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Cannabis practices among a gender-diverse sample of young adults

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ABSTRACT

Background: Gender is an important factor in understanding cannabis patterns, yet few studies have explored cannabis patterns among gender minority (GM) individuals – particularly among high-risk age groups including young adults. The evolving cannabis market is reshaping typical patterns of cannabis use in the U.S. The combination of these factors warrants increased efforts to examine cannabis practices in gender-diverse samples.
Methods: Online survey participants between 18 and 34 (N = 2377) from the U.S. provided information on cannabis practices from May – July 2021. Gender differences across several cannabis outcomes (onset, methods of consumption, product potency, frequency, and quantity) were assessed. Bivariate tests and multiple regression models examined associations between gender (cisgender men: n = 1020; cisgender women: n = 1178; and GM: n = 179) and cannabis outcomes adjusting for sociodemographic characteristics.
Results: In regression models adjusted for sociodemographic characteristics, GM identity was associated with later age of onset and lower likelihood of daily use compared to cisgender men and women. Identifying as a GM person or cisgender woman was associated with fewer lifetime methods of consumption and less potent plant and concentrate product usage.
Conclusions: Findings provide initial insights into potential gender differences in cannabis practices from a sample of heavy cannabis users. GM young adults report use patterns indicative of lower risk compared to cisgender men and women in our sample. Future investigations of gender differences in cannabis use that explore specific gender minority categories and that include alternative sampling strategies are needed to better understand differential risks associated with gender.

1. Introduction

Overwhelmingly, research indicates that gender (e.g., transgender, non-binary) and sexual (e.g., lesbian, gay, bisexual, queer) minority individuals demonstrate greater risk of substance use and subsequent problems compared to cisgender heterosexual individuals (Green and Feinstein, 2012; Ruppert et al., 2020; Schuler et al., 2019). A common methodological limitation of this area of research stems from analyses that treat gender and sexual minority persons as a single homogenous group. Studies that examine gender and sexual minority samples separately have reported greater rates of substance use among gender minority (GM) relative to cisgender individuals *including* those with sexual minority identities (Reisner et al., 2015). For instance, in a 2010 Midwest sample, current rates of illicit drug use were 70.3% among GM respondents compared to 64% among cisgender sexual minority counterparts (Su et al., 2016). Despite this initial progress in understanding the relationship between GM status and substance use, it is particularly difficult to recruit and study GM participants (Vincent, 2018), which has slowed the pace of research on this vulnerable population. As a result, there have been calls to expand research on health-related behaviors and outcomes of this group (Institute of Medicine, 2011).

An increasingly important area in which such research is needed pertains to cannabis consumption among GM persons. An estimated 49.6 million people aged 12 or older used cannabis in the past year (Substance Abuse and Mental Health Services Administration [SAMHSA], 2021) with recent increases in high frequency and high potency product use (Cerdá et al., 2020). The prevalence of cannabis use is highest among young adults (aged 18 – 25 years: 34.5%; SAMHSA, 2021) and is associated with significant negative outcomes, including cannabis use disorder (CUD), cognitive deficits, and functional impairments (Grant et al., 2012). State-level data reveal that young people may be more likely to purchase high potency products

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(Headset Cannabis Market Insights, 2017) that are linked to worsened psychological functioning (Hall et al., 2020; Hines et al., 2020; Sideli et al., 2020) and increases in motor vehicle accidents (Preuss et al., 2021). Many Americans consume cannabis, and research on the diversity of cannabis products continue to emerge. Yet, few data exist to help clarify the cannabis consumption patterns among gender-diverse samples, including GM persons. It could be that GM young adult samples are more vulnerable to increases in risky cannabis use (i.e., high frequency, large quantity, and high potency use) but no work has been done in this area unlike that of other commonly used substances (e.g., alcohol: Coulter et al., 2015; tobacco: Delahanty et al., 2019).

The importance of conducting gender-stratified analyses is evident from clinical implications yielded from sex-stratified samples (e.g., Struble et al., 2019). In terms of cannabis practices and outcomes, daily cannabis use has been associated increased odds of depression and anxiety among females, with greatest risk among those with earlier onset of regular use (Patton et al., 2002). Males are more likely to develop a CUD (Grant et al., 2006; Khan et al., 2013; Wagner and Anthony, 2007), while females have reported greater telescoping or rapid progression from initiation to the development of CUD (Khan et al., 2013; Schepis et al., 2011). In terms of cannabis practices, Cuttler et al. (2016) found that males in the study sample were more likely to use joints/blunts, vaporizers, and concentrates, while females were more likely to use pipes and oral administration methods including edibles, tinctures, and capsules. Males in this study also used cannabis products more frequently and in larger quantities.

While sex-focused data can point to biological implications associated with cannabis use, gender analyses can elucidate sociocultural underpinnings. Little is known about cannabis practices among GM persons beyond frequency of use (most often in days per month) and cannabis-related outcomes. The few population-based and cohort studies that have been done suggest that GM individuals have younger ages of initiation, and higher prevalence of lifetime cannabis use (e.g., adjusted odds ratio: 1.73 compared to cisgender youth; Day et al., 2017) and current use (Christian et al., 2018; Ruppert et al., 2021) compared to cisgender peers. The 2015 U.S. Transgender Survey estimated that about 25% of transgender persons used cannabis in the past month compared to 8% of the general population, and among past-month users, 25% used 29–30 days (James et al., 2016). GM persons may also show larger increases in the probability of using cannabis over time (Dunbar et al., 2022). In terms of cannabis-related outcomes, GM participants may be more likely to report “hazardous” cannabis use indicative of CUD (Newcomb et al., 2020) in addition to disparities across several cannabis-related outcomes, e.g., social, behavioral, and physical health, employment, criminal justice involvement, and mental health treatment needs (Dunbar et al., 2022). Several explanations have been proposed for these disparities, including the use of cannabis to cope with minority stressors and psychological distress. Other potential biopsychosocial factors, including the effects of cannabis on feelings of gender incongruence and LGBTQ+ cultural norms surrounding cannabis, have yet to be systematically examined (Gonzalez et al., 2017). Enhancing our understanding of cannabis practices among GM persons is essential to identifying contributing factors to these usage patterns, which can improve prevention and treatment efforts.

Conclusions from epidemiological research on cannabis use among GM Americans are hindered by three limitations of national probability-based survey samples (e.g., National Survey on Drug Use and Health, Monitoring the Future): (1) GM (i.e., transgender, non-binary) identity is typically not assessed; (2) GM persons are a minority group and therefore the probabilistic sampling of traditional national surveys yields GM participant sample sizes that are too small for in-depth analyses; and (3) National probability-based surveys are extremely time-, labor-, and cost-intensive and prioritize consistency of survey item content from year-to-year, meaning items are not updated regularly to reflect current trends in substance use practices. While national probability-based surveys are excellent for tracking long-term population-level trends, they are limited in their ability to study rapid or diverse changes in cannabis use patterns by restricting items to measure past use (lifetime or past month), and/or frequency of use (in days). These surveys miss out on important facets of cannabis use, including route of administration, potency, and quantity, which are key indicators of cannabis-related problems. Researchers interested in cannabis use among GMs have turned primarily to student or clinical samples (e.g., Christian et al., 2018; Dunbar et al., 2022; Walsh et al., 2020). Such samples provide useful insights about cannabis use among GM persons but are geographically and socio-demographically limited. Unfortunately, larger population-based surveys that recruit entirely GM respondents (i.e., U.S. Transgender Survey) are limited in the coverage of their cannabis-related items (e.g., frequency in the past month; James et al., 2016). Much information is needed on cannabis use practices among GM young adults to better understand the impact of gender identity on risky cannabis practices (and associated outcomes) to inform clinical implications such as assessment, treatment planning, and development of effective interventions.

The present study reflects an initial effort to extend knowledge of cannabis practices among GMs via an online survey developed to measure past-week cannabis consumption across a variety of methods among adults in the U.S. The study sample was limited to those who responded to study advertisements on social media. The inclusion of expanded gender categories allowed for the first examination known to us of detailed cannabis practices across a gender-diverse sample of young adults. Given disparities in cannabis use and related problems, we hypothesized that GM respondents would report cannabis use practices indicative of greater risk, i.e., more methods of consumption, greater frequency, larger quantity, and higher potency, compared to both cisgender men and women. Regarding cisgender men and women, we expected differences to align with previous findings (e.g., Cuttler et al., 2006), such that cisgender men would be more likely to report use of cannabis concentrates (high potency products); cisgender women would report greater likelihood of edible, tincture, and capsule consumption; and cisgender men would report greater frequency and quantity of cannabis use.

2. Methods

2.1. Sample population

The sample was recruited as part of a larger study that involves development of a standardized measure to estimate cannabis consumption. Adults (aged ≥ 18 years) from the U.S. who used cannabis were recruited via two campaign advertisements (described in Livne et al., 2022, see Supplemental Materials) on Facebook (2020) through keyword-target advertising based on self-reported interests. Advertisements sought volunteers to participate in a research study on cannabis. Advertisements contained a hyperlink to an anonymous survey administered through Qualtrics (2022). Participants were recruited from May 2021 to July 2021. Participants provided informed consent prior to survey access. All study procedures were approved by the Dartmouth Committee for Protection of Human Subjects. There was no compensation provided for survey completion.

In total, 5627 respondents clicked on the link and began the online survey. Of those, 96 were excluded due to ineligibility (e.g., not consenting, <18 years old, or invalid responses to attention and logic checks). Forty-five percent of eligible participants were young adults (aged 18 – 34, $n = 2528$), of which 2476 (98.9%) reported lifetime use of cannabis. Respondents who did not provide a response to the gender item ($n = 77$), responded with “prefer not to say” ($n = 21$) or provided an invalid response to self-description ($n = 1$) were dropped from analyses resulting in a final analytic sample of $N = 2377$ young adults. We restricted our sample to young adult (aged 18 – 34) cannabis-using respondents, given that the great majority (89.5%) of GM respondents were in this age range (53.7% cisgender men and 37.5% cisgender women were in this age range). Of note, advertising strategies for this study did not specifically

target GM respondents, and the observed age differences between GM and cisgender survey respondents were consistent with national trends in LGBTQ+ identification such that GM identity is more commonly endorsed among younger individuals (Anderson et al., 2021).

2.2. Survey

The survey was designed to take approximately 10–15 minutes to complete. It included 67 survey items and two validity checks (i.e., captcha verification and simple multiplication). Participants were first taken to an information/landing page on Qualtrics where they consented to the study. They then responded to questions about their sociodemographic characteristics, including age in years, race/ethnicity, employment status, and education.

2.2.1. Gender identity

Gender was assessed by a single item asking respondents to select their self-identified gender. Options included (a) male, (b) female, (c) non-binary, (d) prefer to self-describe, and (e) prefer not to say. Twenty-eight persons chose to self-describe their gender identity, and twenty-seven responses ("transgender man", $n = 13$; "transgender women", $n = 1$; "gender fluid", $n = 4$; "agender", $n = 3$; and other non-cisgender identities; $n = 6$) were recoded and combined with the non-binary respondents to create the GM group. The final sample was comprised of 42.5% cisgender men ($n = 1020$), 49.6% cisgender women ($n = 1178$) and 7.5% GM respondents ($n = 179$; 85.0% non-binary).

2.2.2. Cannabis practices

Participants completed a flexible and personalized survey about cannabis practices based on their cannabis consumption patterns. (Refer to supplemental materials for exact wording of illustrative items). Cannabis items were adapted from published cannabis assessment instruments, particularly the Daily Sessions Frequency and Quantity of Cannabis Use (DFAQ-CU; Cuttler and Spradlin, 2017) Inventory and the International Cannabis Policy Survey (Hammond et al., 2022), and input from cannabis experts who are consultants on this project. Participants reported their age of cannabis initiation along with lifetime and past-week methods of delta-9-tetrahydrocannabinol (THC) consumption: plant (smoking; vaping); concentrates (vaping; dabbing), edibles (drinks; hard candies; chocolates; gummies), and other oral methods (tinctures/drops, capsules/pills). Participants were asked about the potency of plant and concentrate products they reported use of in the past week (in %THC categories). Potency of oral product use was not assessed.

2.2.2.1. Past week frequency. Participants reported their number of cannabis use days in the past week, which was summed for a total and dichotomized into a daily cannabis use variable (yes vs. no daily use in past week). Participants were then asked to select when they used cannabis products across 4 time-of-day quadrants (morning: 6 am-12 pm; afternoon: 12 pm-4 pm; evening: 4 pm-8 pm; and night: 8 pm-6 am). Responses were summed to total time-of-day quadrants out of 28 total quadrants in the past week. To better understand daily frequency of use, the average number of quadrants endorsed on each cannabis-using day was also calculated.

2.2.2.2. Past week quantity. Participants that reported plant or concentrate use in the past week were asked about their quantity of use. Quantity of oral products were not assessed. Participants chose whether they wanted to report their use in (a) number of hits/puffs/tokes per day, (b) number of grams per week, or (c) number of joints per week (for plant use). Participants reporting in hits were asked whether they used about the same amount on each use day in the past week. They were then asked to provide the number of hits of plant and/or concentrate product consumed during each of the 4 time-of-day quadrants. Participants that chose to report in grams provided the total amount of plant and/or concentrate material used in the past week. Due to negative skew in grams responses, persons estimating grams per week of plant consumed were coded into ≤ 1 gram, 1/8th – 1/4th ounce, and $\geq 1/2$ ounce. Concentrate estimates (in grams per week) were recoded as < 1 gram and ≥ 1 gram. Joints reporters provided their number of joints per week alongside typical size (in grams) of each joint.

2.3. Data analysis

First, chi-square tests of independence and k-sample median tests were run for categorical (e.g., methods, potency, daily use, and grams per week) and continuous (e.g., onset, past-week frequency, total and daily time-of-day quadrants, and hits per day) cannabis outcomes to examine whether there were any overall differences detected between the gender groups. Follow-up linear and logistic regression models were built using outcomes significant at the bivariate level. We examined whether gender identity predicted each outcome while controlling for sociodemographic characteristics including age, race/ethnicity, education, and employment status. For each response variable, we first compared GM persons and cisgender women to cisgender men (reference group). A second model compared GM respondents to cisgender women (reference group). Linear regression models used robust standard errors; unstandardized beta coefficients from adjusted models are reported. Adjusted odds ratios are reported for logistic regression models. We applied Benjamini-Hochberg adjustments set to a 5% false discover rate to determine significant effects at both the bivariate and multivariate level.

3. Results

3.1. Participants

Sociodemographic characteristics are presented in Table 1. Age differed significantly across groups, such that GM respondents were 1–2 years younger than cisgender men and women (p-values $\leq .01$). Chi-square tests revealed significant differences in race/ethnicity, employment, and education. GM respondents reported lower rates of employment (full- and part-time) and higher rates of student/other employment status (e.g., disabled) compared to both cisgender men and women (p-values $< .01$). Cisgender women were more likely to identify as Hispanic and endorsed higher levels of education compared only to cisgender men ($p < .001$).

3.2. Onset and product use

Results from bivariate tests are presented in Table 2. Overall group differences emerged for age of onset, total number of lifetime cannabis consumption methods, lifetime history of 'other oral methods' (drops/tinctures, capsules/pills), plant potency, and concentrate potency. Follow-up adjusted regression models are presented in Table 3. Results indicated that GM identity was associated with later age of cannabis initiation compared to both cisgender men and women. Cisgender women also reported later age of onset compared to cisgender men. GM respondents and cisgender women reported fewer lifetime cannabis consumption methods than cisgender men. See Fig. 1 for lifetime and past-week endorsement across each method of consumption. Cisgender women were less likely to report lifetime consumption of other oral methods compared to both GM persons and cisgender men. In terms of product potency, both GM respondents and cisgender women were less likely to report use of high potency (16–30% THC) plant product in the past week compared cisgender men. For concentrate potency, cisgender women were less likely to report use of product over 61% THC compared to cisgender men, while individuals with a GM identity were less likely to report product use above 81% THC compared to cisgender men. GM persons and cisgender women did not differ in potency of plant or concentrate products.

Table 1
Sociodemographic Differences across Gender Groups.

	Cisgender Man $n = 1020$	Cisgender Woman $n = 1178$	Gender Minority $n = 179$	Test Statistic	p
Race				15.77	**.046**
White	71.3	72.1	73.7		
African American	3.6	3.5	5.0		
Hispanic	8.3	5.3	3.9		
Multiracial	11.6	13.1	12.3		
Other	5.2	4.2	5.0		
Employment [1]				37.03	
					<.001
Employed	72.1	71.0	56.0		
Unemployed	9.6	10.9	10.2		
Student	15.4	15.7	24.1		
Other	2.9	2.4	9.6		
Education [2]				22.22	
					<.001
Less than HS	2.3	0.6	1.2		
HS/GED	54.3	47.9	54.8		
Any college	43.4	51.5	44.0		
Age [3]	25.0 (8)	26.0 (8)	23.0 (6)	28.32	
					<.001

Note. $p < .05$ **bolded**.
[1] Employment: $N = 2134$.
[2] Education: $N = 2108$; High School (HS), General Education Development Test (GED).
[3] Median (interquartile range) presented; remaining rows describe percentage of respondents.

Table 2
Cannabis Onset and Product Use across Gender Groups, Bivariate Findings.

	Cisgender Man $n = 1020$	Cisgender Woman $n = 1178$	Gender Minority $n = 179$	Test Statistic	p_{adj}
Onset (years)[1]	16.0 (4)	16.0 (3)	17.0 (3)	37.89	**<.001**
METHOD					
Lifetime					
Total methods[1]	8.0 (4)	7.0 (4)	7.0 (4)	30.18	**<.001**
Any plant	99.0	98.3	97.8	2.88	.347
Any concentrate	94.3	93.1	92.2	1.90	.500
Any edible	95.0	96.7	93.9	5.55	.138
Other oral method	50.5	43.5	50.8	11.96	**.009**
Past 7 Days					
Total methods[1]	2.0 (2)	2.0 (2)	2.0 (2)	0.68	.712
Any plant	78.3	79.9	76.0	1.83	.463
Any concentrate	58.0	54.3	60.6	4.26	.239
Any edible	29.2	32.5	29.5	2.84	.333
Other oral method	7.8	6.1	4.6	3.68	.269
POTENCY					
Plant[2]				27.90	**<.001**
2–15% THC	21.5	32.6	36.2		
16–30% THC	78.5	67.4	63.8		
Concentrate[3]				33.39	**<.001**
40–60% THC	14.0	23.9	25.0		
61–80% THC	35.9	41.0	41.0		
81–100% THC	50.1	35.1	34.0		

Note. delta-9-tetrahydrocannabinol (THC). p_{adj}-values reflect Benjamini-Hochberg adjustments for multiple comparisons. Significant values **bolded**.
[1] Results from k-sample median test reported alongside median (interquartile range); remaining rows report results from chi-square tests of independence alongside percentages.
[2] Total $N = 1693$ (cisgender men $n = 702$; cisgender women $n = 864$; gender minority persons $n = 127$).
[3] Total $N = 1196$ (cisgender men $n = 515$; cisgender women $n = 581$; gender minority persons $n = 100$).

3.3. Cannabis frequency and quantity

Table 4 displays results from bivariate analyses related to past-week frequency and quantity of cannabis use. Frequency comparisons revealed significant group differences in the likelihood of reporting daily use. In adjusted regression models (see Table 5), GM identity was associated with lower likelihood of daily use in the past week compared to cisgender men and women. In terms of quantity estimates, bivariate analyses revealed differences across groups in the estimated number of grams per week of plant material consumed. This effect diminished once controlling for sociodemographic characteristics in multivariate models. No other quantity differences emerged in bivariate or regression analyses.

4. Discussion

The study sheds important light on the presence of potentially risky cannabis practices among a sample of heavy cannabis-using gender-diverse young adults. This study explored detailed aspects of cannabis practices and novel cannabis product use among GM young adults, a vulnerable and under-researched group. We expected that GM respondents would report cannabis use practices indicative of greater risk, i.e.,

Table 3
Onset and Product Use across Gender Groups, Adjusted Regression Models.

	b	*OR*	*95% CI*		p_{adj}
			Lower	Upper	
Age of Onset					
Cisgender Men (ref) vs. Women	0.38	–	0.09	0.67	**.021**
Cisgender Men (ref) vs. GM	1.24	–	0.76	1.71	**<.001**
Cisgender Women (ref) vs. GM	0.86	–	0.39	1.32	**.001**
Lifetime Methods (Total)					
Cisgender Men (ref) vs. Women	−0.65	–	−0.87	−0.43	**<.001**
Cisgender Men (ref) vs. GM	−0.57	–	−0.97	−0.18	**.013**
Cisgender Women (ref) vs. GM	0.08	–	−0.31	0.46	.783
Other Oral Method [1]					
Cisgender Men (ref) vs. Women	–	0.69	0.57	0.83	**<.001**
Cisgender Men (ref) vs. GM	–	1.08	0.77	1.51	.795
Cisgender Women (ref) vs. GM	–	1.57	1.12	2.20	**.022**
Plant Potency					
2–15% THC vs. 16–30% THC					
Cisgender Men (ref) vs. Women	–	0.56	0.44	0.71	**<.001**
Cisgender Men (ref) vs. GM	–	0.50	0.33	0.76	**.003**
Cisgender Women (ref) vs. GM	–	0.90	0.61	1.34	.753
Concentrate Potency					
40–60% THC vs. 61–80% THC					
Cisgender Men (ref) vs. Women	–	0.62	0.43	0.89	**.023**
Cisgender Men (ref) vs. GM	–	0.60	0.34	1.09	.139
Cisgender Women (ref) vs. GM	–	0.97	0.56	1.70	.918
40–60% THC vs. 81–100% THC					
Cisgender Men (ref) vs. Women	–	0.36	0.25	0.52	**<.001**
Cisgender Men (ref) vs. GM	–	0.34	0.18	0.62	**.002**
Cisgender Women (ref) vs. GM	–	0.94	0.53	1.67	.873

Note. p_{adj}-values reflect Benjamini-Hochberg adjustments for multiple comparisons. Significant values **bolded**. Gender minority (GM) respondents. delta-9-tetrahydrocannabinol (THC).
Unstandardized regression coefficients (*b*), odds ratios (*OR*), and 95% confidence intervals (*CI*) reported. Linear and logistic regression models are adjusted for age, race/ethnicity, employment status, and education.
[1] Other oral method was calculated from reports of tinctures/drops and capsule/pill endorsement.

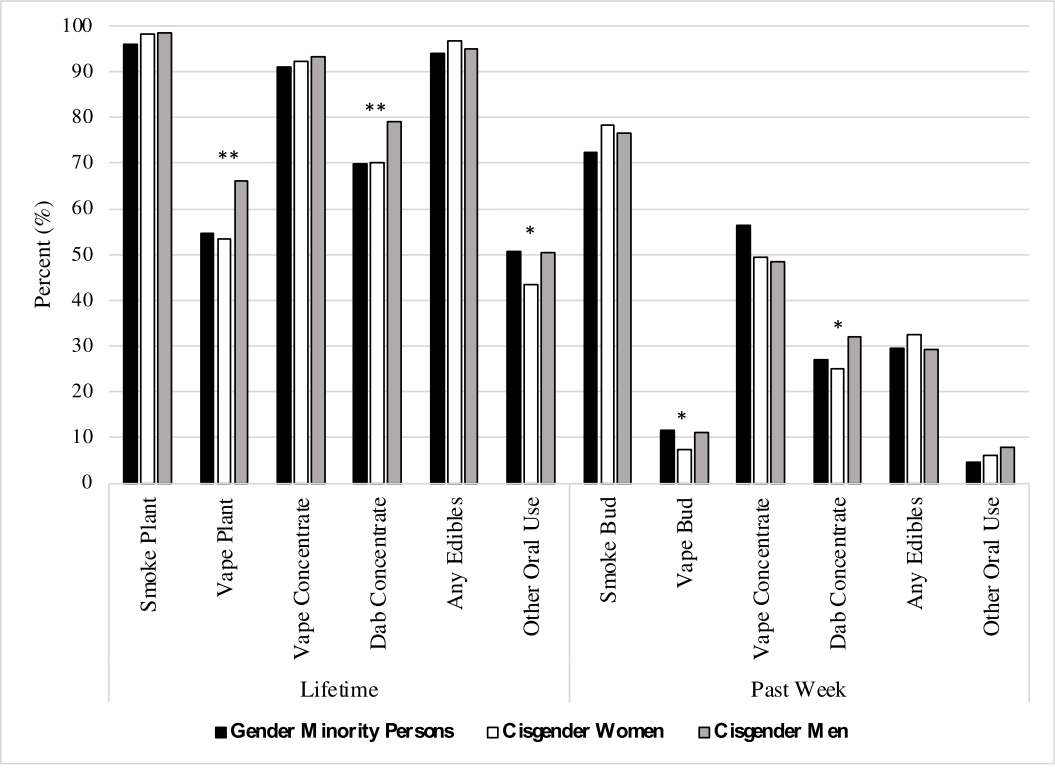

Fig. 1. Lifetime and Past Week Methods of Consumption
Bars represent percentage of respondents from each gender category who endorsed each of the following methods of administration in (a) their lifetime and (b) the past week.
** Cisgender men differ from both cisgender women and gender minority persons ($p<.05$).
* Cisgender men and cisgender women differ ($p<.05$).

Table 4
Cannabis Frequency and Quantity across Gender Groups, Bivariate Findings.

	Cisgender Man $n = 1020$	Cisgender Woman $n = 1178$	Gender Minority $n = 179$	Test Statistic	p_{adj}
FREQUENCY					
Daily use [1]	75.1	74.6	62.0	12.94	**.007**
Total quadrants	18.0 (17.5)	18.0 (15)	14.0 (15)	8.06	.050
Daily quadrants	3.0 (2)	2.0 (2)	2.0 (2)	5.64	.146
QUANTITY					
Plant					
Hits per day	7.0 (10)	8.0 (8)	5.5 (7.8)	1.90	.473
Hits per week	35.0 (77)	35.0 (56)	24.0 (59.3)	1.24	.523
Grams per week [1,2]				12.42	**.047**
≤ 1 g	16.8	21.3	19.7		
1/8–1/4 ounce	47.9	48.5	63.6		
≥ 1/2 ounce	35.3	30.2	16.7		
Concentrate					
Hits per day	6.0 (11)	5.0 (8)	5.0 (7)	1.08	.610
Hits per week	21.0 (56)	18.0 (56)	14.0 (51.3)	1.92	.370
Grams per week [1,3]				4.49	.271
< 1 g	51.3	59.6	54.9		
≥ 1 g	48.7	40.4	45.1		

Note. p_{adj}-values reflect Benjamini-Hochberg adjustments for multiple comparisons. Significant values **bolded**.
[1] Results from chi-square tests of independence reported alongside percentages; remaining rows report k-sample median test reported alongside median (interquartile range).
[2] Total $N = 999$ (cisgender men $n = 453$; cisgender women $n = 480$; gender minority persons $n = 66$).
[3] Total $N = 707$ (cisgender men $n = 337$; cisgender women $n = 319$; gender minority persons $n = 51$).

Table 5
Frequency and Quantity across Gender Groups, Adjusted Regression Models.

	b	*OR*	*95% CI*		p_{adj}
			Lower	Upper	
Daily Use					
Cisgender Men (ref) vs. Women	–	0.92	0.73	1.15	.574
Cisgender Men (ref) vs. GM	–	0.58	0.40	0.85	**.014**
Cisgender Women (ref) vs. GM	–	0.64	0.44	0.92	**.033**
Plant – Grams per Week					
≤1 gram vs. 1/8th-1/4th ounce					
Cisgender Men (ref) vs. Women	–	0.86	0.60	1.24	.591
Cisgender Men (ref) vs. GM	–	1.13	0.57	2.27	.785
Cisgender Women (ref) vs. GM	–	1.32	0.67	2.61	.579
≤1 gram vs. ≥1/2 ounce					
Cisgender Men (ref) vs. Women	–	0.69	0.46	1.02	.100
Cisgender Men (ref) vs. GM	–	0.38	0.16	0.93	.059
Cisgender Women (ref) vs. GM	–	0.55	0.23	1.34	.065

Note. p_{adj}-values reflect Benjamini-Hochberg adjustments for multiple comparisons. Significant values **bolded.** Gender minority (GM) respondents.
Unstandardized regression coefficients (*b*), odds ratios (*OR*), and 95% confidence intervals (*CI*) reported. Linear and logistic regression models are adjusted for age, race/ethnicity, employment status, and education.

more lifetime methods of consumption, greater frequency, larger quantity, and higher product potency, compared to both cisgender men and women. Results were contrary to this hypothesis, as GM persons self-reported later age of cannabis initiation and less frequent use compared to *both* cisgender groups. Compared to cisgender men, GM respondents also reported fewer lifetime methods and lower potency of plant and concentrate products consumed.

Our predictions were developed based on research that relied on population-based surveys (James et al., 2016), and cohort studies (Dunbar et al., 2022) with clinical and other convenience samples; such research has demonstrated elevated rates of use and greater frequency among GM groups. One major difference is that our sample consists of regular cannabis users, whereas prior work contains samples with more diverse cannabis practices (e.g., inexperienced and never-users). In an earlier study in California, GM youth reported earlier age of cannabis initiation than non-GM youth (Day et al., 2017) which was inconsistent with our results. This discrepancy may be related to shifting trends in perceived risk of use and access among youth. Regional differences warrant future exploration (Hughto et al., 2021; Wheldon et al., 2022). Our study examined a multitude of risky cannabis practices including refined frequency measures, product type, potency, and quantity to allow for a more complete picture of cannabis use behaviors among cisgender and GM young adults. The relationships between gender identity and cannabis outcomes may differ among persons with less frequent use.

It could be that rates and frequency of use are higher among GM persons compared to cisgender counterparts in the general population, but within heavy users, this pattern shifts. There are several plausible factors that might contribute to these findings. For example, it could be that engagement in risky cannabis practices are dampened given the increased vulnerability to experiencing negative cannabis-related outcomes (e.g., CUD, mental health disparities; Batchelder et al., 2021; Newcomb et al., 2020). Importantly, our GM group was comprised predominantly of non-binary persons, while previous research on cannabis use among GM persons have been more representative of transgender individuals (James et al., 2016). There may be heterogeneity within our GM group that is not accounted for by combining non-binary persons, transgender men, and transgender women. For example, research on alcohol use has suggested that non-binary persons are less likely to report

past-year heavy drinking compared to cisgender women (Barger et al., 2021). Future work should improve representation of both transgender and non-binary identities within samples and examine the role of sex assigned at birth. Further, while we controlled for age in multivariate models, older age was associated with several risky cannabis practices, including daily use. Given our GM sample was younger than cisgender men and women, it could be that GM respondents are in a transitional period into more risky practices. Age was also positively associated with age of onset, meaning GM persons in our sample could be initiating cannabis use significantly later than same-aged peers. This could suggest a greater window of time for prevention efforts among GM persons to lower the probability of transitions to cannabis use and risky cannabis use. Efforts to recruit younger GM persons in research on cannabis use is needed. Longitudinal designs that assess the interplay of identity, cannabis initiation, and patterns of use could further elucidate reasons for differences across studies.

Cisgender men reported riskier cannabis practices compared to cisgender women in several domains, consistent with Cuttler et al. (2016)'s findings. Specifically, cisgender men reported greater total lifetime methods, and greater potency of plant and concentrate product. Unlike those previous findings, we did observe a significant difference in age of onset of use (later age among cisgender women). Cisgender women were also less likely to report lifetime use of tinctures or capsules, although edible use was similar across groups within our sample. We did not observe significant differences between cisgender men and women in reported frequency or quantity of cannabis use. The differences between these patterns of use may be attributed to the younger heavy cannabis-using sample in the present study. Age is an important factor when considering cannabis practices and trends (e.g., onset, frequency, quantity). Similarly, methods of consumption and potency preferences may differ between regular and non-regular cannabis using samples.

Because these data were collected using Facebook advertising, our sample does not represent cannabis practices among young adults across the U.S., and more importantly, the exact nature of the selection bias related to survey participation is unknown. While random samples of survey participants are not a prerequisite for drawing scientific generalizations (Borodovsky, 2022), it is important to examine in future studies whether other sampling methods also yield lower-risk GM participants. We captured behaviors within a unique, experienced sample of heavy users and thus future research should first explore whether findings observed here are consistent in samples with more diverse cannabis practices. Findings from a subsequent online survey from our team have reproduced the finding that GM young adults report less risky cannabis patterns compared to cisgender counterparts (Struble et al., 2022). With the lack of national surveys assessing diverse gender identities among adults, lack of adequate weighting methods for gender-diverse individuals, and limited cannabis-related questions included in population-based surveys (e.g., frequency), it is our hope that findings from the present study stimulate more rigorous research in this area.

In terms of limitations, our measure of gender identity included male, female, non-binary and "other" response options. Within the young adult sample, approximately 3% of gender data were missing and 1% were unable to be categorized. Ongoing iterations of this survey are improving on this by including more refined gender categories. Sociodemographic characteristics impact substance use outcomes both directly and indirectly through gender identity (e.g., Rada and Drallmeier, 2022; Wheldon and Wiseman, 2019). While we were able to control for several key sociodemographic characteristics, there are other potentially relevant confounders that were not collected in our survey, such as sexual orientation (Sawyer et al., 2022), nor did we incorporate interaction terms which could explore intersectionality of identities. Internalizing symptoms including depression, anxiety, and suicidality were not assessed but could be explored in future studies, as cannabis may be used to cope with mental health problems (Buttazzoni et al., 2021; Kittaneh et al., 2021). In addition, future studies should include other contextual factors such as socioeconomic status and urbanicity, cannabis legalization and regional policies, access/barriers to use, other mental health conditions, and impulsivity (e.g., Hinds et al., 2022; Tan et al., 2021). Finally, constructs related to LGBTQ+ identities such as discrimination, outness, and gender presentation should be examined rigorously (Kcomt et al., 2020). In our survey, additional validators will be incorporated including items related to intoxication, solitary use, concurrent substance use, and CUD.

4.1. Conclusions

Based on the extant literature, we anticipated riskier cannabis practices among GM respondents. However, findings appear to reflect less risky cannabis practices compared to both cisgender men and women in an online sample of heavy cannabis-using respondents. While the relationships between gender identity and cannabis outcomes may differ among persons with less frequent use, our heavy cannabis-using sample provides a unique snapshot into the most vulnerable subgroup of cannabis users which are not well represented via other sampling methodologies. To our knowledge, our study is the first to extend examination of cannabis use behaviors among GM persons beyond overall use and frequency patterns. The inclusion of cannabis-related outcomes, such as CUD measures, could further elucidate the risk of problems relative to patterns of cannabis practices among GM young adults. The present study extends knowledge on cannabis use practices in this understudied and vulnerable group and illustrates the need for more rigorous and inclusive investigations of cannabis-related risks.

Contributors

Cara A. Struble: conceptualization, data cleaning, analysis, writing manuscript, reviewing/editing manuscript; **Jacob T. Borodovsky:** survey design, data collection, data cleaning, analysis conceptualization, writing manuscript, editing manuscript; **Mohammad I. Habib:** data collection, data cleaning, reviewing/editing manuscript; **Deborah S. Hasin:** reviewing/editing manuscript, supervision; **Dvora Shmulewitz:** data analysis, reviewing/edit manuscript; **Ofir Livne:** reviewing/editing manuscript; **Claire Walsh:** data cleaning, reviewing/editing manuscript; **Efrat Aharonovich:** reviewing/editing manuscript; **Alan Budney:** conceptualization, funding acquisition, data collection, writing manuscript, reviewing/editing manuscript, supervision. All authors have confirmed their roles and approved the final article for submission.

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Declaration of Competing Interest

Dr. Alan Budney reports a relationship with Jazz Pharmaceuticals Inc that includes: consulting or advisory, a relationship with Canopy Growth Corporation that includes: board membership, and a relationship with National Institute of Health that includes: funding grants. Dr. Deborah Hasin reports a relationship with National Institutes of Health that includes: funding grants. All other authors of this manuscript have no conflicts of interest to report.

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Supplementary materials

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