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## Patterns and correlates of cannabidiol product and marijuana co-use in a sample of U.S. young adults

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### Abstract

**Objective:** Cannabis-derived products containing cannabidiol with no or minimal levels of delta 9-tetrahydrocannabinol (CBD products) are widely available in the United States and use of these products is common among young adults and those who use marijuana. The purpose of this study was to examine patterns and correlates of CBD product use and co-use with marijuana in a sample of young adults.

**Method:** The study used cross-sectional survey data collected in 2019–2020 from a cohort of young adults (n=2,534; mean age 23) based primarily in California. The survey assessed lifetime, past-year, and past-month frequency and type of CBD products used, frequency and amount of marijuana consumption and indicators of marijuana use-related problems. Linear, Poisson, and logistic regression models compared individuals reporting past month CBD-only use, marijuana-only use, concurrent CBD+marijuana use (co-use), and use of neither product. Among those reporting co-use, we examined associations between CBD use frequency and marijuana use frequency and heaviness of use (occasions per day) and indicators of problem marijuana use (e.g., Cannabis Use Disorder Identification Test Short-Form, solitary use, marijuana consequences).

**Results:** Approximately 13% of respondents endorsed past-month CBD use; of these, over three-quarters (79%) indicated past-month co-use of marijuana. Among individuals reporting co-use,

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more frequent CBD use was associated with more frequent and heavier marijuana use but was not associated with marijuana use-related problems.

**Conclusions:** CBD use was common and associated with higher levels of marijuana consumption in this sample. Routinely assessing CBD use may provide a more comprehensive understanding of individuals' cannabis product consumption.

### Keywords

cannabidiol; CBD; marijuana; young adults; cannabis

## INTRODUCTION

The cannabis regulatory landscape in the United States (U.S.) has changed dramatically in recent decades,<sup>1</sup> increasing access to a wide range of cannabis-derived products for adults throughout much of the country. The cannabis plant contains hundreds of chemicals that account for various pharmacological effects, of which over 100 are recognized as cannabinoids.<sup>2</sup> The two cannabinoids most familiar to the general public are delta 9-tetrahydrocannabinol (THC), the primary psychoactive component in cannabis, and cannabidiol (CBD), which has garnered interest for its medicinal properties, and because –unlike THC– it does not produce intoxication and is thought to have low addictive potential.<sup>3,4</sup>

CBD has received increased attention in the U.S. following the *Agriculture Improvement Act of 2018* (“2018 Farm Bill;” P.L. 115–334), which removed “hemp” (that is, cannabis plants/derivatives containing less than 0.3% THC by dry weight) from the definition of “marijuana” in the Controlled Substances Act.<sup>5</sup> This change helped spur a massive increase in production and marketing of products containing CBD with no or minimal levels of THC. Hereafter, we refer to these as “CBD products,” and we use the term “marijuana” to refer to THC-containing products. CBD products are available in all states/districts with adult-use cannabis laws, and remaining states allow for some regulated sale and possession of CBD.<sup>1</sup> In addition, unlike marijuana, CBD products are sold in licensed cannabis outlets as well as through other retail outlets (e.g., pharmacies, convenience stores, online).<sup>6,7</sup>

This rapid expansion in availability warrants some concern. CBD has been investigated as a potential therapeutic agent for a range of health conditions and patient populations,<sup>8–12</sup> with the most robust evidence shown for epilepsy and seizure disorders.<sup>13,14</sup> However, evidence supporting therapeutic benefits of CBD products for problems like pain, sleep disturbance, or mental health symptoms –among the most commonly endorsed reasons for using CBD<sup>15–18</sup>– is limited.<sup>16</sup> Additionally, although CBD has a generally favorable safety profile,<sup>4,19,20</sup> it can interact with other drugs (e.g., acetaminophen, alcohol), raising concerns about adverse outcomes for some individuals.<sup>13,21</sup> CBD use can also lead to unwanted side effects (e.g., appetite change, fatigue),<sup>4,11,19</sup> indeed, surveys with convenience samples of adults who use CBD indicate that between one third<sup>17</sup> to over half<sup>18</sup> of respondents experienced at least one unanticipated side effect attributed to CBD. Moreover, although products sold through legalized, licensed cannabis outlets must adhere to regulatory standards (e.g., testing for contaminants) set by state authorities, CBD products sold outside

of licensed cannabis retailers are not subject to these standards and labeling inaccuracies (e.g., for CBD dose and other product ingredients) are widespread, raising concerns about consumer safety.<sup>3,22</sup> This underscores the public health importance of examining patterns and correlates of CBD consumption.

Unfortunately, data on CBD use in the U.S. are limited. Most studies have involved small clinical samples with specific medical conditions<sup>12,16</sup> or convenience samples selected for prior CBD use.<sup>17,23</sup> In one of the largest survey studies of CBD use to date, which used data from the 2019 International Cannabis Policy Study (ICPS; a large, nonprobability panel survey of U.S. and Canadian adolescents and adults ages 16–65), Goodman and colleagues found that past-year use of CBD products was common, endorsed by approximately 26% of U.S. participants (n=30,288), with higher rates of past-year use observed among women, White respondents, those with higher educational attainment, and young adults.<sup>15</sup> Higher uptake of CBD products in some groups, particularly young adults, warrants greater attention for several reasons. Because young adults use alcohol and other drugs at higher rates than other age groups,<sup>24</sup> they may be at risk of experiencing drug-drug interactions or other unwanted effects.<sup>13,19,21</sup> from CBD. Additionally, past research suggests that CBD use may be more common among individuals who also use marijuana and other drugs.<sup>15,17,18,23</sup> For example, in the 2019 ICPS, daily or almost daily use of other cannabis products (i.e., marijuana) was associated with a nearly 10-fold increased likelihood of past-year CBD use compared to those who reported never using marijuana.<sup>15</sup> Another recent study examining use patterns and factors associated with CBD use in a convenience sample of 340 U.S. adults (mostly female, non-Hispanic White young adults in college) found that over 80% of individuals reporting CBD use also used marijuana.<sup>18</sup> Additionally, due to overlapping modes administration, young adults who use marijuana may also be more likely to use certain types of CBD products (e.g., combustible; vaping products) that carry additional health risks. Indeed, use of THC and CBD vape cartridges purchased from informal sources was linked to cases of serious lung injury during the 2019–2020 E-cigarette or Vaping-Associated Lung Injury outbreak, which disproportionately affected young adults.<sup>25</sup>

However, few studies assess whether and how young adults who exclusively use CBD may differ from individuals who engage in co-use of both CBD *and* marijuana or from those who exclusively use marijuana. Such information is critical for understanding the extent to which CBD products –and what types of products– may appeal to individuals who do *not* use psychoactive cannabis products like marijuana. Additionally, some research suggests that, compared to individuals who use CBD exclusively, individuals who use both CBD and marijuana may demonstrate different product use patterns. One recent survey of a convenience sample of 182 individuals reporting CBD use found that individuals who used both CBD and marijuana reported more frequent CBD use, and were also more likely to use vaping or combustible CBD products compared to those who exclusively used CBD.<sup>23</sup> Further, although evidence supporting effects of CBD on subjective effects of THC is limited,<sup>16,26,27</sup> *beliefs* that CBD can work synergistically with and/or attenuate undesirable (e.g., anxiogenic) effects of THC are common.<sup>26–28</sup> Such beliefs could contribute to more frequent CBD use among people who use marijuana more heavily or experience marijuana use-related consequences (e.g., use of CBD to mitigate negative consequences of heavier marijuana use). Examining associations between CBD and marijuana use, including among

those who use both types of products, thus has important implications for understanding how people use different cannabis-derived products. Additional studies with large, diverse samples are needed to identify factors associated with CBD use and its co-use with marijuana.

This study adds to the sparse literature on CBD use and its co-use with marijuana in multiple ways. First, we describe frequency and type of CBD product use in a diverse sample of young adults. Second, we assess differences in CBD use between individuals with past month use of CBD but not marijuana products (“*CBD-only*”) and those who co-use both CBD and marijuana products (“*CBD+Marijuana*”). We hypothesized that, compared to the *CBD-only* group, those in the *CBD+Marijuana* group would be more likely to use CBD vaping and combustible products. Third, we compare demographic characteristics, substance use, and health status across individuals based on past-month CBD and/or marijuana use status. We hypothesized that, compared to the *CBD-only* group, individuals in the *CBD+Marijuana* use group would show higher rates of other substance use and poorer health status. Fourth, we compare *Marijuana-only* and *CBD+Marijuana* groups on marijuana use patterns and use-related consequences. We hypothesized that the *CBD+Marijuana* group would report heavier marijuana use and as well as greater marijuana use-related consequences. Finally, for the *CBD+Marijuana* group, we examine associations between frequency of CBD use and marijuana use patterns and consequences. We hypothesized that more frequent CBD use would be associated with more frequent, heavier marijuana use and greater marijuana use-related consequences.

## METHOD

### Dataset.

The current study uses cross-sectional survey data from wave 12 of the ongoing CHOICE-STRATA cohort study. Participants were originally recruited in 2008 (wave 1) from 16 middle schools in Southern California for a voluntary school-based substance use prevention program (note: the intervention took place over 10 years ago and intervention status was not associated with substance use outcomes beyond study wave 2).<sup>29</sup> Participants are contacted annually to complete surveys on substance use, health, and health risk and protective factors since enrollment, with retention over 80% since wave 6 in 2014 when participants started completing surveys online. The wave 12 survey, fielded online between June 2019 and July 2020, was the first wave that assessed CBD use. Young adults were paid \$50 for survey completion. All study procedures were reviewed and approved by RAND Human Subjects Protection Committee. The wave 12 analytic sample includes 2,534 respondents, the majority of whom (89%) currently reside in California; approximately 96% of respondents reside in a state where non-medical cannabis is legal. Individuals averaged 23 years of age at the time of the survey.

### Measures

**Frequency of CBD and marijuana use.:** Questions from the Monitoring the Future (MTF) survey<sup>24</sup> asked, “During your LIFE, how many times have you used or tried...*marijuana?* AND *electronic cigarette or personal vaporizer to vape marijuana?*” (1=zero to 6=seven

or more times), and “During the PAST YEAR, how many times have you used or tried... *marijuana? electronic cigarette or personal vaporizer to vape marijuana?* (1=None to 6=More than 20 times). Frequency of past-month use was assessed with days (range 0–30 days; note: for individuals reporting both “marijuana” and “electronic cigarette or personal vaporizer to vape marijuana,” we used the higher value [days] for past-month frequency). Similar items with identical response options assessed lifetime, past-year, and past-month use of CBD products (“During [your life; the past year; the past 30 days], how many [times/days] did you use... CBD [cannabidiol] products that DO NOT contain THC?”), which appeared after the marijuana use items in the survey. Four CBD/marijuana use groups were derived based on past-month use of each product: *CBD-only*; *Marijuana-only*; *CBD+Marijuana*; and *Non-use*.

**Types of CBD products used.:** Individuals endorsing lifetime, past-year, and past-month use of CBD products were asked to check all products they typically used (“On the days that you use or have used CBD products (i.e., products that contain CBD but DO NOT contain THC), what type(s) of CBD products do/did you typically use?”), with response options adapted from existing questionnaires<sup>17,18</sup> (see Table 1 for a complete list of response options).

**Indicators of heavy and/or problem marijuana use.:** Among those reporting past-month marijuana use, heaviness of use was assessed by asking the number of times per day they used any type of marijuana on a typical use day (response options 0–99), regardless of type of product(s) used. Individuals who endorsed past month use of marijuana products also indicated the types of products or ways they consumed marijuana as follows: joint, blunt, hand pipe, bong, dabs, edibles, personal vaporizer, and beverage.<sup>30</sup> Responses were recoded to indicate any or no use of each type of marijuana (0/1) and summed to create a *poly-marijuana use* variable (i.e., number of different modes of administration; range 1–8). Participants also provided information on solitary marijuana use [“Do you ever use marijuana/cannabis when you’re by yourself?” (yes/no),<sup>31</sup> an indicator of problem use.<sup>32,33</sup> Additionally, participants completed the 3-item Cannabis Use Disorder Identification Test Short-Form (CUDIT-SF).<sup>34</sup> Items are scored as 0=never to 4=daily or almost daily and summed to create a continuous score ( $\alpha = .74$ ), with higher values indicating greater marijuana use-related problems. Individuals also reported on marijuana use consequences using a 10-item measure from the RAND Adolescent/Young Adult Panel Study<sup>35</sup> and the Marijuana Consequences Questionnaire,<sup>36</sup> rating how often (1 = none to 7 = 20+times) they experienced problems in the past year because of using marijuana (e.g., missing school, work, or other obligations). Items were summed to create a total composite score (range = 10 to 70;  $\alpha = .90$ ).

**Physical and mental health.:** Participants provided subjective ratings of physical health using a single item from the SF-12 (“In general, would you say your health is;” scored 1 = poor to 5 = excellent.<sup>37</sup> They completed items from the PHQ-15<sup>38</sup> on the extent to which they had been bothered by four physical ailments in the past four weeks: stomach pain, headaches, feeling tired or having low energy, trouble sleeping (0 = not bothered at all, 1 = bothered a little, 2 = bothered a lot). Items were dichotomized (0 vs 1+) and summed

(summary score range = 0 – 4;  $\alpha = 0.73$ ). We assessed depression with the PHQ 8<sup>39</sup> and anxiety with the GAD-7.<sup>40</sup>

**Other substance use.:** We assessed frequency of alcohol, tobacco, and other illicit drug use (e.g., cocaine, heroin, hallucinogens) with items from MTF, using the same response options described above. We derived dichotomous indicators for any use of alcohol, tobacco, and any other drug use (yes/no) for lifetime, past year, and past month.

**Demographic characteristics.:** Participants reported age, gender, race/ethnicity, sexual orientation, educational attainment, current employment status, whether English is the primary language spoken at their home, and mother's educational attainment (proxy for socioeconomic status).

**Analyses.:** Among those endorsing past-month CBD use, we examined endorsement of specific types of CBD products, and compared rates across *CBD-only* and *CBD+Marijuana* groups using bivariate chi-square tests. Next, we used separate bivariate ANOVA (continuous variables) and logistic regression (binary variables) to compare CBD/marijuana groups on physical and mental health, substance use, and demographic characteristics. We then used multivariable logistic, Poisson (*poly-marijuana use*), and ordinary least squares regression (continuous outcomes) to compare the *Marijuana-only* and *CBD+Marijuana* groups on indicators of heavy or problem marijuana use. These models controlled for demographic factors known to correlate with marijuana use (age, gender, race/ethnicity, mother's education) and intervention group at Wave 1. Finally, among individuals in the *CBD+Marijuana* group, we used logistic, Poisson, and OLS regression models to examine associations between frequency of past-month CBD use and indicators of heavy or problem marijuana use, adjusting for past-month frequency of marijuana use and aforementioned covariates.

## RESULTS

### Use of CBD and Marijuana

In the full sample ( $n = 2,534$ ), 42% of respondents reported lifetime CBD use ( $n = 1,060$ ), 28% past-year use ( $n=714$ ), and 13% past-month use ( $n=318$ ). Among those reporting past-month use, CBD products were used an average of 2.6 ( $SD = 5.8$ ) days in the past month and 9% reported using CBD products daily or near-daily (i.e., on 20+ days). Of those using CBD in the past month, 79% ( $n=249$ ) also endorsed any past-month marijuana use. Overall, 34% of respondents ( $n = 863$ ) reported past-month marijuana use; approximately 29% ( $n=249$ ) of these individuals also endorsed past-month CBD use.

Nearly two-thirds (63%) of participants reported no current CBD or marijuana use (*Non-use* group:  $n = 1,591$ ), 24% reported marijuana use and no CBD use (*Marijuana-only*:  $n = 613$ ), 3% reported CBD use and no marijuana use (*CBD-only*:  $n = 68$ ), and 10% reported CBD and marijuana co-use (*CBD+Marijuana*:  $n = 249$ ).

The most commonly used CBD products were topical, vaping products, edibles, and oils or tinctures (Table 1). Patterns in CBD product types were similar for those endorsing



lifetime, past-year, and past-month CBD use. Among those reporting past-month use, patterns differed slightly across *CBD-only* and *CBD+Marijuana* groups, such that the *CBD+Marijuana* group showed higher rates of CBD vaping and use of CBD concentrates (based on bivariate comparisons; see Table 1).

### Demographic, Health, and Substance Use Differences by CBD/Marijuana Use Group

Overall, the sample was 54% female, 47% Hispanic, 23% non-Hispanic White, 23% Asian, 7% other race/ethnicity, and averaged 22.6 (SD = 0.8) years old (Table 2). Based on unadjusted group comparisons (ANOVA for continuous variables, logit models for binary variables), CBD/Marijuana use groups differed significantly ( $p < .05$ ) with respect to several demographic and other individual characteristics. For example, those in the *CBD-only* group were significantly more likely than those in the *Non-use* group to identify as female, non-Hispanic White, and to speak only English at home, and less likely to identify as heterosexual/straight or Asian. In addition, those in the *CBD+Marijuana* group were more likely to identify as non-Hispanic White and to speak only English at home, and less likely to identify as heterosexual/straight, Hispanic, and Asian compared to the *Non-use* group. Largely similar patterns were observed for the *Marijuana-only* group (Table 2). The four groups did not statistically differ with respect to age, employment status, or mother's education.

Groups differed with respect to physical and mental health status (all reported differences, based on bivariate ANOVA and logit models, significant at  $p < .05$ ). Those in the *Marijuana-only* group reported poorer physical health compared to the *Non-use* group. In addition, those in the *CBD+Marijuana* group reported more problems with physical ailments and greater anxiety symptoms compared to the *Non-use* and *Marijuana-only* groups; those in the *CBD+Marijuana* groups also showed greater depressive symptoms compared to the *Non-use* group. For substance use, the *CBD-only*, *Marijuana-only*, and *CBD+Marijuana* groups were similar, with all groups showing consistently higher endorsement of tobacco, alcohol, and other substance use across nearly all time frames (lifetime, past-year, past-month) compared to the *Non-use* group.

### Differences in Indicators of Heavy and/or Problem Marijuana Use across *Marijuana-only* and *CBD+Marijuana* Groups

Adjusting for demographic and other covariates in multivariable regression models, compared to the *Marijuana-only* group, individuals in the *CBD+Marijuana* group reported using marijuana on more days in the past month and using more times per day on use days (Table 3). Those in the *CBD+Marijuana* group were also significantly more likely to report solitary marijuana use and poly-marijuana use. The two groups did not differ on CUDIT scores or marijuana use-related consequences.

### Associations between Frequency of CBD Use and Indicators of Heavy and/or Problem Marijuana Use in the *CBD+Marijuana* Group

In the *CBD+Marijuana* group, frequency of CBD use in the past month was significantly, positively correlated with frequency of past-month marijuana use ( $r = 0.38$ ,  $p < .0001$ ). Adjusting for frequency of past-month marijuana use in multivariable regression models,

more frequent CBD use was also associated with heavier marijuana use (i.e., using marijuana more times per day on a typical use day) but was not associated with poly-marijuana product use, solitary use, CUDIT scores, or use-related consequences (Table 4).

## DISCUSSION

This study extends the small existing literature on CBD use by reporting on patterns and correlates of CBD product use and co-use with marijuana among a California-based cohort of young adults. CBD use was common in this sample. Over one-in-four respondents (28%) reported CBD use in the past year, consistent with recent estimates (26%) from other large U.S. samples,<sup>15</sup> and 13% reported past-month use of CBD. In the context of widespread availability, limited regulations, and sparse data on safety and potential benefits of different types of CBD products, results underscore the need for greater attention to these products from researchers, public health officials, and regulatory bodies.

As hypothesized, we observed high rates of CBD and marijuana co-use: among those reporting past-month CBD use, nearly 4-in-5 also used marijuana. Few individuals endorsed current use of CBD with no concurrent marijuana use (3% of the full sample); and of this small subset, 93% endorsed prior (lifetime) marijuana use. Consistent with hypotheses, individuals who also used marijuana were more likely to endorse using certain types of CBD products (vaping products and concentrates) than those who only used CBD. This may be attributable, in part, to similarities in mode of administration for marijuana and CBD and has implications for potential risks associated with use of different CBD products. Collectively, findings lend additional support to a correlation between CBD and marijuana use,<sup>15,17,18,23</sup> and suggest that these products may primarily appeal to young adults who have also used marijuana. Thus, despite notable differences in psychoactive effects, CBD use may be a robust indicator of marijuana consumption in young adults, at least in areas where adult-use marijuana is legal.

We also observed differences in demographic and other characteristics by CBD/marijuana use status. For example, compared to the *Non-use* group, those in the *CBD-only* group were more likely to identify as female, consistent with other research.<sup>15</sup> This may be due in part to cannabis industry efforts to target female consumers through beauty/lifestyle products.<sup>41</sup> Additionally, compared to those in the *Marijuana-only* group, individuals in the *CBD+Marijuana* group reported more physical ailments and anxiety symptoms. Although we did not assess reasons for use, these patterns are consistent with use of CBD to manage health conditions.<sup>15,17,18,23</sup> Such findings suggest that health providers may benefit from routinely assessing CBD use to ensure a comprehensive understanding of patient cannabis use and inform decisions about patient care.

Our findings also extend evidence of the overlap between CBD and marijuana use by showing that use of CBD products may be associated with heavier marijuana consumption. Consistent with hypotheses, compared to individuals endorsing *Marijuana-only* use, those reporting *CBD+Marijuana* use showed more frequent and heavier marijuana use, and were more likely to report poly-marijuana and solitary marijuana use. Moreover, after adjusting for frequency of past-month marijuana use in the *CBD+Marijuana* (co-use) group,



more frequent CBD use correlated with heavier marijuana consumption, but *not* CUDIT scores or marijuana use-related consequences. Although we did not assess motivations for *CBD+Marijuana* co-use, these patterns could be consistent with use of CBD to help offset undesired effects of heavier marijuana use and/or supplement or potentiate desired effects.<sup>26, 27</sup> As the cannabis product and regulatory landscape continues to evolve, future studies examining motivations for using (and co-using) different cannabis-derived products will be important for understanding use patterns and consequences and informing regulatory actions to help best public health.

Findings must be considered in context of limitations. First, CBD and marijuana use were self-reported. Second, we do not have data on where CBD was purchased (e.g., from a cannabis outlet with regulated products vs. retailers selling non-regulated products). Future work is needed to better understand how specific THC/CBD concentrations in products may correlate with use and purchasing patterns, consequences, and other factors. Data were also cross-sectional, and the sample was comprised of young adults who primarily resided in California. As such, findings may not be generalizable to all U.S. young adults or other age groups. Future longitudinal research with large, representative samples can help to characterize use patterns for different cannabis products over time and across policy settings.

These limitations aside, this study adds to the small but growing literature on CBD product use. CBD use was common in this sample of young adults and correlated with more frequent and heavier marijuana consumption. Additional research is urgently needed to help inform product regulations and protect consumers as the landscape for cannabis and derivative products continues to evolve.

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### Highlights

- Cannabidiol (CBD) products are widely accessible but few studies assess CBD use.
- Of young adults reporting past-month CBD use, over 75% also used marijuana.
- More frequent CBD use was associated with heavier marijuana use.
- Despite different psychoactive profiles, CBD use correlates with marijuana use.
- Assessing CBD use is important for characterizing patterns of cannabis consumption.

**Table 1.**

Types of CBD product use and bivariate comparisons of current (past-month) product use endorsement across CBD-only and CBD+Marijuana co-use groups

	Lifetime CBD use (n=1,060)	Past-year CBD use (n=714)	Past month CBD use			Unadjusted group difference <sup>2</sup>
			Past month CBD use (all) (n=318)	Past month CBD-only use (n=68)	Past month CBD+Marijuana co-use (n=249)	
On the days that you use or have used CBD products (i.e., products that contain CBD but DO NOT contain THC), what type(s) of CBD products do/did you typically use. Please check all that apply						<i>p</i>
Topical products (e.g., lotions, salves, or creams for external use on the skin)	39.3%	44.3%	52.5%	52.9%	52.2%	0.92
Vaping products (e.g., e-cigarettes or personal vaporizer systems to vape CBD oil or e-liquid)	29.0%	30.4%	35.2%	20.6%	39.4%	<b>0.004</b>
Capsules or pills	6.0%	7.8%	9.1%	11.8%	8.4%	0.40
Edibles (e.g., brownies, gummies, or other candy)	35.8%	36.4%	38.1%	41.2%	37.4%	0.57
Solid concentrates (e.g., dabs, wax, or crystals)	5.1%	6.2%	6.3%	0.0%	8.0%	<b>0.02</b>
Mixed in non-alcoholic beverages (e.g., water, teas, coffee drinks, smoothies, sodas, or other drinks)	8.6%	10.2%	9.8%	14.7%	8.4%	0.12
Mixed in alcoholic beverages (e.g., CBD cocktails)	2.6%	3.1%	3.1%	1.5%	3.6%	0.37
Oils or tinctures (i.e., for oral/sublingual use)	21.0%	26.6%	33.7%	29.4%	34.9%	0.39
Combustible products (e.g., CBD cigarettes)	4.3%	5.2%	6.9%	2.9%	8.0%	0.14

Note. Values are percentages of individuals endorsing each response option.

<sup>1</sup> Past-month frequency of CBD use averaged 2.6 (SD = 5.8) days in the past month; 9% of individuals reported using CBD products daily or near-daily (i.e., on 20+ days). Based on bivariate t- and chi-square tests, the CBD+Marijuana co-use and CBD-only groups did not statistically differ with respect to number of CBD use days in the past month ( $t(df=315) = -1.3, p = .19$ ) or percentage of individuals endorsing daily/near-daily CBD use ( $\chi^2(df=1) = 0.94, p = .33$ ).

<sup>2</sup> Group differences in rates of endorsing each type of product across CBD-only and CBD+Marijuana co-use groups were assessed using bivariate chi square tests.



Health, substance use, and demographic characteristics and unadjusted group comparisons across past-month CBD and marijuana use groups

Table 2.

	Overall (n = 2,534)	CBD/Marijuana Use Group				Group Differences
		Group 1	Group 2	Group 3	Group 4	
<b>Physical and Mental Health Status</b>	<i>M (SD) /%</i>	<i>M (SD) /%</i>	<i>Mean (SD)/%</i>	<i>M (SD) /%</i>	<i>Mean (SD) /%</i>	Unadjusted group comparisons significant at <i>p</i> < .05
Overall Physical Health <sup>a</sup>	3.5 (1.0)	3.5 (1.0)	3.4 (1.0)	3.4 (1.0)	3.4 (1.0)	Group 3 < Group 1
Physical Ailments <sup>b</sup>	2.0 (1.4)	1.9 (1.4)	2.3 (1.3)	2.1 (1.4)	2.4 (1.4)	Group 3 < Group 4; Group 1 < Group 4
Anxiety (GAD-7)	5.2 (5.6)	4.8 (5.4)	6.4 (5.6)	5.3 (5.5)	6.9 (6.2)	Group 3 < Group 4; Group 1 < Group 4
Depression (PQH-8)	5.6 (5.6)	5.2 (5.5)	6.4 (5.6)	5.9 (5.4)	7.0 (6.3)	Group 1 < Group 4; Group 1 < Group 3
<b>Marijuana Use</b>						
Lifetime Marijuana Use	77.4%	64.5%	92.7%	100%	100%	Group 1 < Group 2
Past-year Marijuana Use	51.4%	24.5%	64.7%	100%	100%	Group 1 < Group 2
<b>Tobacco Use</b>						
Lifetime Tobacco Use	75.3%	64.3%	86.8%	94.1%	95.2%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Year Tobacco Use	40.5%	26.0%	52.9%	63.1%	73.1%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Month Tobacco Use	23.1%	11.4%	25.0%	40.1%	54.6%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
<b>Alcohol Use</b>						
Lifetime Alcohol Use	93.2%	89.4%	98.5%	99.5%	99.6%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Year Alcohol Use	76.7%	65.2%	92.5%	96.1%	96.8%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1

	Overall (n = 2,534)	CBD/Marijuana Use Group				Group Differences
		Group 1	Group 2	Group 3	Group 4	
		Current Non-use (n=1591)	Current CBD-only use (n=68)	Current Marijuana-only use (n=613)	Current CBD+Marijuana co-use (n=249)	
	<i>M (SD) %</i>	<i>M (SD) %</i>	<i>Mean (SD) %</i>	<i>M (SD) %</i>	<i>Mean (SD) %</i>	Unadjusted group comparisons significant at <i>p</i> < .05
Past-Month Alcohol Use	64.2%	82.4%	87.3%	91.2%	91.2%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Month Heavy Drinking	36.8%	38.2%	60.2%	69.1%	69.1%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
<b>Other Substance Use</b>						
Lifetime Other Drug Use <sup>c</sup>	53.2%	56.7%	73.7%	83.5%	83.5%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Year Other Drug Use <sup>c</sup>	21.0%	22.1%	39.3%	56.1%	56.1%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
Past-Month Other Drug Use <sup>c</sup>	8.3%	1.5%	16.8%	27.3%	27.3%	Group 3 > Group 1; Group 4 > Group 1
<b>Demographics</b>						
Age <sup>d</sup>	22.6 (0.8)	22.7 (0.7)	22.5 (0.8)	22.5 (0.8)	22.5 (0.8)	<i>n/s</i>
Gender						
% Male	44.6%	22.1%	49.4%	44.2%	44.2%	Group 2 < Group 1; Group 3 > Group 1
% Female	54.2%	75.0%	49.3%	53.8%	53.8%	Group 2 > Group 1; Group 3 < Group 1
% Other	1.2%	2.9%	1.3%	2.0%	2.0%	<i>n/s</i>
Sexual orientation <sup>e</sup> : % Heterosexual/straight	83.6%	70.2%	80.4%	70.9%	70.9%	Group 2 < Group 1; Group 3 < Group 1; Group 4 < Group 1
Race/Ethnicity						
% Non-Hispanic White	23.1%	30.9%	26.1%	37.4%	37.4%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1
% Hispanic	46.8%	50.0%	48.5%	40.2%	40.2%	Group 4 < Group 1;

	CBD/Marijuana Use Group				Group Differences
	Group 1	Group 2	Group 3	Group 4	
Overall (n = 2,534)	Current Non-use (n=1591)	Current CBD-only use (n=68)	Current Marijuana-only use (n=613)	Current CBD+Marijuana co-use (n=249)	Unadjusted group comparisons significant at <i>p</i> < .05
<i>M (SD) %</i>	<i>M (SD) %</i>	<i>Mean (SD) %</i>	<i>M (SD) %</i>	<i>Mean (SD) %</i>	
% Asian	27.5%	13.2%	17.8%	13.7%	Group 2 < Group 1; Group 3 < Group 1; Group 4 < Group 1
% Other	6.1%	5.9%	7.7%	8.8%	<i>n/s</i>
Education: % College degree or higher	44.6%	44.1%	38.0%	38.6%	Group 3 < Group 1
Currently employed	73.2%	69.1%	75.4%	76.4%	<i>n/s</i>
Mother's education: % College degree or higher	53.2%	51.5%	53.3%	58.5%	<i>n/s</i>
Only Speak English at Home	40.6%	60.0%	50.4%	56.8%	Group 2 > Group 1; Group 3 > Group 1; Group 4 > Group 1

Note. Group differences for each variable or level (for multi-level categorical variables) were assessed using pairwise comparisons from bivariate ANOVA (for continuous variables) and logistic regression (for categorical variables) models. Directions of group differences that were significant at *p* < .05 are shown. *n/s* = indicates that no group comparisons were significant at *p* < .05. We selected this approach over, for example, multinomial logit models (e.g., specifying CBD/Marijuana group as the dependent variable) because the purpose was to compare defined groups on individual characteristics, rather than to predict group membership or product “choice.”

<sup>a</sup> Overall physical health scored 1 (poor) to 5 (excellent).

<sup>b</sup> Physical ailments summary score ranged 0 to 4, with higher scores reflecting more ailments.

<sup>c</sup> Other drug use includes the following: cocaine, heroin, hallucinogens, methamphetamine, prescription drug misuse, inhalant use, or any other illicit drug use.

<sup>d</sup> Age range 18–26, 98% ages 21–24.

<sup>e</sup> Sexual orientation was examined as a binary variable (heterosexual/straight vs. other); other category includes individuals who identified as gay, lesbian, bisexual, questioning, or asexual.

<sup>f</sup> Employment status was examined as a binary variable (currently employed vs. not employed); currently employed category includes those individuals who reported currently working at a paid full-time or part-time job.

Adjusted comparisons of indicators heavy and/or problem marijuana use across Marijuana-only and CBD+Marijuana co-use groups

**Table 3.**

	Marijuana-only use (n=613)	CBD+Marijuana co-use (n=249)	Group difference
<b>Amount of consumption</b>	M (SD)/%	M(SD)/%	p-value
Frequency of past-month marijuana use	11.1 (11.0)	14.0 (11.6)	<b>0.0009</b>
Heaviness of daily marijuana use (# times used per day)	2.5 (3.3)	3.3 (6.9)	<b>0.04</b>
<b>Poly-marijuana product use</b>			
Number of marijuana products used	2.7 (1.7)	3.6 (2.2)	< <b>0.0001</b>
<b>Indicators of Problem Use</b>			
CUD (CUDIT Score)	1.3 (2.4)	1.6 (2.6)	0.07
Solitary marijuana use	69.8%	76.7%	< <b>0.05</b>
<b>Marijuana use-related consequences</b>			
Number of negative consequences endorsed	16.3 (8.8)	17.0 (9.8)	0.40

Note. Group differences for *Frequency of past-month marijuana use*, *Heaviness of daily marijuana use*, *CUDIT score*, and *Number of negative consequences* were assessed using separate ordinary least squares regression models; group differences in poly-marijuana use (# products/methods used) were assessed using Poisson regression; group differences in solitary marijuana use were assessed using logistic regression. Models controlled for age, gender, race/ethnicity, mother's education, and CHOICE intervention group at Wave 1.

**Table 4:**

Adjusted associations between frequency of CBD use and indicators of heavy and/or problem marijuana use in the CBD + Marijuana co-use group.

	Dependent variable				
	Amount of consumption Number of times used per day) (B [95% CI], <i>p</i> )	Poly-marijuana product use Number of types of marijuana products used (IRR [95% CI], <i>p</i> )	Indicators of Problem Use		Marijuana Use-related Consequences Number of negative consequences endorsed (B [95% CI], <i>p</i> )
			Solitary marijuana use (AOR [95% CI], <i>p</i> )	CUDIT score (B [95% CI], <i>p</i> )	
<b>Frequency of past-month CBD use (independent variable)<sup>a</sup></b>	<b>0.14 (0.05, 0.23), p = 0.0023</b>	0.001 (-0.01, 0.01), p = 0.76	0.94 (0.89, 1.00), p = 0.06	0.0009 (-0.04, 0.04), p = 0.97	-0.15 (-0.31, 0.02), p = 0.09

Note. Values are estimates of associations between number of CBD use days in the past month (independent variable) and dependent variables among individuals in the *CBD + Marijuana* co-use group.

<sup>a</sup>Models controlled for age, race/ethnicity, gender, mother's education, CHOICE intervention group at wave 1, and frequency of past-month marijuana use. B = unstandardized effect estimate from ordinary least squares regression model; IRR = interval rate ratio from Poisson regression model; AOR = adjusted odds ratio from logistic regression model.