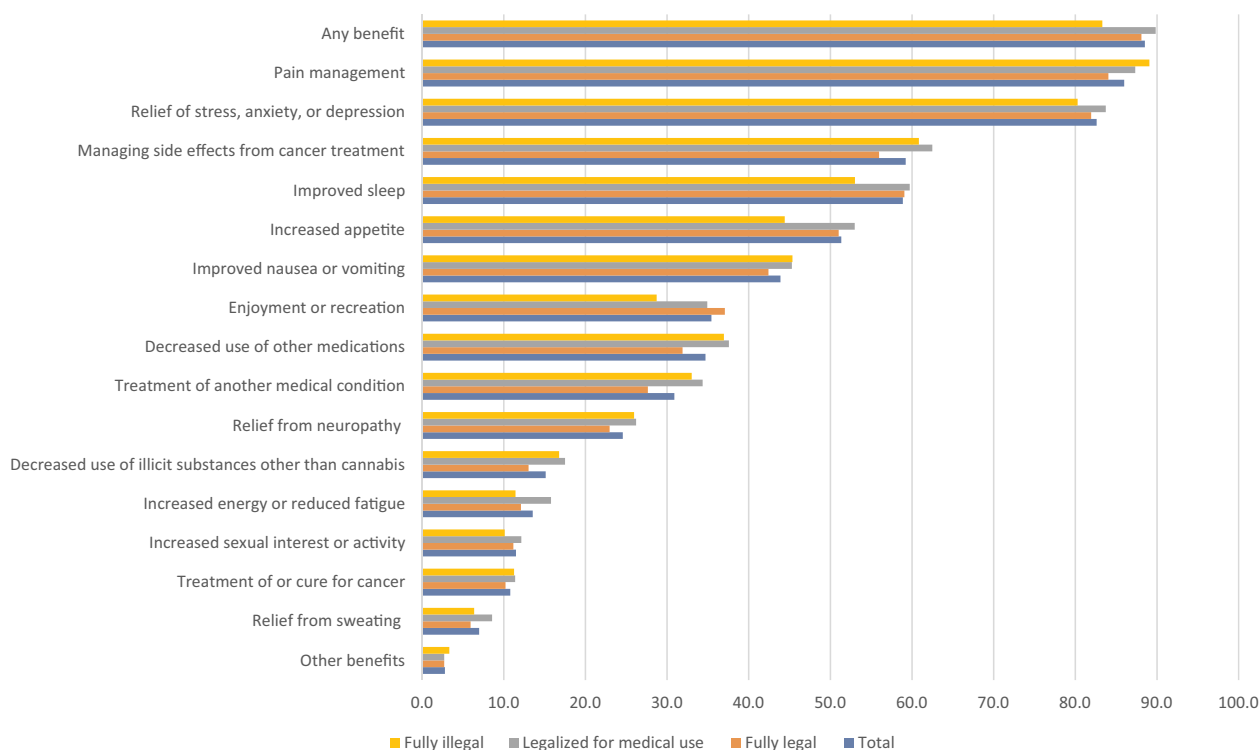


Figure 2. Perceived benefits of cannabis use among cancer patients (n = 12 614; 10 sites).

cannabis use (Figure 2). Benefits cited most frequently included pain management; relief of stress, anxiety, or depression; improved sleep; and managing side effects from cancer treatment. Reporting specific benefits did not appear to be related to state-level cannabis policies. Fewer (65%) cancer patients perceived any risks related to cannabis use (Figure 3). Specific enumerated risks included the inability to drive, difficulty concentrating, lung damage, and impaired memory. Reporting of specific risks among cancer patients varied by state cannabis policies, with inability to drive, impaired memory, risk of addiction to cannabis, and legal risks cited more frequently by patients residing in states where cannabis was fully illegal.

Health-care provider discussions and recommendations

Table 3 presents the results concerning health-care provider communication for all and by state legal status. Among all respondents, more than 60% of patients reported that they would be somewhat or extremely comfortable in speaking with health-care providers about cannabis, even among states where cannabis use was illegal. However, a minority (21.5% of sample) of patients reported discussing cannabis use with a health-care provider, and of those who did, the majority (72.4%) discussed it with the treating oncologist. When stratified by state cannabis policies, 22.3% of respondents residing in states where cannabis was fully legal, 23.3% in states where cannabis was legalized for medical use, and 11.0% in states where cannabis was fully illegal discussed cannabis use with a health-care provider. Cancer patients who used cannabis since diagnosis were more likely to discuss cannabis use with health-care providers than patients who did not use cannabis since diagnosis (50.9% vs 7.6%; $P < .001$), and a higher percentage of those patients who used cannabis since diagnosis than those who didn't reported discussing use with the primary care provider, treating oncologist,

nurse, or other health-care provider (Supplementary Table 2, available online).

Approximately 9% of cancer patients reported that a health-care provider recommended cannabis use, and of those, 46.1% reported that the oncologist involved with treatment recommended use (Table 3). In states where cannabis was fully legal and legalized for medical use, a higher percentage of patients reported that health-care providers recommended cannabis than in states where cannabis was fully illegal. Regardless of state policies governing cannabis use, the oncologist involved with treatment was the most common health-care provider making cannabis use recommendations.

Patterns of use among cancer patients who reported using cannabis since diagnosis

Approximately one-third of respondents reported using cannabis since being diagnosed with cancer (Table 4). More than 70% of respondents were aged 50 years or older, 55.8% were female, most were White race, and more than half were college graduates or had postgraduate education. Among cancer patients who reported using cannabis since cancer diagnosis, 81.4% used cannabis prior to diagnosis, and more than 51.7% were from states where cannabis was fully legal. Among cancer types, the highest percentage of cannabis use since diagnosis was for breast cancer (17.7%), followed by prostate cancer (10%).

Frequency of cannabis use

Among cancer patients who used cannabis since diagnosis, 60% reported current use (Table 5). The median number of days cancer patients reported using cannabis within the past 30 days was 17.1 (range = 14.8-19.5 days). Approximately 40% used cannabis up to 10 days within the past 30 days, 13.1% used 11 to 20 days, and 29.9% used between 21 and 30 days. Estimates of current cannabis use varied by state cannabis policies governing use with the percentage of current use being higher among patients

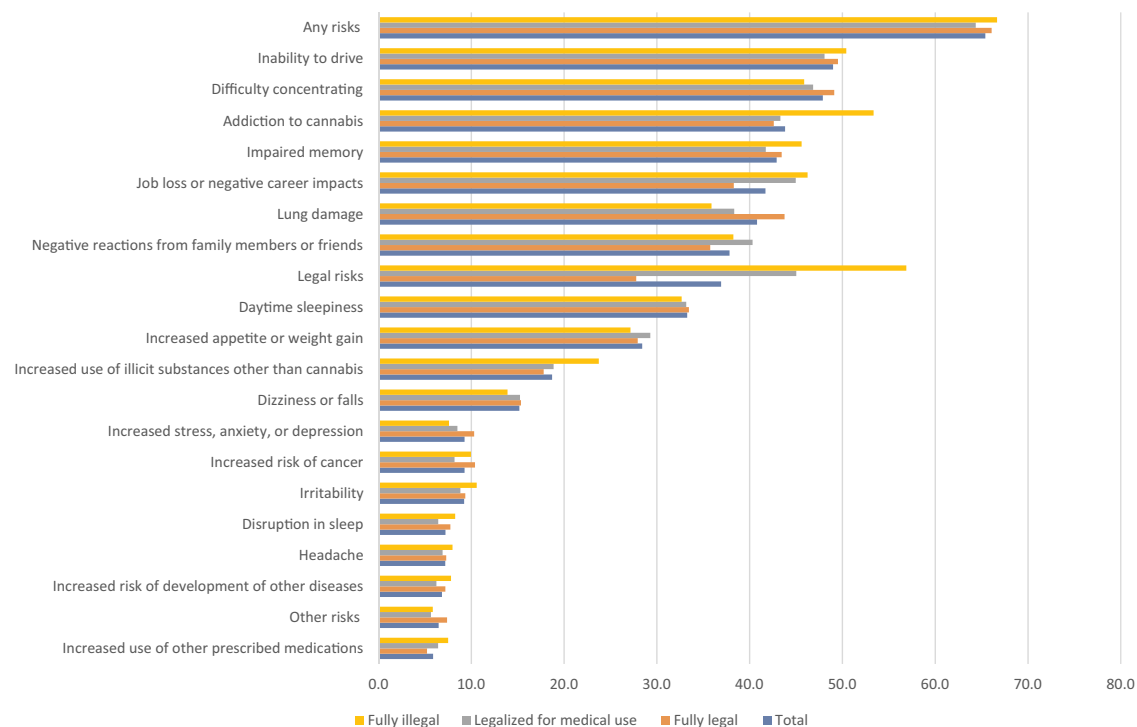


Figure 3. Perceived risks of cannabis use among cancer patients (n = 12 614; 10 sites).

residing in states where cannabis was fully legal (59.0%, $P = .010$) and legalized for medical use (62.7%, $P < .001$) than in states where cannabis was fully illegal (50.0%). The median number of days for current use differed by state cannabis policies, with cancer patients who resided in states where cannabis was fully illegal reporting a higher median number of days used than cancer patients who resided in states where cannabis was legalized for medical use (19.1 vs 14.2, $P < .001$).

Use of cannabis during and after cancer treatment

Among the sample of respondents who reported initiating treatment (96%) and using cannabis since cancer diagnosis, a weighted 72.1% reported using it during treatment, and 41.0% reported using it daily (Table 5). A greater percentage of patients who resided in states where cannabis was fully legal and where it was medically legal used cannabis during treatment than in states where cannabis was fully illegal (74.5% and 70.5%, respectively, vs 61.3%; $P < .01$). There were no differences in frequency of cannabis use during treatment by state cannabis policies. Approximately 76% of the sample of respondents had completed treatment, and among those, a weighted 78.7% reported using cannabis after treatment. No differences were observed in use of cannabis after completion of treatment by state cannabis policies governing use. However, a greater percentage of respondents continued to use cannabis a few times a month after treatment in states where it was fully legal than in states where it was fully illegal (21.3% vs 14.4%; $P = .04$). Conversely, a greater percentage of respondents in states where cannabis was fully illegal continued to use cannabis less than once per month than in states where cannabis was fully legal or legal for medical use ($P = .02$).

Modes of cannabis use

The modes of cannabis used among cancer patients since cancer diagnosis are shown in Figure 4. Patients reported eating in food,

such as brownies, cakes, cookies, and candy; smoking in a joint; bong, pipe, or blunt; and taking by mouth by pills, tinctures, or sublingually as most frequent modes of using cannabis. Whereas eating in food was the most frequent mode of use among cancer patients who resided in states where cannabis was fully legal (30.8%), smoking was the most frequent mode of use among patients in states where cannabis was legalized for medical use (28.2%) and fully illegal (38.0%). Cannabis use since cancer diagnosis did not vary substantially by cancer site for males and females; however, the mode of use varied by sex where smoking was the most frequent mode of use among male prostate (37.8%), lung (36.0%), melanoma (33.3%), and lymphoma (33.7%) patients (Supplementary Figure 1, available online). Eating in food was the most frequent mode of use among female breast (22.7%), melanoma (31.3%), and lymphoma (26.4%) patients, and taking by mouth was the most frequent mode of use by female lung cancer patients.

Reasons for using cannabis

The most frequent reasons cancer patients reported using cannabis since diagnosis, ordered by frequency, was for difficulty sleeping; pain; mood changes; stress, anxiety, or depression; and recreation or enjoyment (Figure 5). Although difficulty sleeping remained the most frequently cited reason for using cannabis among patients who ate cannabis in food or took it by mouth, when stratified by mode of cannabis use, cancer patients who smoked by joint, bong, pipe, or blunt reported mood changes; stress, anxiety, or depression; and recreation or enjoyment as the main reasons for using cannabis (Figure 6). Taking pills, tinctures, or sublingually by mouth was the most common mode of use for pain, and eating in food was the most common mode for difficulty sleeping. Regardless of mode of use, 59.7%–67.7% of cancer patients reported improvement in symptoms related to pain, difficulty sleeping, and mood resulting from their use of cannabis since diagnosis (Figure 7).

Table 3. Communication with health-care providers about cannabis use among all respondents^a

Characteristic	Total (n = 12 614)		Fully legal (n = 5229)		Legalized for medical use (n = 6318)		Fully illegal (n = 1067)	
	n	Weighted percent (95% CI)	n	Weighted percent (95% CI)	n	Weighted percent (95% CI)	n	Weighted percent (95% CI)
Comfort in speaking to health-care providers about cannabis ^b								
Extremely uncomfortable	1291	9.9 (9.3 to 10.5)	578	6487	599	4187	1088	11.0 (9.0 to 13.1)
Somewhat uncomfortable	1486	11.4 (10.7 to 12.1)	691	7565	638	4588	1386	14.0 (11.8 to 16.3)
Somewhat comfortable	3058	23.6 (22.7 to 24.5)	1424	16077	1354	9455	2495	25.3 (22.4 to 28.1)
Extremely comfortable	4960	38.7 (37.7 to 39.7)	2246	25 381	2215	15 806	4737	48.0 (44.7 to 51.2)
Missing	1819	16.4 (15.9 to 16.9)	290	2843	1512	16 450	165	1.7 (0.8 to 2.5)
Discussed use with provider								
Missing responses (n = 227)								
No	9680	78.5 (77.6 to 79.4)	3931	44 183	4816	38 024	8712	89.0 (86.9 to 90.8)
Yes	2707	21.5 (20.6 to 22.4)	1167	13 098	1408	11 817	1148	11.0 (9.2 to 13.1)
Discussed with type of provider								
Primary care provider	1073	38.9 (36.6 to 41.2)	419	4789	607	4951	412	35.8 (27.2 to 45.4)
Oncologist involved with treatment	1899	72.4 (70.1 to 74.5)	881	9828	924	8025	834	75.6 (66.9 to 82.7)
Nurse or physician's assistant involved with treatment	924	34.6 (32.4 to 37.0)	420	4757	462	3873	390	34.1 (25.7 to 43.8)
Pharmacist	140	5.5 (4.6 to 6.7)	60	771	69	667	99	8.3 (4.5 to 15.0)
Nutritionist or dietician	150	5.8 (4.8 to 7.0)	55	622	90	860	39	3.1 (1.2 to 8.0)
Another health-care professional	742	27.1 (24.9 to 29.3)	260	3202	453	3712	243	20.8 (14.2 to 29.6)
Provider recommended cannabis use								
Missing responses (n = 206)								
No	11 222	90.9 (90.2 to 91.5)	4686	52 303	5513	43 164	9507	96.9 (95.8 to 97.8)
Yes	1186	9.1 (8.5 to 9.8)	412	4934	732	6743	352	3.1 (2.2 to 4.3)
Recommended by type of provider								
Primary care provider	274	20.8 (18.1 to 23.8)	73	804	193	1822	58	17.5 (8.7 to 31.9)
Oncologist involved with treatment	519	46.1 (42.7 to 49.6)	181	2016	321	3368	154	46.7 (31.2 to 62.9)
Nurse or physician's assistant involved with treatment	263	23.0 (20.0 to 26.2)	114	1344	138	1399	101	28.1 (15.7 to 44.9)
Pharmacist ^c	28	2.2 (1.3 to 3.1)	8	104	15	119	39	11.8 (1.5 to 22.1)
Nutritionist or dietician ^c	68	7.1 (4.9 to 9.3)	25	330	39	451	26	7.8 (0.1 to 15.4)
Another health-care professional	506	41.0 (37.5 to 44.5)	149	2011	337	2790	139	40.2 (26.7 to 55.3)

^a Asked of all patients those who used and those who didn't use; reported for sites that used probability sampling; percents are adjusted by age (3 categories as in Table 2), race (5 categories as in Table 2), and sex at birth. CI = confidence interval; n = unweighted sample size; No. = weighted to reflect estimates of population size.

^b This question was not asked in the survey of Sidney Kimmel Cancer Center (n = 1568). These respondents were included in the "missing" category.

^c Not adjusted to demographics because of small cells and model failures to converge.

Table 4. Demographic and clinical characteristics of cancer patients who used cannabis since diagnosis (n = 4163)

Characteristic	n	No. (%)
	4163	38 454 (32.9)
Age, y		
Median (range)	4163	61.14 (19-92)
Younger than 50	979	8883 (23.1)
50-64	1409	12 521 (32.6)
65 and older	1679	15 610 (40.6)
Missing	96	1440 (3.7)
Sex		
Male	1817	16 347 (42.5)
Female	2296	21 446 (55.8)
Unknown or missing	50	661 (1.7)
Race and ethnicity		
Asian and Pacific Islander	74	1049 (2.7)
Black	246	3926 (10.2)
Hispanic	214	1915 (5.0)
Other	130	1365 (3.6)
Unknown or missing	80	897 (2.3)
White	3419	29 301 (76.2)
Education		
High school graduate or less	627	6285 (16.3)
Some college	707	6889 (17.9)
College graduate	1094	10 851 (28.2)
Postgraduate	916	9620 (25.0)
Unknown or missing	819	4809 (12.5)
Cannabis use prior to diagnosis		
No	772	7026 (18.3)
Yes	3378	31 314 (81.4)
Unknown or missing	13	113 (0.3)
State cannabis policy		
Fully legal	1852	19 873 (51.7)
Legalized for medical use	2008	16 008 (41.6)
Fully illegal	303	2573 (6.7)
Type of cancer		
Brain	98	719 (1.9)
Breast	792	6802 (17.7)
Colorectal (combine colon and rectum)	212	1805 (4.7)
Other gastrointestinal (esophagus, stomach, small intestine)	138	2300 (6.0)
Liver and gall bladder	82	774 (2.0)
Pancreas	72	842 (2.2)
Oropharyngeal	96	924 (2.4)
Lung	272	2530 (6.6)
Melanoma	164	1210 (3.1)
Prostate	415	3840 (10.0)
Gynecologic malignancy (combine cervix, cervical, uterine, ovary)	163	1434 (3.7)
Kidney	139	1108 (2.9)
Bladder	88	661 (1.7)
Thyroid	97	779 (2.0)
Lymphoma (non-Hodgkin lymphoma, Hodgkin lymphoma)	179	1647 (4.3)
Myeloma	73	643 (1.7)
Leukemia	91	656 (1.7)
Other	816	6266 (16.3)
Not reported	478	6099 (15.9)
Cancer treatment status		
Hormonal only	197	1304 (3.4)
Active	46	375 (28.8)
Completed	30	186 (14.3)
Not reported	121	743 (56.9)
Chemotherapy only	451	3559 (9.3)
Active	95	928 (26.1)
Completed	244	1868 (52.5)
Not reported	112	763 (21.5)
Immunotherapy only	181	1182 (3.1)
Active	28	275 (23.2)
Completed	128	752 (63.6)
Not reported	25	156 (13.2)
Radiation only	564	3752 (9.8)
Active	15	175 (4.7)
Completed	382	2449 (65.3)
Not reported	167	1128 (30.1)

(continued)

Table 4. (continued)

Characteristic	n	No. (%)
More than 1 treatment	1220	10 508 (27.3)
Active ^a	573	5386 (51.3)
Completed ^a	420	3753 (35.7)
Not reported	227	1369 (13.0)
Not reported ^b	916	13 137 (34.2)

^a Considered active if at least 1 of the treatments is active.

^b Questions related to cancer treatment were not asked in the survey by Memorial Sloan Kettering Cancer Center and Oregon Health and Science University Knight Cancer Center. n = unweighted sample size; No. = weighted to reflect estimates of population size.

Discussion

In this large descriptive study of more than 12 000 cancer patients who were undergoing cancer treatment or had recently completed cancer treatment, we determined the prevalence and patterns of cannabis use in geographically and demographically diverse catchment areas of 12 NCI-Designated Cancer Centers in states with varying cannabis legal landscapes. We observed that close to one-third of cancer patients used cannabis since their cancer diagnosis, and 60% (or 20% of the sample) reported current use of cannabis. Most patients who used cannabis since cancer diagnosis had used it prior to diagnosis, with 6% of patients reporting use of cannabis after diagnosis without having used it previously. Overall, the reported use of cannabis following the diagnosis of cancer is consistent with prior surveys (10,16,17). The reported use in surveys must be interpreted with caution because of possible selection bias among respondents agreeing to complete the survey, particularly in states where cannabis use is illegal.

Of note, the reported use of cannabis since diagnosis only varied slightly by legal status, among the 10 sites with probability samples, with the percentage of use being higher among patients who resided in states where cannabis was fully legal (34.3%) or legalized for medical use (31.5%) than in states where cannabis was fully illegal (24.7%) (data not shown). However, among those who reported cannabis use, current reported use was lower among patients residing in states where cannabis is fully illegal (50%) than in states with legal use (59%-62.7% current use) (Table 5). The lower overall reported use and current use suggests that the state's legal cannabis context may influence patients' decisions regarding cannabis use and is consistent with findings in the general population where the prevalence of cannabis use varies by state legalization status (18).

We also observed that cancer patients primarily ate cannabis in food, smoked it, or took it by mouth in the form of pill, tinctures, or sublingually rather than other forms such as vaping and in lotions. These responses are similar to results of other surveys where cancer patients used edibles most often (14). Among a group of patients having any approved condition seeking certification for medical cannabis in Michigan, smoking as the mode of use was reported less frequently among cancer patients than those without cancer (19), consistent with the overall results of our survey. Mode of use varied by legal status where, interestingly, smoking was the most frequent mode among patients residing in states where cannabis was either illegal or legalized only for medical use, while eating in food was the most common mode where cannabis was fully legal. Available evidence is limited on adverse health risks associated with mode of delivery, but inhalation of smoked cannabis raises concern about other exposures and harms related to respiratory outcomes (20).

Interestingly, 36% of male and 20% of female lung cancer respondents reported smoking cannabis. There could be a preference for smoking cannabis among those who smoked cigarettes (21), and lung cancer patients, who may be current or former cigarette smokers, may prefer smoked cannabis. Although smoked cannabis can lead to exposure to carcinogenic combustion products, whether it increases risk to respiratory cancers as cigarette smoking does remain an open question (20,22).

Consistent with other surveys (8,14,23-25), cancer patients in our survey used cannabis primarily for symptom relief, including difficulty sleeping, pain, and mood changes. However, close to 30% reported using it recreationally or for enjoyment, likely reflecting the use of cannabis among cancer patients before cancer diagnosis.

In general, cancer patients perceived that the benefits of using cannabis outweighed the risks. Benefits noted were consistent across legal status. Patients in states where cannabis use is illegal noted the associated legal risks with use. Among patients residing in fully illegal cannabis states, perceived risks were greater and specifically related to associated legal risks and addiction to cannabis. These risks may also be shared by providers in those states and contribute to stigma associated with cannabis use, which could adversely affect patient-provider relationships. Whether these perceived risks and benefits related to use during cancer treatment reflect actual benefits and harms requires further extensive investigation, preferably in the context of randomized trials.

Of concern is the lack of conversation with health-care providers about cannabis use despite patients stating they would feel comfortable discussing its use. Though most of the patients, regardless of legal status, reported they were comfortable communicating use with providers about cannabis, much fewer reported having the discussion. In addition, those patients residing in states with illegal cannabis status were less likely to discuss cannabis use with their providers. Given the increasing availability of cannabis, it is important to have open communication between patient and providers, particularly because there may be harmful treatment interactions. For example, some studies have observed decreased responses and overall survival among patients treated with immune checkpoint inhibitors (7) and immunotherapy (26-28). At least 1 clinical study has shown similar tumor progression among cannabis-treated and cannabis-naïve non-small cell lung cancer patients treated with immune checkpoint inhibitors (29). More broadly, there is evidence of potential drug interactions with cannabis, suggesting that health-care providers should monitor responses of cannabis users, especially those with chronic conditions (30).

The low overall response rate across cancer centers is a limitation of the survey, and selection bias must be considered in interpreting results. Moreover, response rates varied markedly

Table 5. Frequency and duration of use among cancer patients who used cannabis since cancer diagnosis (weighted, 10 centers; n = 4163)^a

Characteristic	Total (n = 4163)			Fully legal (n = 1852)			Legalized for medical use (n = 2008)			Fully illegal (n = 303)			P, fully legal vs fully illegal	P, legalized for medical vs fully illegal
	n	No.	Weighted percent (95% CI)	n	No.	Weighted percent (95% CI)	n	No.	Weighted percent (95% CI)	n	No.	Weighted percent (95% CI)		
Current use														
Missing responses (n = 39)														
No	1596	15 311	40.0 (38.2 to 41.9)	714	8178	41.0 (38.2 to 43.9)	734	5873	37.3 (34.7 to 39.9)	148	1261	50.0 (43.8 to 56.1)	.0101	.0002
Yes	2528	22 791	60.0 (58.1 to 61.8)	1118	11 514	59.0 (56.1 to 61.8)	1255	9965	62.7 (60.1 to 65.3)	155	1312	50.0 (43.9 to 56.2)		
No. days, median (range)														
0-10	1184	9334	40.4 (38.1 to 42.7)	356	3574	30.0 (26.9 to 33.4)	774	5328	54.3 (51.1 to 57.4)	54	433	33.8 (26.3 to 42.2)	.387	<.0001
11-20	327	3050	13.1 (11.6 to 14.7)	160	1488	13.2 (11.1 to 15.8)	136	1264	12.0 (9.9 to 14.4)	31	298	21.7 (15.4 to 29.7)	.0125	0.0034
21-30	769	6899	29.9 (27.9 to 32.1)	391	3543	29.9 (26.9 to 33.1)	308	2774	28.3 (25.4 to 31.4)	70	581	44.1 (36.0 to 52.5)	.0012	0.0003
Use during treatment														
Missing responses (n = 32)														
Treatment not started (n = 152)														
No	1185	10 404	27.9 (26.2 to 29.7)	483	4994	25.5 (23.1 to 28.0)	590	4522	29.5 (27.1 to 32.0)	112	948	38.8 (32.9 to 44.9)	<.0001	.0039
Yes	2794	26 452	72.1 (70.3 to 73.8)	1279	14 141	74.5 (72.0 to 76.9)	1333	10 768	70.5 (68.0 to 72.9)	182	1542	61.3 (55.1 to 67.1)		
Every day, %	1218	10 893	41.0 (38.7 to 43.2)	532	5728	40.2 (36.9 to 43.7)	610	4528	42.0 (38.9 to 45.2)	76	636	40.3 (32.8 to 48.3)	.9901	.6879
Few times per wk, %	596	5846	21.8 (20.0 to 23.7)	270	2903	20.4 (17.9 to 23.2)	283	2550	23.2 (20.5 to 26.2)	43	393	25.2 (18.9 to 32.8)	.1903	.5972
Few times per mo, %	453	4333	15.5 (13.9 to 17.3)	221	2489	16.8 (14.3 to 19.5)	197	1569	13.8 (11.8 to 16.2)	35	275	17.2 (12.4 to 23.5)	.8779	.2372
≤once per mo, %	517	5274	19.3 (17.5 to 21.3)	251	2954	20.1 (17.5 to 23.1)	239	2090	19.0 (16.5 to 21.8)	27	230	14.9 (10.0 to 21.7)	.1458	.2450
Use after treatment														
Missing responses (n = 331)														
Treatment not completed (n = 686)														
No	644	5990	21.3 (19.6 to 23.2)	267	2607	20.0 (17.4 to 22.8)	316	2862	22.3 (19.8 to 25.0)	61	521	24.1 (18.8 to 30.3)	.1816	.5696
Yes	2502	21 662	78.7 (76.9 to 80.4)	1057	10 283	80.0 (77.3 to 82.6)	1248	9725	77.7 (75.0 to 80.2)	197	1654	75.9 (69.7 to 81.2)		
Every day, %	929	7880	36.2 (34.0 to 38.5)	375	3636	35.4 (32.0 to 39.0)	492	3737	38.1 (34.9 to 41.3)	62	507	30.3 (23.7 to 37.8)	.2207	.0611
Few times per wk, %	473	4126	18.8 (17.1 to 20.7)	210	1923	19.2 (16.7 to 22.0)	223	1827	18.0 (15.5 to 20.9)	40	376	21.6 (15.9 to 28.6)	.4765	.2921
Few times per mo, %	478	4327	19.8 (17.9 to 21.8)	220	2228	21.3 (18.3 to 24.7)	228	1862	19.2 (16.7 to 22.1)	30	237	14.4 (10.0 to 20.3)	.0411	.1325
≤once per mo, %	607	5219	23.7 (21.8 to 25.7)	250	2480	23.1 (20.1 to 26.4)	294	2228	23.1 (20.5 to 26.0)	63	511	31.5 (24.8 to 39.0)	.0279	.0234

^a The percents are adjusted by age (3 categories as in Table 2), race (5 categories as in Table 2), and sex at birth. CI = confidence interval; n = unweighted sample size; No. = weighted to reflect estimates of population size.

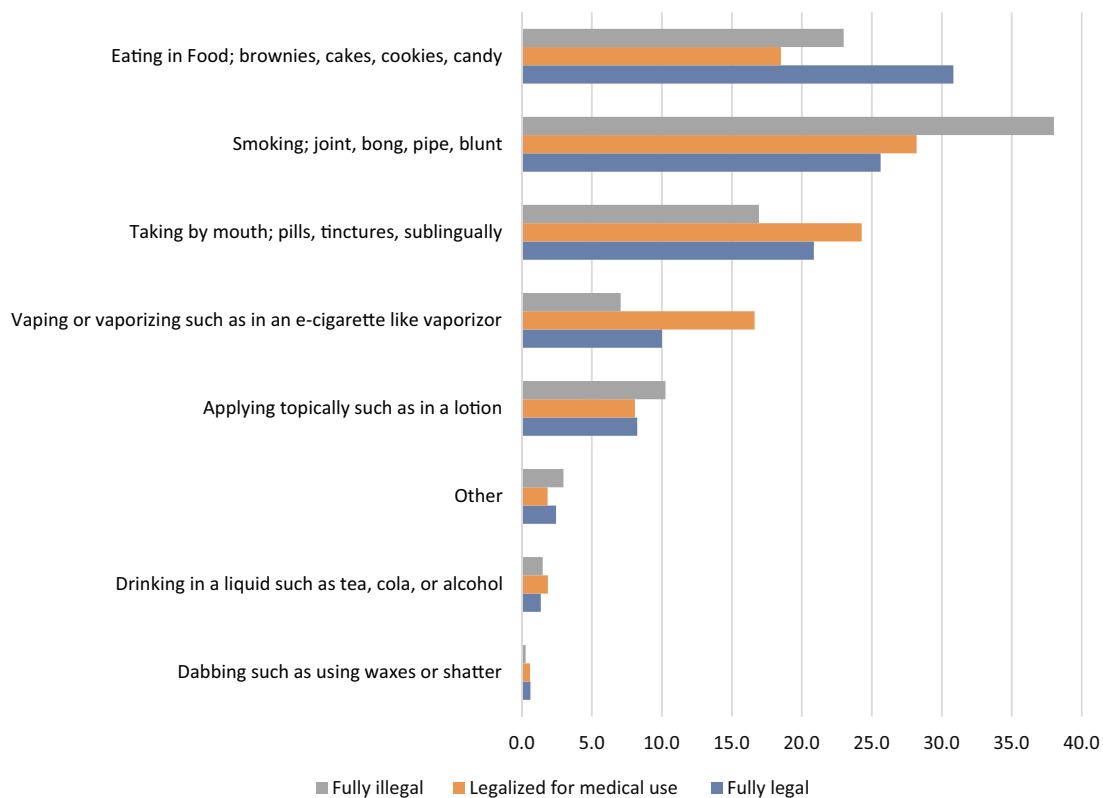


Figure 4. Mode of cannabis used most often by state cannabis policy.

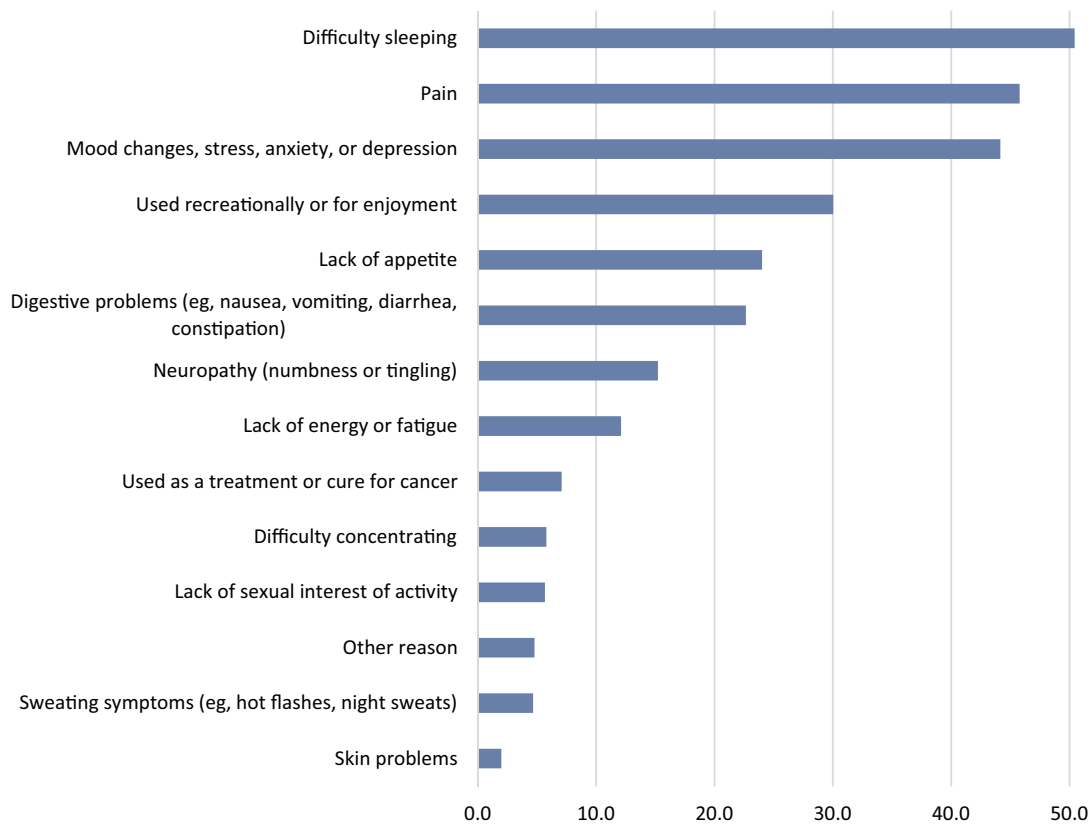


Figure 5. Reasons for use among cancer patients who used cannabis since diagnosis (n = 4163).

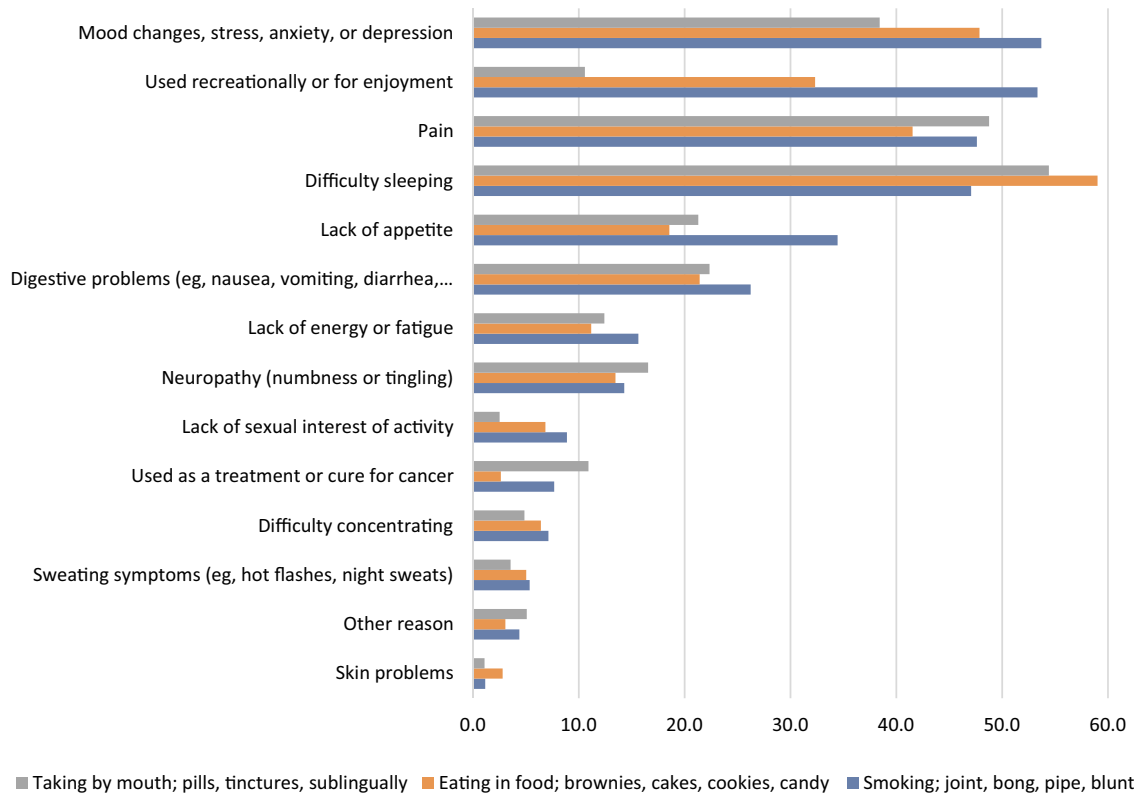


Figure 6. Reasons for using cannabis since diagnosis by most common modes of use (n = 4163).

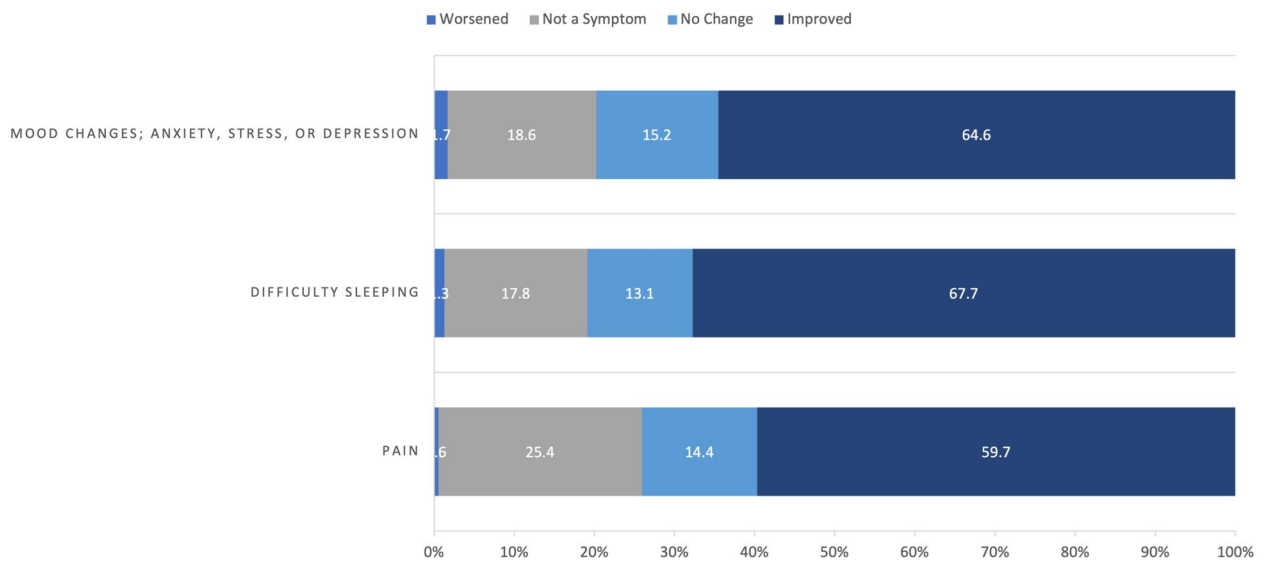


Figure 7. Perceived impact on symptoms among cancer patients who used cannabis since diagnosis of cancer (n = 4163).

across states regardless of legal statuses. Although the reported use was consistent with other smaller surveys, given the potential sensitivity of the subject, particularly in states where cannabis use is illegal, and despite most surveys being conducted anonymously, it is difficult to know whether users of cannabis were more or less likely than never users to respond. Moreover, cancer patients treated at NCI-Designated Cancer Centers are not representative of the US population of cancer patients given that most patients receive treatment at other cancer treatment facilities. Although the legal landscape for cannabis use is

changing, state legalization status was fixed at the time of survey administration, particularly for medical use, and was consistent over the period since diagnosis and the reference time for the survey. Although a limitation of the survey, we don't believe changes in adult nonmedical cannabis laws during survey administration had an impact on cannabis use since diagnosis. Given the low response rate for patients in cancer centers, representation of cancer center catchment areas is dubious. Thus, overall estimates should be interpreted with caution and estimates of prevalence are questionable.

This large geographically diverse survey demonstrates that patients are using cannabis regardless of its legality in their state of residence. The use of cannabis is likely to increase given liberalization of legal status along with the perception of benefits. Thus, it is critical to address the knowledge gaps and determine actual benefits and harms of cannabis use during cancer treatment, particularly assessing any potential treatment interactions, and to enhance patient-provider communication. Future research should assess actual benefits and risks of using cannabis among cancer patients undergoing treatment in controlled clinical trials.

Data availability

All data included in this effort are de-identified and do not include identifying information for any respondents. De-identified data for all but three of the Cancer Centers will be made available in the Database for Genotypes and Phenotypes (dbGaP) (<https://dbgap.ncbi.nlm.nih.gov/aa/wga.cgi?page=login>), an NIH controlled-access repository; the title of this publication should be used to search for this dataset in dbGaP. Requests for the data from Hollings Cancer Center, Medical University of South Carolina should be sent to Dr. Erin McClure (mcclure@musc.edu). Contact Dr. Brooke Worster (Brooke.Worster@jefferson.edu) for requests to data collected by Sidney Kimmel Cancer Center, Jefferson Health. For requests to data collected by Memorial Sloan Kettering Cancer Center, contact Dr. Rebecca Ashare (crdashare@mskcc.org).

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Conflicts of interest

Dr Jon O. Ebbert has consulting agreements with K Health, Exact Sciences, and MedinCell and serves on the scientific advisory board for Applied Aerosol Technologies, which are not related to the current work.

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