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Social Determinants of Health Associated with How Cannabis is Obtained and Used in Patients with Cancer Receiving Care at a Cancer Treatment Center in Pennsylvania

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ABSTRACT

Despite increased rates of cannabis use among patients with cancer, there are gaps in our understanding of barriers to accessing cannabis. Social determinants of health (SDoH) are associated with access to healthcare, but few studies have evaluated how SDoH relate to cannabis access and use among cancer patients. We examined whether access to and modes of cannabis use differed across indicators of SDoH among patients receiving treatment from a large National Cancer Institute (NCI) designated cancer center. This anonymous cross-sectional survey was developed in collaboration with the NCI Cannabis Supplement consortium, which funded 12 supplements to NCI Center Core Grants across the United States. We evaluated the association of race, gender, income, and age with mode of cannabis use, source of obtaining cannabis, what influences their purchase, and medical cannabis certification status. Overall, 1,053 patients receiving treatment for cancer in Pennsylvania completed the survey and 352 (33.4%) reported using cannabis since their cancer diagnosis. Patients who identified as Black/African-American were less likely to have medical cannabis certifications (p=0.04). Males and Black/African-Americans were more likely to report smoking cannabis (vs other forms, ps<0.01) and to purchase cannabis from an unlicensed dealer/seller (p<0.01). Lower-income patients were more likely to be influenced by price and ease of access (ps<0.05). Although cannabis users were younger than non-users, age was not associated with any outcomes. The current data shed light on how critical drivers of health disparities (such as race, gender, and income) are associated with where patients with cancer obtain cannabis, what forms they use, and what may influence their purchase decisions.

Key words: = cannabis; cancer; social determinants of health; marijuana; race

As of the end of 2022, 37 states and the District of Columbia have approved cannabis for medical use, and all of these states list cancer as a 'certifying' condition. Between 24%-40% (Bar-Lev Schleider et al., 2018; Pergam et al., 2017; Tringale et al., 2019) of cancer patients use

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cannabis at some point during their treatment and among those, 75% use cannabis to manage symptoms including pain, anxiety and insomnia (Martell et al., 2018; Turgeman & Bar-Sela, 2017). Nevertheless, gaps exist between expanding state laws and the scanty scientific evidence base on cannabis use in persons with cancer. For instance, the 'accepted' medical diagnoses vary by state, not due to scientific evidence but rather state politics (NCSL, 2022). This results in a confusing landscape for patients about who may—or may not—benefit from cannabis. It is not surprising that national guidelines lack recommendations about possible therapeutic uses of cannabis, which poses challenges for oncology clinicians (Worster et al., 2021).

The lack of scientific evidence, real-world clinical guidance, and an explosion of new cannabis products has created further complexity. For example, there is substantial product variability in state-regulated medical and adult-use dispensaries; some oral formulations contain up to 100mg of THC in a single ingestible product, whereas others contain 5-10mg in the same sized product. High concentrations of THC have a higher likelihood of adverse side effects including palpitations, anxiety, panic attacks, and psychosis (Dobbins et al., 2022). Health risks may also vary according to the form used (Choi et al., 2021). Cannabis used for perceived medical purposes often involves lower potency products and non-combusted modes of use (Smith & Goniewicz, 2020). Many patients who use cannabis medicinally report dry herb/flower vaporization (Shiplo et al., 2016), which contains lower THC concentrations and fewer potential inhalation health risks compared to most liquid cannabis concentrates administered through vaping (Smith & Goniewicz, 2020). Conversely, blunt use (i.e., hollowed-out cigar wrappers filled with cannabis and smoked) is associated with greater health risks compared to other combustible (e.g., pipes) and noncombustible (e.g., edibles) methods (Cooper & Haney, 2009; Fairman, 2015; Peters et al., 2012). Edible cannabis products are also not without risk and have been associated with accidental over ingestion (Noble et al., 2019).

Social determinants of health (SDoH) have come to the forefront as critical drivers of a wide range of health outcomes and risks (Healthy People, 2030). Cannabis use is no exception. Evidence is emerging that access to regulated cannabis products in dispensaries varies by persons' race, gender, age, and the ability to pay out of pocket (Cooke et al., 2018; Novak et al., 2021). Studies have also found that blunt use is highest among Black/African-Americans compared to Whites (Cohn et al., 2016; Montgomery & Mantey, 2017), with rates of daily blunt use among Black/African-Americans more than double that of Whites (25% vs. 10%) (Mantey et al., 2021). This represents another important health disparity, given increased health risks associated with blunt use. However, very little is known about SDoH associated with cannabis use in patients with cancer.

The current study aimed to examine SDoH that may be associated with access to forms of cannabis associated with lower risk (i.e., edible, vaping flower/herb) among patients from a large National Cancer Institute (NCI) designated cancer center. We investigated differences by race, gender, age, income in rates of medical cannabis certification (the process a state resident goes through to obtain cannabis for a medically approved condition), forms of cannabis use, source of obtaining cannabis, and factors that influence the purchase of cannabis. Given racial disparities in both cancer pain management (Meghani et al., 2014) and symptom burden (Bulls et al., 2022), as access to cannabis expands, it will be essential to identify possible barriers to access to avoid widening health disparities in cancer care.

METHODS

Setting

We conducted an anonymous cross-sectional survey of patients with cancer receiving treatment at an NCI-designated cancer center in Pennsylvania from July 2021 through November 2021. During this time, the Pennsylvania Medical Marijuana Program made medical cannabis available for Pennsylvania residents with an approved "serious medical condition" (including cancer); adult use of cannabis was not legal. Pennsylvania residents are required to register in a state-run online database and see a physician who confirms they have a medically eligible diagnosis (e.g., pain, cancer, anxiety). This enables residents to get access to state-regulated cannabis dispensaries. Eligibility criteria included: >18 years old, able to communicate in English and

provide informed consent, cancer diagnosis, and currently receiving or received cancer treatment in the last year.

Electronic health records identified 14,483 patients, and survey invitations were sent to a randomly selected representative sample of 5,808 patients. All data were collected via REDCap electronic database (Harris et al., 2019; Harris et al., 2009). Patients had the option to receive compensation for completing the survey. The Institutional Review Board determined this study to be exempt.

Measures

The survey was developed in collaboration with the NCI Cannabis Supplement consortium, which funded 12 supplements to NCI Center Core Grants across the United States. The survey included questions about current and past use (quantity, frequency, modes of use), reasons for use, perceptions of benefits and risk, conversations with providers, stigma, access and barriers to access, and intersection with opioids. The survey also collected demographic characteristics and cancer-related information (type, stage, treatment). The current analysis focuses on medical certification rates for cannabis (yes/no), modes of use, where patients get cannabis, and what influences their use (see Tables 2 & 3). Except for mode of use, which asked respondents to select the "most common" mode used, multiple options could be selected for other outcomes.

Data Analysis

Survey weights were calibrated to population totals via iterative raking on age, gender, race, ethnicity, and cancer types. Per recommendations from the NIH, we included two variables: race and ethnicity. Race included the categories Asian, Black or African American, White, Multiple Races, and Other/Unknown. Ethnicity included Hispanic and Non-Hispanic. Summary statistics for clinical and demographic characteristics were computed for the 1,053 patients who completed the survey and stratified by cannabis use since cancer diagnosis (yes/no). Means and standard deviations were used for continuous measures, and frequencies and percentages were used for categorical measures. Primary analyses were conducted on patients who used cannabis since their diagnosis using weighted estimates (n=352). Outcomes (mode of use, source of obtaining cannabis, influence on use, and medical certification) were compared between racial groups (Black/African-American vs White), age (<65 vs ≥65 years), gender, and income (<$35,000, $35,000-$74,999, $75,000-$99,999, >=$100,000) using chi-squared models. For outcomes associated with multiple SDoH, follow-up logistic regression models evaluated the unique contribution of each SDoH. For all models, alpha=0.05.

RESULTS

Participant Characteristics

Table 1 shows descriptive information for the full sample and subset who used cannabis since their cancer diagnosis. Overall, 63.4% (n=667) were female, 10% identified as Black/African-American, 51% had an income >$100k per year, and the average age was 60.6 years (SD=13.1). There were significant differences in ethnicity, age, health insurance status, and occupation status such that individuals who identified as Hispanic, were younger, were insured by Medicaid, or identified as students or disabled were more likely to have used cannabis. Additionally, patients with breast cancer and those diagnosed with Stage I/II cancer were less likely to use cannabis. Because of the small number of patients who identified as Hispanic, our analyses focus on race and because most (96%) of the sample identified as either White or Black/African-American, analyses focused on these groups.

Cannabis Medical Certification

Overall, 42.9% of patients reported being medically certified for cannabis. Patients who identified as Black/African-American were significantly less likely to be medically certified compared to White patients (p=0.04; Table 2). Medical certification rates did not differ by gender, age, or income.

Source of Obtaining Cannabis

The most common sources of obtaining cannabis were friend/family member (n=134, 38.1%) and medical dispensary (n=166, 47.2%).

Table 1. *Participant Characteristics*

Participant Characteristics	Total (*N*= 1053)	Used Cannabis Since Cancer Diagnosis (n=352)		Have Not Used Cannabis Since Cancer Diagnosis (n=701)		p-value[1]
		Unweighted n	Weighted % (95% CI)	Unweighted n	Weighted % (95% CI)	
Sex[2]						
Male	381 (36.4%)	124	30.5 (25.8, 35.5)	257	69.6 (64.5, 74.2)	0.68
Female	672 (63.4%)	228	31.8 (28.2, 35.5)	444	68.3 (64.5, 71.8)	
Race[3]						
Asian	16 (1.5%)	2	11.2 (0.03, 0.37)	14	88.8 (63.4, 97.3)	0.06
Black or African American	100 (9.5%)	44	41.0 (31.6, 51.7)	56	58.7 (48.3, 68.4)	
White	896 (85.1%)	293	30.1 (27.1, 33.2)	603	69.9 (66.8, 72.9)	
Multiple Races	10 (1%)	4	39.3 (14.3, 71.4)	6	60.7 (28.6, 85.7)	
Other/Unknown	31 (2.9%)	9	31.2, 28.4, 34.2)	22	76.1 (58.9, 87.6)	
Ethnicity						
Hispanic	38 (3.6%)	19	47.9 (31.5, 64.9)	19	52.1 (35.7, 68.0)	0.034
Non-Hispanic	1,015 (96.4%)	333	30.8 (27.9, 33.8)	682	69.2 (66.2, 72.1)	
Age						
< 65 years	599 (56.9%)	246	40.0 (35.9, 44.2)	353	60.0 (55.8, 64.1)	<0.001
≥ 65 years	454 (43.1%)	106	22.2 (18.5, 26.5)	348	77.8 (73.5, 81.5)	
Health Insurance						
Private (employer-based)	524 (51.6%)	188	34.8 (30.6, 39.3)	336	65.2 (60.7, 69.4)	<0.001
Private (self)	48 (4.7%)	21	40.2 (26.7, 55.3)	27	59.8 (44.7, 73.3)	
Medicare	388 (38.2%)	97	22.5 (18.5, 27.0)	291	77.5 (73.1, 81.5)	
Medicaid/ other State program	37 (3.6%)	20	52.0 (35.2, 68.4)	17	48.0 (31.6, 64.8)	
TRICARE, VA, or Indian Health Service, Tribal Health Services	8 (0.8%)	2	27.4 (6.5, 67.1)	6	72.6 (32.9, 93.5)	
Some other source	11 (1.1%)	5	46.0 (19.8, 74.5)	6	54.1 (25.5, 80.2)	
Income						
< $35,000	93 (8.9%)	38	37.7 (28.0, 48.5)	55	62.3 (51.5, 72.0)	0.22
$35,000 - $74,999	250 (23.9%)	87	32.9 (27.0, 39.4)	163	67.1 (60.7, 73.0)	
$75,000 - $99,999	169 (16.1%)	60	34.0 (27.0, 41.8)	109	66.0 (58.2, 73.0)	
>=$100,000	536 (51.2%)	166	28.3 (28.4, 34.3)	370	71.7 (67.6, 75.5)	
Occupation Status						
Employed	475 (45.1%)	173	36.0 (31.6, 40.7)	302	64.0 (59.3, 68.4)	<0.001
Unemployed	24 (2.3%)	6	20.8 (8.8, 41.7)	18	79.2 (58.3, 91.2)	
Homemaker	39 (3.7%)	12	29.4 (17.0, 45.9)	27	70.6 (54.1, 83.0)	
Student	6 (0.6%)	5	68.1 (19.4, 95.0)	1	31.9 (5.0, 80.6)	
Retired	423 (40.2%)	109	23.2 (19.4, 27.6)	314	76.8 (72.4, 80.7)	
Disabled	73 (6.9%)	45	59.5 (46.9, 70.9)	28	40.5 (29.1, 53.1)	
Other	13 (1.2%)	2	18.9 (4.6, 52.8)	11	81.1 (47.2, 95.4)	
Cancer Type						
Gastrointestinal	126 (12.0%)	50	36.7 (27.8, 46.5)	76	63.4 (53.5, 72.2)	0.22
Genitourinary	136 (12.9%)	36	24.7 (18.0, 33.0)	100	75.3 (67.0, 82.0)	0.08
Hematologic	166 (15.8%)	62	36.9 (29.4, 45.1)	104	63.1 (54.9, 70.6)	0.11
Breast	347 (33.0%)	98	25.9 (21.5, 30.9)	249	74.1 (69.2, 78.5)	0.01
Other	338 (32.1%)	130	35.2 (28.4, 34.2)	208	64.8 (59.2, 70.1	0.06
Cancer Stage at Diagnosis						
Stage I/II	584 (55.8%)	178	28.1 (24.5, 32.0)	406	71.9 (68.0, 75.5)	0.03
Stage III/IV	386 (36.9%)	141	34.2 (29.3, 39.4)	245	65.8 (60.6, 70.7)	
Unknown/In Situ	77 (7.4%)	32	41.3 (30.3, 53.2)	45	58.7 (46.8, 69.7)	

Note. CI = Confidence Interval. [1]The p-values are from weight adjusted Chi-square tests comparing those who used cannabis since diagnosis and those who have not. [2]Analyses were conducted with sex (assigned at birth) and gender identity. Results were unchanged and sex was retained. [3]When comparing rates of cannabis use between Black/African-American and White patients only, the difference was significant (p=0.04).

Table 2. *Outcomes by Sex, Race, and Age for Patients who Used Cannabis Since Cancer Diagnosis (n=352)*

	Gender, % within category			Race, % within category			Age, % within category		
Outcomes	**Male**	**Female**	**p-value**	**White**	**Black/African-American**	**p-value**	**< 65**	**≥ 65**	**p-value**
Medical certification (% yes)	35.8 (27.2,45.4)	45.6 (39.1, 52.4)	0.09	46.0 (40.1, 51.9)	28.2 (16.2, 44.4)	0.04	41.6 (35.3, 48.1)	42.3 (32.4, 52.7)	0.91
Source of obtaining cannabis									
Grow it	2.5 (.7, 8.1)	.81 (.1, 5.5)	0.3	1.3 (.3, 4.1)	2.6 (.4, 16.8)	0.52	0	4.2 (1.5, 11.2)	0.01
Internet	2.0 (.62, 6.2)	3.5 (1.6, 7.3)	0.41	2.6 (1.3, 5.2)	4.6 (1.1, 16.8)	0.45	2.3 (.9, 5.7)	3.9 (1.6, 9.4)	0.40
Friend/family	44.9 (35.9, 54.9)	34.5 (28.7, 41.7)	0.08	36.2 (30.7, 42.1)	51.5 (35.7, 67.0)	0.07	40.0 (33.7, 46.6)	37.1 (27.8, 47.4)	0.63
Unlicensed dealer/seller	17.4 (10.9, 26.5)	8.2 (5.0, 13.1)	0.01	8.6 (5.7, 12.6)	27.2 (15.0, 44.1)	0.0009	11.8 (8.0, 17.1)	11.6 (5.9, 21.6)	0.97
Dispensary (prescription)	38.0 (29.3, 47.6)	49.7 (43.0, 56.4)	0.05	47.7 (41.9, 53.6)	35.3 (21.8, 51.6)	0.15	46.9 (40.4, 53.5)	41.8 (32.2, 52.1)	0.41
Dispensary in another state (recreational)	19.5 (13.1, 28.1)	13.5 (9.3, 19.1)	0.17	15.2 (11.4, 19.8)	17.1 (7.9, 33.3)	0.76	15.4 (11.1, 21.0)	16.6 (10.4, 25.5)	0.79
Factors that influence purchase									
Price	34.6 (26.1, 44.2)	23.3 (17.9, 29.7)	0.03	24.0 (19.3, 29.5)	42.1 (27.5, 58.2)	0.02	30.1 (24.4, 36.6)	23.2 (15.3, 33.6)	0.24
Availability/Variety of products	39.0 (30.4, 48.4)	38.9 (32.4, 46.0)	0.98	36.9 (31.4, 42.7)	49.7 (34.2, 65.3)	0.13	39.6 (33.3, 46.3)	37.8 (28.4, 48.2)	0.76
Ease of access	57.7 (48.1, 66.7)	48.4 (41.7, 55.1)	0.12	50.2 (44.4, 56.0)	62.7 (46.8, 76.3)	0.14	49.4 (42.6, 55.7)	57.4 (47.4, 66.9)	0.18
Safety of product	40.9 (32.0, 50.6)	52.5 (45.6, 59.3)	0.05	48.3 (42.4, 54.2)	45.8 (30.8, 61.6)	0.77	51.0 (44.4, 57.6)	42.4 (32.8, 52.6)	0.16
Quality of product	52.9 (43.4, 62.3)	52.6 (45.7, 59.5)	0.95	51.4 (45.4, 57.4)	56.6 (40.5, 71.5)	0.55	52.5 (45.8, 59.1)	53.2 (43.0, 63.2)	0.91
Need for medical registry ID card	13.9 (8.6, 21.8)	29.8 (23.8, 36.5)	0.002	23.2 (18.6, 28.5)	25.9 (14.7, 41.3)	0.71	23.8 (18.7, 29.9)	23.1 (15.8, 32.5)	0.89
Method of payment	4.8 (1.6, 13.4)	2.7 (1.1, 6.9)	0.18	2.1 (1.0, 4.4)	10.2 (3.1, 28.8)	0.01	4.0 (2.0, 8.1)	2.6 (.4, 16.3)	0.68
More than 1 mode of cannabis (% Yes)	55.9 (46.3, 65.1)	58.3 (51.4, 64.9)	0.68	55.3 (49.4, 61.0)	66.6 (49.6, 80.1)	0.21	61.4 (54.8, 67.6)	49.9 (39.8, 60.1)	0.06
Most common mode of use									
Smoking	31.4 (23.3, 40.7)	16.3 (11.8, 22.0)	P<0.001	17.1 (13.1, 22.0)	39.0 (22.5, 54.4)	0.01	21.9 (16.8, 27.9)	22.8 (15.0, 33.0)	0.66
Eating/ingesting	41.8 (33.2, 50.9)	52.8 (45.9, 59.7)		53.2 (47.1, 59.1)	32.9 (20.6, 48.0)		49.1 (42.6, 55.6)	47.5 (37.5, 57.7)	
Vaping	24.0 (16.8, 33.0)	17.0 (12.4, 22.9)		20.0 (15.6, 25.1)	17.7 (8.3, 33.9)		21.0 (16.0, 27.0)	17.4 (10.9, 26.6)	
Applying topically	2.8 (.9, 8.5)	13.9 (9.6, 19.7)		9.7 (6.7, 13.9)	10.4 (6.9, 13.9)		8.1 (5.2, 12.4)	12.3 (6.9, 21.1)	

Note. All values are weighted estimates and 95% Confidence Intervals.

Table 3. *Outcomes by Income Category for Patients who Used Cannabis Since Cancer Diagnosis (n=352)*

	Income, % within category				
Outcomes	**<$35,000**	**$35,000-$74,999**	**$75,000-$99,999**	**>=$100,000**	**p-value**
Medical certification (% yes)	44.0 (28.2, 61.2)	39.0 (28.6, 50.5)	35.7 (24.1, 49.3)	44.5 (36.8, 52.6)	0.68
Source of obtaining cannabis					
Grow it	0	1.9 (.3, 12.2)	0	2.2 (.7, 7.1)	0.64
Internet	5.4 (1.1, 21.7)	1.0 (.1, 6.9)	6.9 (2.5, 17.5)	1.8 (.5, 5.5)	0.13
Friend/family	46.5 (30.4, 63.4)	41.2 (30.5, 52.8)	40.2 (27.8, 53.8)	35.6 (28.2, 43.7)	0.65
Unlicensed dealer/seller	6.4 (1.5, 23.6)	23.8 (14.9, 35.8)	13.2 (6.1, 26.1)	5.7 (2.8, 11.3)	0.003
Dispensary (prescription)	43.6 (28.3, 60.1)	43.5 (32.7, 54.9)	45.3 (32.6, 58.7)	45.8 (38.1, 53.8)	0.99
Dispensary in another state (recreational)	22.2 (10.0, 42.3)	7.3 (3.2, 15.5)	16.8 (9.1, 29.1)	19.0 (13.6, 26.1)	0.11
Factors that influence purchase					
Price	38.3 (23.1, 56.1)	39.0 (28.4, 50.6)	36.5 (24.6, 50.2)	15.1 (10.2, 21.9)	0.0003
Availability/Variety of products	55.5 (38.2, 71.6)	42.3 (31.8, 53.6)	30.9 (20.1, 44.3)	35.1 (27.8, 43.1)	0.08
Ease access	70.2 (53.6, 82.8)	57.7 (46.4, 68.3)	40.1 (27.9, 53.6)	47.9 (40.0, 56.0)	0.02
Safety of product	50.9 (34.0, 67.7)	41.5 (30.9, 53.0)	54.2 (40.9, 66.8)	48.0 (40.1, 56.0)	0.53
Quality of product	53.4 (36.3, 69.8)	52.4 (41.2, 63.4)	56.4 (43.3, 58.8)	50.8 (42.7, 58.8)	0.92
Need for medical registry ID card	18.8 (9.1, 34.7)	33.7 (23.8, 45.1)	15.1 (7.9, 27.1)	21.3 (15.5, 28.5)	0.05
Method of payment	9.1 (3.6, 20.9)	5.9 (1.7, 18.9)	0	2.1 (.5, 8.3)	0.15
More than 1 mode of cannabis (% yes)	69.7 (52.3, 82.9)	55.8 (44.3, 66.8)	49.9 (36.9, 63.0)	57.4 (49.4, 65.1)	0.33
Most common mode of use					
Smoking	32.3 (17.9, 51.0)	28.3 (19.0, 39.8)	18.4 (10.1, 31.0)	17.5 (12.1, 24.7)	0.55
Eating/ingesting	48.1 (31.7, 64.9)	45.9 (34.8, 57.3)	54.4 (41.0, 67.1)	48.5 (40.6, 56.6)	
Vaping	16.1 (7.4, 31.4)	16.5 (9.7, 26.7)	18.4 (10.0, 31.4)	23.5 (17.1, 31.3)	
Applying topically	3.6 (.4, 21.7)	9.4 (4.4, 18.8)	8.9 (3.9, 19.2)	10.5 (6.4, 16.7)	

Note. All values are weighted estimates and 95% CI.

Other sources included: unlicensed dealer/seller (n=35, 9.9%), recreational cannabis store/dispensary in another state (n=55, 15.6%), internet (n=10, 2.8%), and growing it (n=4, 1.1%). Source of obtaining cannabis differed by gender, race, and income, but not age. Male patients, Black/African-American patients, and patients with a self-reported income between $35,000 and $74,999 were more likely to obtain cannabis from an unlicensed dealer/seller than their counterparts (*p*s<0.02, Tables 2-3). Only race remained significant for the follow-up logistic regression model including gender, income, and race (OR=3.3, 95%CI 1.2,9.0, p=0.02). Female patients were also more likely to obtain cannabis from a dispensary with a medical certification card (*p*=0.05).

Factors that Influence Purchase of Cannabis

Approximately half the sample reported that product quality (n=184, 52.3%) and safety (n=173, 49.2%), and ease of access/convenience (n=179, 50.9%) influenced their cannabis purchase. Availability/variety of products (n=132, 37.5%), price (n=93, 26.4%), need for medical certification (n=83, 23.6%), and payment method (n=10, 2.8%) also influenced their purchase. Factors affecting cannabis purchase differed by gender, race, and income, but not age. Male patients, Black/African-American patients, and patients with a self-reported income <$100,000 reported being more influenced by price than their counterparts (*p*s<0.05, Tables 2-3). For the logistic regression, income (OR=0.63, 95%CI 0.49,0.82, p=0.001) and gender (OR=0.54, 95%CI 0.31,0.95, p=0.03) were significantly associated with being influenced by price, but the race effect was mitigated. Female patients and patients with a self-reported income between $35,000 and $74,999 reported being more influenced by the need for a medical registry ID card, compared to their counterparts (*ps*<0.05, Tables 2-3). In the logistic regression, only gender was significantly associated with being influenced by the need for a medical registry ID card (OR=2.5, 95%CI 1.4,4.7, p=0.004). Lastly, patients reporting the lowest income (<$35,000) were more influenced by ease of access/convenience compared to other income groups (p=0.02). Being influenced by the safety or quality of the product were similar across SDoH variables.

Mode of Use

More than half the sample reported more than one mode of cannabis use (n=202, 57.4%). The most common modes of use were: ingested/oral (i.e, tinctures, edibles, drinking) (n=175, 50.0%), smoked (n=73, 21.0%), vaped (n=70, 20.0%), and topical (n=32, 9.1%). Mode of use differed by gender (*p*<0.001) and race (*p*=0.01), but not age or income (Tables 2-3). Male and Black/African-American patients were more likely to report smoking as their most common mode of use. The logistic regression indicated that gender and race significantly predicted smoking as the most common mode of use (gender: OR=0.38, 95%CI 0.23,0.62; race: OR=3.9, 95%CI 2.0,7.8; *p*s<0.001). In contrast, female and White patients were more likely to use ingested formulations. When gender and race were included in the logistic regression model, only race remained significant (OR=0.44, 95%CI 0.23,0.88; *p*=0.02), indicating that Black/African-American patients were 56% less likely than White patients to use ingested/oral forms of cannabis.

DISCUSSION

We examined the association of select SDoH variables (i.e., gender, race, age, income) with access to and use of forms of cannabis associated with lower risk among outpatients with cancer in Pennsylvania. We found that overall cannabis use rates, medical certification rates, sources of obtaining cannabis, and forms of cannabis used differed by respondent race. Patients who identified as Black/African-American were more likely to report using cannabis in forms associated with adverse health outcomes, such as smoking cannabis. We also found differences by gender and income, suggesting males and lower-income patients may be more likely to use riskier forms of cannabis (i.e., smoked, obtained via unlicensed dealer/seller). Although cannabis users were younger than non-users, age was not associated with any outcomes. Taken together, these findings suggest that certain SDoH play an important role in how patients with cancer may access and use cannabis.

The current data suggesting that Black/African-American patients with cancer are more likely to report using cannabis compared to White patients are consistent with epidemiological

studies in both the general population and in cancer survivors (Do et al., 2021; Jeffers et al., 2021). Our data also show that Black/African-American patients with cancer are less likely to be medically certified for cannabis in Pennsylvania. Although our data did not explore why medical certification rates differed, it is possible that mistrust arising in response to historical and contemporary structural racism in healthcare (Primm et al., 2010; Webb Hooper et al., 2020) may have reduced Black/African-American patients' willingness to enroll in the program. Because adult cannabis use has not been legalized in Pennsylvania, it was not surprising that Black/African-American patients in our study were also more likely to obtain cannabis from an unlicensed dealer/seller and were slightly more likely to obtain cannabis from family /friend. Without access to products at a dispensary, Black/African-American patients may be less likely to have access to forms of cannabis associated with reduced health risks (e.g., ingested formulations). Indeed, Black/African-American patients were more likely to use smoked forms of cannabis, potentially increasing their exposure to carcinogens (Cooper & Haney, 2009) and risk for smoking-related illnesses that may interfere with cancer treatment (Schauer et al., 2017; NASEM, 2017). This access issue is important as self-reported cannabis use has been found to ameliorate disparities in cancer pain relief for Black/African-American patients (Meghani et al., 2021). Although correlational, these findings may represent a cascading impact of SDoH on health disparities related to cannabis use. Further research is necessary to address lack of access to medical cannabis among Black/African-American patients.

Our findings also suggested that patients with lower self-reported income were more influenced by ease of access and the need for a medical registry card, whereas those at the highest income level were least influenced by price. Those at lower income levels were also more likely to obtain cannabis from an unlicensed dealer/seller, but this effect was no longer significant when accounting for race. This suggests costs also limit cannabis access, often inequitably by race. Recent studies of dispensary locations have found disparities related to age, gender, race, and ability to pay out of pocket (Cooke et al., 2018; Novak et al., 2021). Insurance coverage and social support programs to reduce the financial stress of cannabis use exist in Europe and should be further studied (Schmidt-Wolf & Cremer-Schaeffer, 2019).

Although nearly half the sample reported that product safety and quality influenced their purchases, a substantial portion of patients reported they obtained cannabis from sources less likely to be monitored for safety (e.g., unlicensed dealer/seller). This highlights the importance of e-health literacy (Leader et al., 2021) and gaps in patient education, given that many cannabis users are unaware of product labeling and safety standards. In addition to race, males were more likely to obtain cannabis from an unlicensed dealer/seller and less likely to get it from a dispensary. Moreover, males were more likely to smoke cannabis, and their purchases were more influenced by price. Rates of medical certification did not differ by gender suggesting that males tended to engage in riskier cannabis use-related behaviors and may be less influenced by medical certification. More research is needed to better understand these gender differences.

Limitations

Several limitations warrant mention. First, these data were cross-sectional and causal inferences cannot be made. Second, our sample was predominantly White, and a relatively small group of patients identified as Black/African-American, Asian, Hispanic, or other race; therefore, findings may not be generalizable, in particular to patients with cancer outside of Pennsylvania. We used race as a social construct and proxy for a multitude of social disadvantages in the United States (Hill et al., 2022; Meghani & Chittams, 2015). However, unmeasured SDoH variables (e.g., racism, health literacy) may also account for some of our findings. Lastly, although selection bias in survey responses may have influenced our findings, the data were adjusted to account for differences in response rate across demographic groups.

Conclusion

The prevalence of cannabis use for symptom management among patients with cancer has risen considerably in recent years, highlighting the need to understand factors that impact access and safer use. These data shed light on how drivers of health disparities (e.g., race, income) are associated with

where patients with cancer obtain cannabis, what forms they use, and what influences their purchase decisions. More research is needed to understand the health outcomes associated with these differences in cannabis use and access-related factors such as the role of clinician-patient communication on certification, education around safe cannabis use, and the impact of statewide policies intended to increase access to cannabis.

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Recent work in several fields of science has identified a bias in citation practices such that papers from women and other minority scholars are under-cited relative to the number of such papers in the field (Bertolero et al., 2020; Caplar et al., 2017; Chatterjee & Werner, 2021; Dion et al., 2018; Dworkin et al., 2020; Wang et al., 2021). Here we sought to proactively consider choosing references that reflect the diversity of the field in thought, form of contribution, gender, race, ethnicity, and other factors. First, we obtained the predicted gender of the first and last author of each reference by using databases that store the probability of a first name being carried by a woman (Dworkin et al., 2020; Zhou et al., 2022). By this measure (and excluding self-citations to the first and last authors of our current paper as well citations listed in this statement), our references contain 20.83% woman(first)/woman(last), 12.5% man/woman, 40.22% woman/man, and 26.44% man/man. This method is limited in that a) names, pronouns, and social media profiles used to construct the databases may not, in every case, be indicative of gender identity and b) it cannot account for intersex, non-binary, or transgender people. Second, we obtained predicted racial/ethnic category of the first and last author of each reference by databases that store the probability of a first and last name being carried by an author of color (Ambekar et al., 2009; Sood & Laohaprapanon, 2018). By this measure (and excluding self-citations), our references contain 2.95% author of color (first)/author of color(last), 16.8% white author/author of color, 20.74% author of color/white author, and 59.5% white author/white author. This method is limited in that a) names and Florida Voter Data to make the predictions may not be indicative of racial/ethnic identity, and b) it cannot account for Indigenous and mixed-race authors, or those who may face differential biases due to the ambiguous racialization or ethnicization of their names. We look forward to future work that could help us to better understand how to support equitable practices in science.

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