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How much THC is in that joint? A daily diary study of young adults' knowledge of the cannabinoid content of cannabis products

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Abstract

Objective: Many young adults report frequent cannabis use and are at risk for cannabis harms. Knowledge of the tetrahydrocannabinol (THC) and cannabidiol (CBD) concentrations of cannabis products may promote harm reduction, but few studies have characterized cannabinoid concentration knowledge in this population. This study used day-level data to examine predictors of cannabinoid concentration knowledge and associations of cannabinoid concentration knowledge with substance-related consequences among young adults.

Method: Participants (*N*=131; mean age 22.11 years, 64.12% female) from a larger study of cannabis and alcohol co-use completed daily surveys over 21 days assessing knowledge of the cannabinoid concentrations of cannabis used, forms of cannabis used, motives for cannabis use (medicinal, nonmedicinal, both), and substance-related consequences.

Results: On average, participants reported at least some knowledge of the THC and CBD concentrations of their cannabis on a respective 48% and 32% of their cannabis days. Generalized linear mixed models revealed that participants with a greater propensity to use non-flower (relative to flower) cannabis products and to report medicinal (relative to exclusively non-medicinal) motives for cannabis use reported greater cannabinoid concentration knowledge overall across days, controlling for sociodemographic factors and level of cannabis involvement. Participants with greater overall cannabinoid concentration knowledge reported positive substance-related consequences more often. In addition, participants were more likely to report negative substance-related consequences on days during which cannabinoid concentrations were known versus unknown.

Conclusions: Findings suggest that cannabinoid concentration knowledge may be higher among young adults who report primarily non-flower and medicinally-motivated cannabis use, although

cannabinoid concentration knowledge, alone, may not protect against negative substance-related consequences at the day level.

Keywords: Marijuana; medical cannabis; cannabinoid content; cannabis potency; emerging adults; cannabis and alcohol co-use; ecological momentary assessment

Introduction

Cannabis use among young adults is highly prevalent (35–49%; Government of Canada, 2021; Substance Abuse and Mental Health Services, 2022). Many young adults use cannabis at high frequencies (Health Canada, 2022), which is associated with risk for harms (Volkow et al., 2014). Recent guidance on lower-risk cannabis use recommends selecting products with low delta-9-tetrahydrocannabinol (THC) concentrations or low THC-to-cannabidiol (CBD) ratios (Fischer et al., 2017). However, in jurisdictions where non-medical cannabis is legal and the cannabis market is rapidly diversifying, there is considerable variability in cannabinoid concentrations both within and between cannabis product categories (Freeman & Lorenzetti, 2020; Hammond & Goodman, 2022; Tassone et al., 2023), which may impede consumer understanding of cannabinoid concentrations and complicate the selection of lower-risk products. Select studies indicate that only 6–41% of consumers report knowledge of the cannabinoid concentrations of their preferred cannabis products (Hammond & Goodman, 2022; Lineham et al., 2023; Sikorski et al., 2021). Consequently, using guesswork or relying exclusively on knowledge of THC (but not CBD) concentrations when titrating cannabis doses are common (Freeman et al., 2014; Wheeler et al., 2020), and many people who use cannabis do not know or overestimate safe THC doses (Kruger et al., 2021).

Although these studies suggest low consumer cannabinoid concentration knowledge, their reliance on methods requiring retrospective recall may yield biased knowledge estimates. Thus, whether consumer knowledge is truly low or rather driven by recall biases remains unknown. Daily diary methods may be advantageous in characterizing cannabinoid concentration knowledge by assessing whether individuals know the THC and CBD concentrations of their cannabis products closer in time to their use, reducing recall biases.

However, these methods have yet to be applied to assess cannabinoid concentration knowledge among young adults.

Studies examining consumer knowledge of cannabinoid concentrations have also rarely examined factors that could contribute to individual differences in knowledge. For example, young adults who more frequently use cannabis may be more familiar with cannabis product labels, and consequently, have greater knowledge of the cannabinoid concentrations of their cannabis. In addition, previous research has shown that cannabinoid concentration knowledge varies across users of different forms of cannabis (Hammond & Goodman, 2022; Lineham et al., 2023), and that people who report medicinal, relative to non-medicinal, motives for cannabis use have greater knowledge of the cannabinoid concentrations of their cannabis (Sikorski et al., 2021). However, given that many young adults use multiple forms of cannabis concurrently (Government of Canada, 2021), and a growing number of young adults reporting both medicinal and non-medicinal reasons for cannabis use (Government of Canada, 2021), knowledge may also vary *within person*, across different cannabis days, depending on the form(s) of cannabis used and motives (medicinal, non-medicinal) for use. Daily diary methods are needed to clarify whether day-level variation in these behaviours and motives is associated with day-level variation in cannabinoid concentration knowledge.

Furthermore, daily diary methods are uniquely positioned to capture acute (e.g., day-level) consequences of cannabis use and their potential associations with cannabinoid concentration knowledge. Knowing cannabinoid concentrations may protect against negative consequences and promote positive consequences by facilitating the selection of lower-risk cannabis products (i.e., lower-THC or lower-THC-to-CBD products; Fischer et al., 2017) and titration of cannabis doses to achieve desired subjective effects while minimizing potential

negative consequences. However, associations of cannabinoid concentration knowledge with acute consequences have yet to be examined among young adults.

The current study used daily diary methods to characterize knowledge of cannabinoid concentrations of cannabis used among young adults. We hypothesized that day-level variation in forms of cannabis used would be associated with day-level variation in cannabinoid concentration knowledge, and that young adults would be more likely to know the cannabinoid concentrations of their cannabis on days when their use was medicinally (versus non-medicinally) motivated. Moreover, we expected that knowing cannabinoid concentrations would be associated with increased likelihood of experiencing positive consequences and reduced likelihood of experiencing negative substance-related consequences following cannabis use. We included several sociodemographic correlates of cannabis use as covariates in our analyses (age, sex, income, education level), as these characteristics may contribute to knowledge of cannabinoid concentrations and substance-related consequences.

Method

Participants and recruitment

This study used daily diary data from a larger ecological momentary assessment (EMA) study examining young adult cannabis-alcohol co-use. Young adults reporting regular use of both cannabis and alcohol (N=151)[1] were recruited from Ontario, Canada using social media posts, online ads, and fliers in the community. Participants who did not report cannabis use during the EMA period (n=20) were excluded, leaving an analytic sample of N=131. Eligibility criteria for the larger study were: ages 19–25 years, using both alcohol and cannabis at least weekly during the past month, using cannabis and alcohol simultaneously at least twice during the past month, owning a smartphone, absence of regular (monthly) illicit drug use, no treatment

for or attempts to reduce cannabis or alcohol use, absence of severe mental illness or neurodevelopmental disorder, and not exclusively using cannabis medically. Sample characteristics are shown in Table 1.

Procedures and measures

Baseline

Following an online screener, eligible participants attended a two-hour baseline interview, during which they provided informed consent, were oriented to the EMA protocol and application (MetricWire, Inc., Waterloo, ON), and completed other assessments for the larger study that are not included in the current analysis. The baseline interview also included training on reporting cannabis flower consumption in grams (using images from the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory [DFAQ-CU]; Cuttler & Spradlin, 2017) and alcohol consumption in standard drinks (using a standard drink conversion chart).

Following the baseline interview, participants completed an online questionnaire. The questionnaire included the Cannabis Use Disorders Identification Test – Revised (CUDIT-R; Adamson et al., 2010), with eight items that are summed to obtain an index of hazardous cannabis use, and items from the DFAQ-CU (Cuttler & Spradlin, 2017) assessing current cannabis use frequency (ranging from never using cannabis to using cannabis more than once per day) and grams of cannabis flower used in a typical cannabis use session, day, and week. The CUDIT-R and DFAQ-CU are reliable and valid among young adults (e.g., Coelho et al., 2024; Gette et al., 2023).

Daily Assessments

The day after the baseline assessment, participants began completing the 21-day EMA protocol, including daily, randomly-timed, and event-contingent surveys. Only daily surveys assessed cannabinoid concentration knowledge and were used in analyses. Daily surveys were available from 7:00AM–1:00PM, with several reminder notifications preceding expiry. Each survey asked whether cannabis was used during the previous day, and if so, the form(s) of cannabis used (flower, concentrates, edibles/beverages, other), quantities of cannabis consumed (grams of flower, concentrate hits, and edible/beverage servings), and motives for use (medicinal, non-medicinal, both). Images of grams of cannabis flower (from the DFAQ-CU), alongside a one-dollar bill to provide relative scale, were available through the application, and participants were emailed full-size versions of these images to reference. Participants were next asked *"Do you know the THC content of the cannabis you consumed yesterday (i.e., because it was printed on the package)? This does not include estimated content of cannabis obtained from unregulated sources (e.g., an illegal dealer, home-grown)."* Response options included "*all THC content known,*" "*some THC content known,*" or "*no THC content known*." An identically-worded item was administered to assess CBD concentration knowledge. Participants were asked to consider only cannabis obtained from regulated sources, as we assumed the cannabinoid concentrations of unregulated products to be unknown. In addition, participants reported whether they used alcohol during the previous day, and if so, the number of standard drinks consumed (with a standard drink conversion chart available through the application).

Next, participants completed a checklist of several positive (seven items) and negative (18 items) substance-related consequences, reporting whether they had experienced each substance-related consequence "*between the time [they] first started using alcohol and/or cannabis yesterday and now.*" As the larger study examined cannabis-alcohol co-use, we

included consequence items that were broadly applicable to both cannabis and alcohol use, similar to prior EMA studies, with some cannabis-specific items included.[2] Consistent with other EMA studies of co-use (e.g., Gunn et al., 2022; Mallett et al., 2019; Sokolovsky et al., 2020), select items were drawn from the Marijuana Consequences Questionnaire (MCQ; Simons et al., 2012) and the Young Adult Alcohol Consequences Questionnaire (YAACQ; Read et al., 2006), with some items adapted from prior EMA studies (Carpenter & Merrill, 2021). As we could not differentiate between consequences experienced due to cannabis versus alcohol on days when participants used both substances, substance-related consequences were considered in aggregate. Our substance-related consequence scales each showed adequate person-level reliability across the 21 days (negative substance-related consequences: a=0.81 [95% CI=0.74, 0.85]; positive substance-related consequences: a=0.77 [95% CI=0.70, 0.82]). Particpants received gift cards worth $40 CAD for completing the baseline assessment and $45–$115 CAD for completing the EMA protocol (bonuses were commensurate with survey completion rate).

Analysis

We first calculated the proportions of days when THC and CBD concentrations of cannabis used were fully or partially known (weighted by the number of observations each participant provided), both aggregated across all cannabis days and stratified by form of cannabis used. We then calculated unweighted descriptive statistics (means, standard deviations) for the person-level proportions of days when participants knew the THC and CBD concentrations of their cannabis, aggregated across all cannabis days.

We used generalized linear mixed models (GLMMs) with days (level 1) nested within participants (level 2) to examine predictors of cannabinoid concentration knowledge. Knowing cannabinoid concentrations for any cannabis used on a given day (1=yes, 0=no) was the

dependent variable and modelled using a binomial distribution (with separate models for THC and CBD). Day-level independent variables included dummy coded variables for form of cannabis used (flower [referent category], concentrates, edibles/beverages, multiple forms),[3] and cannabis use motive (comparing medicinal versus exclusively non-medicinal, given that only 3.45% of cannabis days were exclusively medicinal). Person-level means of each day-level dummy variable were included as independent variables to examine between-person differences in propensity to use each form of cannabis and to endorse medicinal cannabis use motives (rescaled as percentages of days). Other person-level independent variables included sex (1=male, 0=female), age (years), income (13 bands from $0–$200,000+; see Table 1), highest level of education (seven bands from less than high school to doctoral degree; see Table 1), and current cannabis use frequency (seven bands from two to three times per month to more than once per day; see Table 1). At the day level, we controlled for number of days since baseline assessment and whether the day was a weekend day (Friday–Sunday) versus week day (Monday–Thursday). Further, at the person level, we controlled for the percentage of days that were weekend days.

GLMMs were also used to examine associations of cannabinoid concentration knowledge with same-day substance-related consequences. As only 19.89% and 37.81% of cannabis days involved endorsing more than one negative or positive substance-related consequence, respectively, logistic models were specified to predict the likelihood of reporting one or more substance-related consequence on a given day (with separate models for positive and negative consequences). Knowing cannabinoid concentrations for any cannabis used (1=yes, 0=no) was specified as a day-level independent variable, and the person-level percentage of days when any cannabinoid concentrations were known was specified as a person-level independent variable

(with separate models for THC and CBD). In each model, we controlled for cannabis consumption (grams of flower, concentrate hits, edible/beverage servings) at both the day and person levels. We also controlled for number of days since baseline assessment and a weekend day versus week day dummy variable at the day level, and the percentage of days that were weekend days, age, sex, and CUDIT-R scores at the person level. Moreover, as substance-related consequences may also have been attributable to alcohol use on days involving co-use, we controlled for number of standard drinks at the day level, and the person-level mean of this variable at the person level.

GLMMs included all cannabis days, including those wherein cannabis was exclusively obtained from unregulated sources (and consequently, participants were asked to report not knowing the cannabinoid concentrations of their cannabis; see *Procedures and Measures*). In each model, we person-mean centered all day-level independent variables to disaggregate within- from between-person variance (Enders & Tofighi, 2007; Yaremych et al., 2021), and we grand-mean centered all person-level independent variables. Days with partially missing data were dropped from analyses (0.97% to 1.24% of observations across models). Models were specified with random intercepts and fixed slopes and fit using maximum likelihood estimation.[4] Analyses were conducted in R (R Core Team, 2022) using the *glmmTMB* package (Brooks et al., 2017).

Results

Participants (*N*=131) completed a combined total of 2465 daily surveys (89.60% completion rate), of which 1142 (46.33%) involved previous-day cannabis use and were included in analyses. On average, each participant contributed 8.72 (*SD*=6.07) cannabis days to analyses. Across all cannabis days, 64.62% involved reporting one or more positive substance-related

consequence and 37.39% involved reporting one or more negative substance-related consequence. Further day-level descriptive statistics for cannabis days are provided in Table 2.

Cannabinoid concentration knowledge

Across all cannabis days, participants reported knowing all, some, or none of the THC concentrations of cannabis used on 40.02% (*n*=457), 4.90% (*n*=56), and 55.08% (*n*=629) of cannabis days, respectively. Participants reported knowing all, some, or, none of the CBD concentrations of cannabis used on 25.92% (n=296), 5.34% (*n*=61), and 68.74% (*n*=785) of cannabis days, respectively. Knowledge of THC and CBD concentrations across different forms of cannabis is summarized in Table 3. At the person level, the average participant reported knowing any and all THC concentrations of cannabis used during a respective 47.75% (*SD*=42.51) and 42.57% (*SD*=41.98) of their cannabis days, and knowing any and all CBD concentrations of cannabis used during a respective 31.78% (*SD*=40.92) and 27.83% (*SD*=38.98) of their cannabis days. ICCs for knowing THC (0.64) and CBD (0.71) concentrations of any cannabis used indicated that 64%–71% of the variance in cannabinoid concentration knowledge was attributable to person-level differences.

Correlates of cannabinoid concentration knowledge

Table 4 provides results of GLMMs predicting likelihood of knowing cannabinoid concentrations of any cannabis used. The model-predicted probabilities of knowing the THC and CBD concentrations for the average participant on the average cannabis day were 0.42 and 0.05, respectively. No cannabis-related variables were significantly associated with likelihood of knowing THC concentrations at the day level, whereas participants were significantly (3.46 times) more likely to know the CBD concentrations of their cannabis on days when they used multiple forms of cannabis (relative to cannabis flower). At the person level, reporting medicinal

motives for cannabis use on an additional one percent of cannabis days was significantly associated with being 5% and 4% more likely to know THC and CBD concentrations, respectively, overall across days. In addition, using concentrates and edibles/beverages (relative to cannabis flower) on an additional one percent of cannabis days were associated with being a respective 3% and 4% more likely to know THC concentrations overall across days, and using concentrates (relative to cannabis flower) on an additional one percent of cannabis days was associated with being 5% more likely to know CBD concentrations overall across days.

Table 5 provides results of GLMMs examining associations of cannabinoid concentration knowledge with likelihood of experiencing substance-related consequences. In both the THC and CBD models, the model-predicted probabilities of experiencing positive and negative substance-related consequences were 0.72 and 0.37, respectively, for the average participant on the average cannabis day. Although cannabinoid concentration knowledge was not significantly associated with positive substance-related consequences at the day level, participants who knew THC and CBD concentrations of their cannabis on an additional one percent of days were 1% more likely to report positive substance-related consequences overall across days (a statistically significant association). In contrast, knowing THC and CBD concentrations was significantly associated with increased likelihood (1.87 times for THC and 2.76 times for CBD) of reporting negative substance-related consequences at the day level, above and beyond quantities of cannabis consumed.

Discussion

Amid a rapidly diversifying legal cannabis market, there is a need to understand consumers' knowledge of cannabinoid concentrations to inform public health guidance. This study is the first investigation of young adult cannabinoid concentration knowledge using daily

diary methods. On average, young adults knew the THC and CBD concentrations of at least some of their cannabis on a respective 48% and 32% of their cannabis days— rates slightly higher than those in a previous study of Canadian young adults prior to Canada's non-medical cannabis legalization (approximately 13%–32%; Sikorski et al., 2021), as well as studies of general adult samples in jurisdictions of varying cannabis legislation (approximately 6%–41%; Hammond & Goodman, 2022; Lineham et al., 2023). Higher reports of knowledge in our study may reflect differences in our study's sample characteristics (e.g., weekly cannabis users), data collection methods (i.e., daily diaries), or legal context. Still, findings indicate that young adults often do not know the cannabinoid concentrations of their cannabis, even when assessed at the day level.

Our study extends previous research by examining both person-level and day-level predictors of cannabinoid concentration knowledge. We observed the hypothesized links between the forms of cannabis used and cannabinoid concentration knowledge, although at the person level rather than day level. Specifically, a greater propensity for edible or beverage (versus flower) use was associated with greater overall THC concentration knowledge. As edibles and beverages increase risk of over-intoxication due to their slower-onset effects (Barrus et al., 2016), young adults who more frequently use these products may be more accustomed to considering their THC concentrations. In addition, we found that a greater propensity for concentrate (relative to flower) use was associated with greater overall THC and CBD concentration knowledge. Select types of concentrates, including tinctures, oils, sprays, and vape cartridges, are among the most commonly used cannabis products by young adults self-describing as CBD-dominant users (Fedorova et al., 2021; Wheeler et al., 2020). Thus, it is possible that young adults who primarily use concentrates are generally more concerned with the

relative THC versus CBD content of their cannabis, regardless of the specific product they are using during a given day. However, these interpretations of the relations between forms of cannabis used and cannabinoid concentration knowledge are speculative and warrant further investigation.

We also found that young adults with a greater propensity for medicinal (relative to non-medicinal) cannabis use reported greater overall knowledge of both THC and CBD concentrations. These associations align with hypotheses, although were observed at the person level rather than day level. These results are consistent with previous research showing that people who tend to use cannabis for medicinal reasons more often know and validly report the cannabinoid concentrations of their cannabis (Coelho et al., 2023; Sikorski et al., 2021). Our dimensional representation of medicinal cannabis use motives (i.e., percentage of days involving medicinal motives) is a strength, as young adults rarely report using cannabis exclusively for medicinal reasons (Government of Canada, 2021). Our finding that young adults with greater propensity for medicinal motives reported knowing cannabinoid concentrations more often may suggest that these young adults are more conscious of the health benefits and risks of cannabis use and attend more to the cannabinoid concentrations of their cannabis, overall, even when using cannabis non-medicinally. Future research is required to evaluate this supposition.

Our findings support the importance of cannabis education that targets young adults with low cannabinoid concentration knowledge, as these individuals may have limited understanding of cannabinoid concentrations across days, reglardless of the cannabis products they are using or their motives for use on a particular day. Cannabis education may be delivered in targeted ways, including as part of substance use education initiatives at universities. In addition, public health

initiatives could focus on improving cannabinoid concentration knowledge through labelling practices, such as standardized servings or doses and dose-unit packaging (Hammond, 2021).

Importantly, the current study was the first to examine cannabinoid concentration knowledge as a predictor of substance-related consequences among young adults. As hypothesized, knowing cannabinoid concentrations of cannabis used was associated with increased likelihood of experiencing positive substance-related consequences, though only at the between-person level. Perhaps young adults with greater overall knowledge of cannabinoid concentrations more reliably titrate cannabinoid doses that maximize positive subjective effects of cannabis. However, in contrast to hypotheses, cannabis days when young adults reported knowing cannabinoid concentrations of their cannabis were *more* likely to involve negative substance-related consequences, above and beyond the effects of cannabis consumption, cannabis use motives, and hazardous cannabis use level. Perhaps attention to cannabinoid concentrations among young adults reflects motivation to maximize intoxication (i.e., by selecting products with greater THC content) rather than to avoid cannabis harms, which may account for the relationship between greater knowledge and increased risk for negative substance-related consequences (Fischer et al., 2017). Although additional research is needed to clarify the mechanism of this relation, results suggest that increasing cannabinoid concentration knowledge may not necessarily reduce cannabis harms among young adults.

This study had several limitations. First, as cannabinoid concentrations were, by default, reported as unknown when cannabis was obtained from unregulated sources, cannabinoid concentration knowledge cannot be fully disentangled from cannabis source. Second, assessing cannabinoid concentration knowledge daily may have led participants to seek information about their cannabis products for subsequent surveys, potentially overestimating knowledge. Third, our

sample of N=131 may have provided limited power to detect small, person-level effects. As this study was a secondary analysis that was not originally planned, an a priori power analysis was not used to determine sample size. Although there was a large number of day-level observations (*n*=1142), we did not deliberately power the study to detect day-level effects of a certain size, which is an important limitation. Fourth, for several day-level variables, a subset of participants did not exhibit within-person variability (see Table S3). However, these participants still contributed variance to between-person effects in the model. Fifth, odds ratios in models predicting substance-related consequences should be interpreted in light of relatively low model-predicted probabilities of experiencing negative substance-related consequences for the average participant on the average day (0.37); this suggests that the likelihood of experiencing negative substance-related consequences on a given day when cannabis is used may be relatively low, regardless of whether cannabinoid concentrations are known. Sixth, reported substance-related consequences may also have been attributable to alcohol use on days involving co-use, although we mitigated this issue by controlling for alcohol consumption in consequence models. Seventh, given the focus of the parent study on cannabis-alcohol co-use, our assessment of substance-related consequences used checklists of items selected and adapted from validated cannabis consequence and alcohol consequence measures and from prior EMA studies, rather than using a single validated measure specific to cannabis consequences. Consequently, several psychometric properties of our substance-related consequence scales were unknown. As many EMA studies have administered only select substance-related consequence items from larger scales to minimize participant burden, validating brief substance-related consequence scales for EMA studies is an important future research direction. Eighth, our study was observational, precluding

causal inferences. Finally, participants all reported regular use of both cannabis and alcohol, limiting generalizability to young adults who exclusively use cannabis.

In summary, young adults with a greater propensity for non-flower and medicinally-motivated cannabis use reported greater overall knowledge of the THC and CBD concentrations of their cannabis. Moreover, greater overall cannabinoid concentration knowledge was associated with more often experiencing positive substance-related consequences, but days when cannabinoid concentrations were known were more likely to involve negative substance-related consequences. Findings elucidate which young adults may need further education regarding cannabinoid concentrations, although also indicate that increasing cannabinoid concentration knowledge, alone, may be insufficient to guard against cannabis harms in this population.

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Table 1. Sample characteristics (*N* = 131)

	M (*SD*) or *n* (%)
Age	22.11 (2.10)
Sex	
Male	47 (35.88)
Female	84 (64.12)
Gender[a]	
Man	50 (38.17)
Woman	78 (59.54)
Transgender	2 (1.53)
Non-binary	4 (3.05)
Race/ethnicity[a]	
White/Caucasian	84 (64.12)
Black/African Descent/African	11 (8.40)
Asian	20 (15.27)
Pacific Islander	2 (1.53)
Indigenous/Native North American	1 (0.76)
East Indian	14 (10.69)
Middle Eastern	4 (3.05)
Hispanic/Latinx	7 (5.34)
Prefer to specify	6 (4.58)
Household income	
$0–$19,999	30 (22.90)
$20,000–$39,999	27 (20.61)
$40,000–$59,999	22 (16.79)
$60,000–$79,999	21 (16.03)
$80,000–$99,999	9 (6.87)
$100,000–$149,999	3 (2.29)
$150,000–$199,999	8 (6.11)
$200,000+	10 (7.63)
Prefer not to respond	1 (0.76)
Highest level of education	
Less than high school	3 (2.29)
High school diploma or GED	45 (34.35)
Some college	26 (19.85)
Associates degree or technical certification	7 (5.34)
Bachelors degree	47 (35.88)
Masters degree	3 (2.29)
Doctoral degree	0 (0.00)
CUDIT-R total score	10.61 (5.29)
DFAQ-CU current cannabis use frequency	
2–3 times a month	5 (3.82)
Once a week	16 (12.21)
Twice a week	26 (19.85)
3–4 times a week	31 (23.66)
5–6 times a week	14 (10.69)
Once a day	27 (20.61)
More than once a day	12 (9.16)
DFAQ-CU grams of cannabis flower used in a typical session	0.41 (0.28)
DFAQ-CU grams of cannabis flower used in a typical day	0.54 (0.51)
DFAQ-CU grams of cannabis flower used in a typical week	2.78 (3.63)

Note. *M* = mean; *SD* = standard deviation; CUDIT-R = Cannabis Use Disorder Identification Test; AUDIT = Alcohol Use Disorder Identification Test; DFAQ-CU = Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory. [a]Participants could select more than one option; [b]No participants reported using cannabis less than 2–3 times a month, and thus lower frequency categories are not included in the table.

Table 2. Day-level descriptive statistics for the 1142 cannabis days

	n (%)
Form(s) of cannabis used	
Flower	719 (62.96)
Concentrates	172 (15.06)
Edibles/beverages	134 (11.73)
Multiple	116 (10.16)
Motive(s) for cannabis use	
Medicinal	39 (3.42)
Non-medicinal	963 (84.40)
Both medicinal and non-medicinal	139 (12.18)
Reported one or more positive consequence	
Yes	738 (64.62)
No	403 (35.29)
Reported one or more negative consequence	
Yes	427 (37.39)
No	711 (62.26)
Cannabis source(s)	
Regulated	510 (44.66)
Unregulated	600 (52.54)
Both regulated and unregulated	32 (2.80)
Reported concurrent alcohol use	
Yes	429 (37.57)
No	713 (62.43)
Day of week	
Weekend (Friday–Sunday)	525 (45.97)
Week day (Monday–Thursday)	617 (54.03)
	M (*SD*)
Grams of cannabis flower used	0.52 (0.76)
Number of concentrate hits used	1.47 (3.99)
Number of edible/beverage servings consumed	0.48 (3.39)
Number of standard drinks consumed	1.43 (2.67)

Table 3. Cannabinoid concentration knowledge stratified by form(s) of cannabis used

	Knowledge of cannabinoid concentrations for all cannabis used	Knowledge of cannabinoid concentrations for some cannabis used	Knowledge of cannabinoid concentrations for no cannabis used
	n (%)	*n* (%)	*n* (%)
THC			
Cannabis flower (*n*=719)	236 (32.82)	41 (5.70)	442 (61.47)
Edibles or beverages (*n*=134)	67 (50.00)	8 (5.97)	59 (44.03)
Concentrates (*n*=172)	105 (61.05)	2 (1.16)	65 (37.79)
Multiple forms of cannabis (*n*=116)	49 (42.24)	5 (4.31)	62 (53.45)
CBD			
Cannabis flower (*n*=719)	155 (21.56)	29 (4.03)	535 (74.41)
Edibles or beverages (*n*=134)	37 (27.61)	24 (17.91)	73 (54.48)
Concentrates (*n*=172)	66 (38.37)	3 (1.74)	103 (59.88)
Multiple forms of cannabis (*n*=116)	38 (32.76)	5 (4.31)	73 (62.93)

Note. THC = delta-9-tetrahydrocannabinol, CBD = cannabidiol.

Table 4. Results of generalized linear mixed models predicting likelihood of knowing cannabinoid concentrations of any cannabis used

	OR [95% CI]	Estimate	*SE*	*p*
THC model				
Intercept	0.71 [0.305, 1.656]	-0.342	0.432	0.428
Level 1				
Medicinal (vs. exclusively non-medicinal) motives for use	0.76 [0.359, 1.628]	-0.268	0.385	0.486
Form of cannabis used – concentrates (vs. flower)	1.53 [0.705, 3.325]	0.426	0.396	0.281
Form of cannabis used – edibles/beverages (vs. flower)	1.52 [0.503, 4.585]	0.418	0.564	0.458
Form of cannabis used – multiple forms (vs. flower)	0.88 [0.379, 2.044]	-0.128	0.430	0.767
Days since baseline assessment	**0.91 [0.878, 0.945]**	**-0.093**	**0.019**	**<0.001**
Weekend day (vs. week day)	1.24 [0.803, 1.910]	0.214	0.221	0.334
Level 2				
Medicinal (vs. exclusively non-medicinal) motives for use	**1.05 [1.019, 1.090]**	**0.052**	**0.017**	**0.002**
Form of cannabis used – concentrates (vs. flower)	**1.03 [1.002, 1.060]**	**0.030**	**0.014**	**0.036**
Form of cannabis used – edibles/beverages (vs. flower)	**1.04 [1.006, 1.068]**	**0.036**	**0.015**	**0.020**
Form of cannabis used – multiple forms (vs. flower)	1.05 [0.998, 1.095]	0.044	0.024	0.062
Weekend day (vs. week day)	0.99 [0.963, 1.026]	-0.006	0.016	0.707
Sex – female (vs. male)	0.28 [0.048, 1.611]	-1.278	0.895	0.153
Age (years)	0.92 [0.566, 1.495]	-0.083	0.248	0.737
Household income	0.87 [0.701, 1.074]	-0.142	0.109	0.193
Highest level of education	1.00 [0.475, 2.105]	0.000	0.380	0.999
DFAQ-CU cannabis use frequency	0.67 [0.388, 1.174]	-0.393	0.282	0.164
CBD model				
Intercept	**0.06 [0.016, 0.203]**	**-2.872**	**0.652**	**<0.001**
Level 1				
Medicinal (vs. exclusively non-medicinal) motives for use	0.95 [0.390, 2.320]	-0.050	0.455	0.913
Form of cannabis used – concentrates (vs. flower)	1.80 [0.711, 4.581]	0.590	0.475	0.215
Form of cannabis used – edibles/beverages (vs. flower)	2.34 [0.571, 9.620]	0.852	0.721	0.237
Form of cannabis used – multiple forms (vs. flower)	**3.46 [1.101, 10.89]**	**1.242**	**0.585**	**0.034**
Days since baseline assessment	**0.94 [0.896, 0.977]**	**-0.067**	**0.022**	**0.002**
Weekend day (vs. week day)	0.96 [0.579, 1.609]	-0.036	0.261	0.891
Level 2				
Medicinal (vs. exclusively non-medicinal) motives for use	**1.04 [1.004, 1.086]**	**0.043**	**0.020**	**0.031**
Form of cannabis used – concentrates (vs. flower)	**1.05 [1.010, 1.088]**	**0.048**	**0.019**	**0.012**

Form of cannabis used – edibles/beverages (vs. flower)	1.03 [0.997, 1.068]	0.031	0.018	0.073
Form of cannabis used – multiple forms (vs. flower)	1.04 [0.979, 1.096]	0.035	0.029	0.223
Weekend day (vs. week day)	1.01 [0.970, 1.045]	0.007	0.019	0.725
Sex – female (vs. male)	0.26 [0.034, 1.972]	-1.350	1.035	0.192
Age (years)	1.31 [0.729, 2.340]	0.267	0.297	0.369
Household income	0.95 [0.732, 1.225]	-0.054	0.131	0.679
Highest level of education	1.17 [0.487, 2.815]	0.158	0.448	0.725
DFAQ-CU cannabis use frequency	0.77 [0.405, 1.450]	-0.266	0.325	0.414

Note. OR = odds ratio, 95% CI = 95% confidence interval, SE = standard error, THC = delta-9-tetrahydrocannabinol, CBD = cannabidiol, DFAQ-CU = Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory. One observation in which the use of an unspecified other form of cannabis was used was omitted from models. Models included 1128 participant-days and 130 participants.

Table 5. Results of generalized linear mixed models predicting likelihood of experiencing positive and negative substance-related consequences

	Positive Consequences[a]				Negative Consequences[b]			
	OR [95% CI]	Estimate	*SE*	*p*	OR [95% CI]	Estimate	*SE*	*p*
THC models								
Intercept	**2.55 [1.832, 3.542]**	**0.94**	**0.17**	**<0.001**	**0.58 [0.409, 0.817]**	**-0.55**	**0.18**	**0.002**
Level 1								
Knowledge of THC concentrations for any cannabis used	1.58 [0.896, 2.799]	0.46	0.29	0.113	**1.87 [1.067, 3.270]**	**0.63**	**0.29**	**0.029**
Medicinal (vs. exclusively non-medicinal) motives for use	0.95 [0.493, 1.845]	-0.05	0.34	0.889	0.71 [0.359, 1.392]	-0.35	0.35	0.316
Grams of cannabis flower used	1.26 [0.817, 1.958]	0.23	0.22	0.293	**1.88 [1.207, 2.943]**	**0.63**	**0.23**	**0.005**
Number of concentrate hits used	1.05 [0.988, 1.118]	0.05	0.03	0.116	**1.07 [1.014, 1.136]**	**0.07**	**0.03**	**0.014**
Number of edbible/beverage servings consumed	1.15 [0.874, 1.501]	0.14	0.14	0.324	0.97 [0.928, 1.021]	-0.03	0.02	0.268
Number of standard drinks consumed	**1.20 [1.097, 1.321]**	**0.19**	**0.05**	**<0.001**	**1.22 [1.119, 1.329]**	**0.20**	**0.04**	**<0.001**
Days since baseline assessment	0.98 [0.955, 1.008]	-0.02	0.01	0.161	1.00 [0.968, 1.024]	0.00	0.01	0.744
Weekend day (vs. week day)	1.19 [0.856, 1.659]	0.18	0.17	0.300	0.78 [0.552, 1.107]	-0.25	0.18	0.165
Level 2								
Knowledge of THC concentrations for any cannabis used	**1.01 [1.001, 1.017]**	**0.01**	**0.00**	**0.036**	1.00 [0.996, 1.013]	0.00	0.00	0.317
Medicinal (vs. exclusively non-medicinal) motives for use	1.00 [0.992, 1.016]	0.00	0.01	0.537	1.00 [0.985, 1.011]	0.00	0.01	0.737
Grams of cannabis flower used	1.00 [0.996, 1.008]	0.00	0.00	0.549	1.00 [0.992, 1.006]	0.00	0.00	0.786
Number of concentrate hits used	1.00 [0.999, 1.001]	0.00	0.00	0.898	1.00 [0.999, 1.001]	0.00	0.00	0.834
Number of edbible/beverage servings consumed	1.00 [0.999, 1.005]	0.00	0.00	0.206	1.00 [0.999, 1.003]	0.00	0.00	0.337
Number of standard drinks consumed	**1.56 [1.225, 1.985]**	**0.44**	**0.12**	**<0.001**	**1.45 [1.183, 1.782]**	**0.37**	**0.10**	**<0.001**
Weekend day (vs. week day)	1.01 [0.998, 1.028]	0.01	0.01	0.098	1.00 [0.980, 1.011]	0.00	0.01	0.568
Sex – female (vs. male)	**0.48 [0.244, 0.959]**	**-0.73**	**0.35**	**0.037**	**0.37 [0.174, 0.780]**	**-1.00**	**0.38**	**0.009**
Age (years)	1.04 [0.896, 1.209]	0.04	0.08	0.600	0.97 [0.822, 1.135]	-0.03	0.08	0.674
CUDIT-R total score	0.99 [0.933, 1.060]	-0.01	0.03	0.856	**1.10 [1.024, 1.177]**	**0.09**	**0.04**	**0.009**
CBD models								
Intercept	**2.55 [1.839, 3.544]**	**0.94**	**0.17**	**<0.001**	**0.58 [0.410, 0.819]**	**-0.55**	**0.18**	**0.002**
Level 1								
Knowledge of CBD concentrations for any cannabis used	1.94 [0.996, 3.784]	0.66	0.34	0.051	**2.76 [1.414, 5.385]**	**1.01**	**0.34**	**0.003**
Medicinal (vs. exclusively non-medicinal) motives for use	0.93 [0.484, 1.794]	-0.07	0.33	0.833	0.67 [0.343, 1.322]	-0.40	0.34	0.251
Grams of cannabis flower used	1.27 [0.820, 1.968]	0.24	0.22	0.284	**1.91 [1.219, 2.987]**	**0.65**	**0.23**	**0.005**
Number of concentrate hits used	1.05 [0.990, 1.121]	0.05	0.03	0.099	**1.07 [1.015, 1.135]**	**0.07**	**0.03**	**0.013**
Number of edbible/beverage servings consumed	1.14 [0.881, 1.489]	0.14	0.13	0.312	0.98 [0.930, 1.023]	-0.02	0.02	0.304
Number of standard drinks consumed	**1.20 [1.095, 1.320]**	**0.18**	**0.05**	**<0.001**	**1.22 [1.118, 1.328]**	**0.20**	**0.04**	**<0.001**
Days since baseline assessment	0.98 [0.954, 1.006]	-0.02	0.01	0.137	0.99 [0.967, 1.022]	-0.01	0.01	0.670
Weekend day (vs. week day)	1.20 [0.864, 1.678]	0.19	0.17	0.273	0.80 [0.562, 1.130]	-0.23	0.18	0.202
Level 2								
Knowledge of CBD concentrations for any cannabis used	**1.01 [1.001, 1.018]**	**0.01**	**0.00**	**0.024**	1.01 [0.998, 1.017]	0.01	0.00	0.115

Medicinal (vs. exclusively non-medicinal) motives for use	1.00 [0.993, 1.017]	0.00	0.01	0.443	1.00 [0.985, 1.010]	0.00	0.01	0.703
Grams of cannabis flower used	1.00 [0.995, 1.008]	0.00	0.00	0.591	1.00 [0.992, 1.006]	0.00	0.00	0.797
Number of concentrate hits used	1.00 [0.999, 1.001]	0.00	0.00	0.860	1.00 [0.999, 1.001]	0.00	0.00	0.833
Number of edbible/beverage servings consumed	1.00 [0.999, 1.005]	0.00	0.00	0.224	1.00 [0.999, 1.003]	0.00	0.00	0.415
Number of standard drinks consumed	**1.55 [1.219, 1.960]**	**0.44**	**0.12**	**<0.001**	**1.47 [1.194, 1.801]**	**0.38**	**0.10**	**<0.001**
Weekend day (vs. week day)	1.01 [0.997, 1.027]	0.01	0.01	0.122	0.99 [0.979, 1.010]	-0.01	0.01	0.504
Sex – female (vs. male)	**0.48 [0.244, 0.951]**	**-0.73**	**0.35**	**0.035**	**0.36 [0.171, 0.772]**	**-1.01**	**0.38**	**0.008**
Age (years)	1.01 [0.870, 1.176]	0.01	0.08	0.880	0.95 [0.803, 1.113]	-0.06	0.08	0.498
CUDIT-R total score	1.00 [0.936, 1.063]	0.00	0.03	0.933	**1.10 [1.026, 1.180]**	**0.10**	**0.04**	**0.007**

Note. OR = odds ratio, 95% CI = 95% confidence interval, SE = standard error, THC = delta-9-tetrahydrocannabinol, CBD = cannabidiol, CUDIT-R = Cannabis Use Disorder Identification Test – Revised. One observation in which the use of an unspecified other form of cannabis was used was omitted from models.

[a]Positive consequences models included 1131 participant-days and 131 participants.

[b]Negative consequence models included 1128 participant-days and 131 participants.

[1] 177 participants were enrolled in the study following an initial online eligibility screening; however, nine participants were unable to confirm their identity and/or eligibility during the baseline interview and were thus withdrawn from the study and did not complete the EMA protocol. An additional 17 participants were withdrawn for completing <10% of the prompted EMA surveys, resulting in a sample of *N*=151.

[2] Three alcohol-specific items were also included in the EMA surveys, but were not used for the current analyses given our focus on cannabis use.

[3] One observation involved the use of another, unspecified form of cannabis and was excluded from models.

[4] Models with random slopes specified for each day-level predictor were tested but failed to converge. Further, convergence issues persisted when including only those random slopes that improved model fit relative to the fixed slopes models. Thus, day-level predictors were specified with fixed slopes.