



## Experience of migraine, its severity, and perceived efficacy of treatments among cannabis users

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### ABSTRACT

**Objectives:** As the legal and cultural landscape surrounding cannabis use in the United States continues to evolve, more Americans are turning to cannabis to self-medicate a number of ailments, including migraines. The purpose of the present study was to examine patterns of cannabis use and its associated relief among migraineurs.

**Design:** Participants were  $N = 589$  adult cannabis users living in states with full legal access. Using a cross-sectional design, participants completed an online survey assessing their cannabis use profiles, migraine experience, and self-reported relief from cannabis and non-cannabis treatments.

**Results:** 161 participants (27.3 %) reported experiencing migraines. 76.4 % of migraineurs ( $N = 123$ ) endorsed using cannabis to treat their migraines. 69.9 % ( $N = 86$ ) of migraineurs using cannabis for migraine relief also endorsed using non-cannabis products (e.g., over-the-counter pain medication, triptans) to treat their migraines. Although their subjective health was similar ( $p = .17$ ), migraineurs who endorsed using cannabis to treat their migraines reported more severe migraines compared to those who did not ( $p = .02$ ). Migraineurs reported significantly more migraine relief from cannabis compared to non-cannabis products, even after controlling for migraine severity ( $p = .03$ ). The majority of migraineurs using cannabis to treat their migraines were *not* medical cardholders (65.0 %), suggesting that these individuals were self-medicating in lieu of physician guidance.

**Conclusions:** The present study provides insight into the prevalence of cannabis use for migraine relief in a sample of cannabis users, and suggests that these migraineurs experience a high level of migraine relief from cannabis. Future studies are needed to determine the cannabis forms, potencies, and dosages that are most effective at treating migraine pain.

### 1. Background

As the legality and use of cannabis in the United States increases,<sup>1,2</sup> a larger number of Americans are turning to cannabis to self-medicate for a number of ailments, including migraines.<sup>3</sup> Globally, migraines are the second leading cause of disability in individuals under the age of 50.<sup>4</sup> In the U.S., approximately 15 % of adult women and 6 % of adult men report experiencing migraines and severe headaches.<sup>5</sup> Both chronic and episodic migraines pose a major public health concern when left untreated by negatively impacting physical health, quality of life, interpersonal relationships, productivity, and financial security.<sup>6</sup>

Unfortunately, a number of acute and prophylactic migraine medications (both first- and second-line treatments) are not effective for all migraineurs.<sup>7</sup> Even triptans, one of the two medication classes developed specifically for the treatment of acute migraine headache, display

limited efficacy.<sup>8</sup> Research suggests that 25 % of triptan users do not respond to the medication, and of those who do, only one-third remain pain-free two hours after triptan use.<sup>9,10</sup> Ergot alkaloids, the only other migraine-specific medication class<sup>11</sup> also display limited efficacy. Furthermore, some migraine medications confer an unfavorable side-effect profile, resulting in poor compliance and, consequently, limited efficacy.<sup>8,12</sup> As such, the therapeutic benefit of alternative migraine treatment options, including cannabis, warrants further exploration.

Cannabis is becoming an “off-label” or “last resort” treatment for migraineurs,<sup>13,14</sup> due in part to the limited tolerability and efficacy of existing migraine medications. Considerable evidence demonstrates that cannabis and its constituent cannabinoids, including psychoactive 9-delta-tetrahydrocannabinol (THC) and non-psychoactive cannabidiol (CBD), is an effective chronic pain treatment.<sup>15</sup> In addition, emerging

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evidence from preclinical studies suggests that endocannabinoids modulate migraine-associated pain pathways,<sup>7,16–18</sup> and an endocannabinoid deficiency is theorized to contribute to the pathophysiology of migraine.<sup>7,19–24</sup>

Existing survey studies of medical cannabis patients suggest that 2.7%–9% of patients are using cannabis primarily for headache and migraine relief.<sup>7,25,26</sup> However, it is important to note that cannabis is widely available for purchase without consulting a clinician in states with legal access, despite a dearth of empirical patient data and unpredictable results.<sup>3</sup> In fact, survey data suggests that cannabis is often used alongside, or in lieu of, migraine medication, often without physician approval.<sup>8,27</sup> For instance, a recent survey study found that 36% of recreational cannabis users treat headaches and migraines with cannabis.<sup>28</sup> As such, more research is needed to understand associations between cannabis use and subsequent relief patterns of migraine sufferers living in states with full legal access.

Although limited, the extant literature suggests that cannabis is a promising treatment option for individuals suffering from headache disorders. One study found that 85% of individuals using medically prescribed cannabis to treat migraines reported a decrease in migraine frequency.<sup>29</sup> Negative effects, notably somnolence and difficulty controlling drug effects, were reported in 11.6% of participants, and were experienced only after the use of edible, rather than inhaled, cannabis.<sup>29</sup> A qualitative study of online migraine forums found that migraineurs frequently discussed cannabis as an effective acute and prophylactic migraine treatment, noting its ability to alleviate migraine symptoms and reduce the frequency of migraine attacks.<sup>3</sup> Interestingly, the same study also discussed the potential for higher doses of cannabis to trigger or exacerbate, rather than alleviate, migraine symptoms. Using archival data from a medical cannabis mobile application, Cuttler, Spradlin, Cleveland, and Craft<sup>30</sup> found that medical cannabis patients experience significant reductions in headache and migraine severity ratings after cannabis use. While Cuttler et al.<sup>30</sup> did not find an effect of cannabinoid content on migraine pain, one study indicated that particular strains may be more efficacious in reducing migraine symptom severity, noting that strains high in THC and low in CBD may be beneficial due to the analgesic, anti-inflammatory, and anti-emetic properties of THC.<sup>8</sup>

To date, no placebo-controlled clinical trials have investigated the effectiveness of cannabis for alleviating migraine or headache-associated pain. However, a small 8-week randomized controlled trial (RCT) found that migraineurs taking 0.5 mg of nabilone (a synthetic cannabinoid) daily reported greater reductions in migraine pain intensity and daily analgesic intake compared to migraineurs taking 400 mg of ibuprofen daily.<sup>31</sup> Importantly, side effects of nabilone were uncommon and mild, and self-reported quality of life improved after treatment with nabilone but not ibuprofen.<sup>31</sup> Another 3-month prospective study found that migraineurs taking 200 mg of THC + CBD per day experienced a greater improvement in migraine symptoms compared to migraineurs taking 25 mg of the tricyclic antidepressant amitriptyline.<sup>32</sup>

To summarize, migraine sufferers in states with full legal access are potentially using many forms of cannabis ostensibly to treat their migraines without physician approval or guidance. Consequently, it is imperative to understand their patterns of cannabis use and its associated relief as compared to non-cannabis products. Using data gathered from an online survey advertised to cannabis users in states with legal recreational cannabis, the present study begins to address existing gaps in the empirical literature. It is hypothesized that cannabis users, both medical and recreational, who experience migraines will report using cannabis to treat their migraine headaches. Furthermore, it is hypothesized that migraineurs using both cannabis and non-cannabis products to treat their migraines will report more relief from cannabis products. Lastly, it is hypothesized that relief from both cannabis and non-cannabis products will be positively related to subjective health, such that those experiencing greater migraine relief will report better subjective health. In addition, exploratory analyses will be conducted to

further characterize the correlates among migraine relief, migraine severity, and cannabis use patterns.

## 2. Method

### 2.1. Procedure

A voluntary, anonymous survey was shared online to measure cannabis use and health profiles, including migraine experience, in individuals aged 21 and older living in states with legal recreational cannabis. The survey was hosted on Qualtrics (<https://oit.colorado.edu/qualtrics>) and required electronic informed consent. Participants were eligible for inclusion in the present study if they (1) reported residing in a state with legal recreational cannabis, (2) endorsed using cannabis for medical and/or recreational purposes, and (3) responded to the migraine experience question (details below). Data collection occurred from January 2017 to August 2019. Additional procedure details are described in recent publications.<sup>33</sup> The majority of respondents were recruited from Facebook and Instagram (67%) through advertisements targeting individuals aged 21–70 residing in California, Colorado, Nevada, Oregon, and Washington, who “liked” pages related to cannabis use (e.g. cannabis dispensaries, pain clinics, Cannabis Culture Magazine, etc.). In Colorado, participants were also recruited through advertisements at dispensaries (11%) and an integrative care medical clinic (22%) in the Boulder-Denver area. There were no differences in the distribution of recruitment sources for the subgroup of respondents with and without migraines. All procedures were reviewed and approved by the institutional review board of University of Colorado Boulder.

### 2.2. Measures

**Demographics.** To assess broad correlates of migraine, respondents were asked demographic questions, including their age, gender, race, ethnicity, education, and employment.

**Migraine Experience.** To determine migraine experience, respondents were asked, “do you experience migraines?”. Respondents who answered “yes” to this question were categorized as migraineurs while respondents who answered “no” were categorized as non-migraineurs.

**Migraine Severity.** Migraine severity was assessed with an adapted version of the Brief Pain Inventory.<sup>34</sup> Participants responded to seven items asking them to indicate how often migraines had interfered with their “general activity”, “mood”, “walking ability”, “work outside the home and housework”, “relations with other people”, “sleep”, and “enjoyment of life” in the past week. Responses to each of these seven items were rated by participants on a 5-point Likert-type scale ranging from 0 (*Never*) to 4 (*Always*). The mean response for these seven items was calculated to create a measure of migraine severity, with a higher score indicating more severe migraines ( $\alpha = .96$ ).

**Cannabis Use as Migraine Treatment.** Whether participants’ used cannabis to treat their migraines was assessed with a single dichotomous (Yes/No) question: “Do you use cannabis to treat or mitigate your migraine symptoms?”

**Relief from Cannabis Products.** Migraineurs who indicated that they used cannabis to treat their migraines were asked to report their average migraine relief from cannabis products. Migraineurs responded to the question, “How much relief do cannabis or hemp products usually provide for your migraines?” on a 10-point scale ranging from 0 to 100% relief.

**Relief from Non-Cannabis Products.** All migraineurs were also asked to report how much relief they typically experience when using non-cannabis treatments (e.g., over-the-counter pain medication, triptans) by responding to the question, “How much relief do non-cannabis treatments or medications usually provide for your migraines?” on a 10-point scale ranging from 0 to 100% relief.

**Subjective health.** Perceptions of current health-status were assessed with an adapted version of the PROMIS-10.<sup>35</sup> Participants responded to

seven items asking them to rate several aspects of their overall health, including quality of life, social well-being, physical and mental health. Responses to each of these seven items were rated by participants on a 6-point Likert-type scale ranging from 0 (*Poor*) to 5 (*Excellent*). The mean response for these seven items was calculated to create a measure of subjective health status, with a higher score indicating better subjective health ( $\alpha = .88$ ).

### 2.2.1. Cannabis use patterns

**Cannabis Administration.** Participants were asked about their use of different forms of cannabis administration (e.g., smoking/vaporizing dry cannabis flower, using higher strength concentrates, consuming edibles, and using topicals).

**Monthly Use.** For each form of cannabis administration that was endorsed, participants were asked to indicate how many times per month they consumed cannabis in that manner (e.g., "On average, how often do you consume cannabis edibles?"). Responses to this question were rated by participants on a 12-point Likert-type scale ranging from 0 (*Do not currently use*) to 11 (*Daily*).

**Frequency of Use on Cannabis Use Days.** For each form of cannabis administration that was endorsed, participants were asked to indicate how many times per day they consumed cannabis in that manner (e.g., "On days that you smoke or vaporize cannabis flower, how many times per day do you use on average?"). Responses to this question were rated by participants on a 20-point Likert-type scale ranging from 1 (*One time per day*) to 20 (*More than 20 times per day*).

**Cannabinoid Potency.** For each form of cannabis endorsed, participants were asked to estimate the concentration of THC and CBD present in the form of product they used most often. The range and unit of response choices differed based on product form. Although a self-report metric, detailed responses are possible in our sample due to regulations in all represented states that require cannabinoid content (as determined through state licensed testing laboratories) be displayed on all legal market products. Similar self-reports amongst cannabis users who are aware of the THC/CBD potency of the cannabis they use show consistency across different time points and methods.<sup>36</sup>

**Cannabis Use Disorder Symptoms.** Cannabis Use Disorder symptoms were assessed using the 11-item Marijuana Dependence Scale (MDS).<sup>37</sup> The MDS is a self-report measure developed based on dependence criteria found in the Diagnostic and Statistical Manual of Mental Disorders (DSM) and is widely used to assess cannabis dependency in a variety of populations, including adolescents and adults.

Participants also answered questions on general cannabis use characteristics, including medical cannabis patient status and age at first cannabis use.

### 2.3. Planned analyses

All analyses were conducted in Rstudio version 3.6.1 ([www.rstudio.com](http://www.rstudio.com)). To compare migraineurs (M) to non-migraineurs (NM) on continuous outcomes of interest, we ran independent samples *t*-tests. To compare these groups on categorical outcomes of interest (e.g., medical cannabis patient status), we ran logistic regressions with migraine status as the independent variable (migraineur = -1, non-migraineur = +1). When comparing non-migraineurs (NM), migraineurs who use cannabis to treat their migraines (M+CT), and migraineurs who do not use cannabis to treat their migraines (M-CT) on outcomes of interest, we ran one-way ANOVAs and conducted post-hoc Tukey Tests to determine group differences. Analyses with two or more continuous predictors and continuous criterion variables (e.g., difference between relief obtained from cannabis versus non-cannabis medications) were conducted using linear regression. All analyses implemented listwise deletion of missing data.

## 3. Results

### 3.1. Sample characteristics

Of the 620 participants that completed the survey, 589 participants endorsed using cannabis and answered the migraine experience question, and were thus included in the present study. 161 participants reported that they experienced migraines (migraineurs, M), while 428 reported that they did not (non-migraineurs, NM). More women ( $N = 97$ ) than men ( $N = 64$ ) reported experiencing migraines. On average, women reported more severe migraines than men,  $t(158) = 2.02, p = .05$ . Migraine severity was negatively associated with subjective health,  $r(157) = -.33, p = .02$ .

The majority of migraineurs (76.40 %;  $N = 123$ ) reported using cannabis to treat their migraines. Of these participants, 69.92 % ( $N = 86$ ) also reported using non-cannabis products to treat their migraines, while the other 30.08 % ( $N = 37$ ) reported using only cannabis products to treat their migraines.

Approximately one quarter of migraineurs (23.60 %;  $N = 38$ ) did not report using cannabis to treat their migraines. The majority of these participants (78.95 %;  $N = 30$ ) reported using non-cannabis products to treat their migraines, while the remaining 21.05 % ( $N = 8$ ) did not. Despite not currently using cannabis as a migraine treatment, 34.21 % ( $N = 13$ ) of these 38 participants indicated that they would be interested in trying it (see Fig. 1).

Table 1 compares non-migraineurs (NM), migraineurs who do not use cannabis to treat their migraines (M-CT), and migraineurs who do use cannabis to treat their migraines (M+CT) on relevant demographics and subjective health. There were few significant demographic differences between the groups. However, there were more men than women in the NM group compared to the M+CT and M-CT groups, and those in the NM and M+CT groups were more likely to be medical cannabis holders compared to those in the M-CT group. Furthermore, although subjective health was similar across the three groups, those in the M+CT group reported more severe migraines compared to those in the M-CT group.

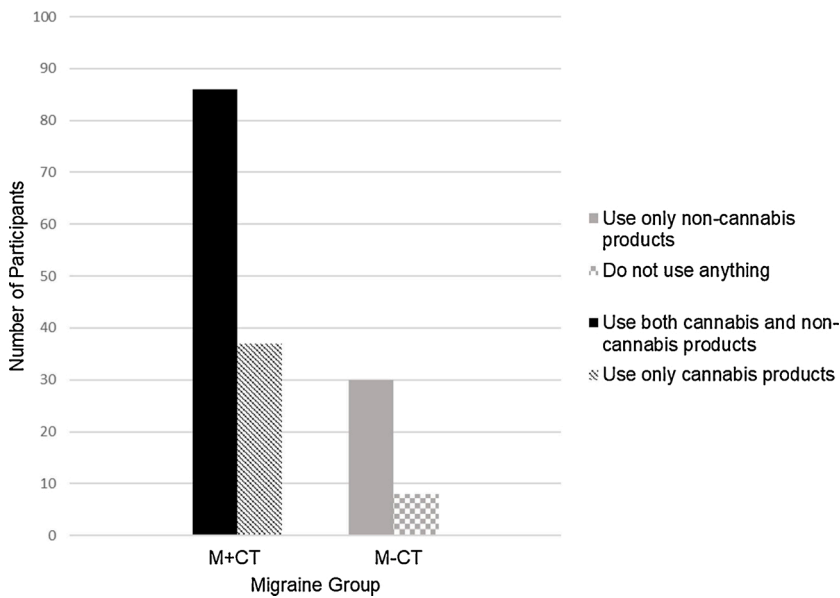
Table 2 compares the groups on cannabis use patterns. On average, 88.57 % of participants endorsed using cannabis recreationally; this proportion did not differ significantly between the NM, M-CT, and M+CT groups. Those in the NM and M+CT group started using cannabis at an earlier age compared to those in the M-CT group. In addition, those in the M+CT group used cannabis flower and concentrates more per month than those in the NM and M-CT group. Compared to the NM group, the M+CT group used edibles more frequently. Groups did not differ in regards to cannabis dependence, and cannabis use disorder symptoms were mild across the board.

### 3.2. Migraine relief

Among migraineurs, the average reported relief from cannabis products was 75.82 % ( $SD = 20.76$ ) and the average reported relief from non-cannabis products was 51.01 % ( $SD = 29.09$ ). In order to compare relief experienced from cannabis versus non-cannabis products, a difference score (relief from cannabis minus relief from non-cannabis) was computed for migraineurs who used *both* types of products to treat their migraines ( $N = 86$ ). Regressing this difference score on the intercept showed that cannabis products led to significantly more relief than non-cannabis products among users who relied on both cannabis and non-cannabis products,  $b = 28.19, F(1, 82) = 64.38, p < .001$ . After controlling for migraine severity, cannabis products still led to significantly more relief than non-cannabis products,  $b = 17.96, F(1, 81) = 4.64, p = .03$ .

### 3.3. Associations between migraine severity and use patterns

Migraine severity was negatively associated with relief from non-



**Fig. 1.** Number of participants using cannabis products, non-cannabis products, both cannabis and non-cannabis products, and no products to treat their migraines. Among the 123 migraineurs who endorsed using cannabis to treat their migraines (M+CT), 86 (69.92 %) reported using both cannabis and non-cannabis products to treat their migraines while 37 (30.08 %) reported only using cannabis products. Among the 38 migraineurs who did not endorse using cannabis to treat their migraines (M-CT), 30 (78.95 %) reported using only non-cannabis products while 8 (21.05 %) reported that they did not use any medication to treat their migraines.

**Table 1**  
Sample demographics and baseline characteristics of non-migraineurs (NM), migraineurs who use cannabis to treat their migraines (M+CT), and migraineurs who do not use cannabis to treat their migraines (M-CT).

	NM	M+CT	M-CT
N	428	123	38
Gender (% male)	61.21 % <sup>a</sup>	37.40 % <sup>b</sup>	47.37 % <sup>b</sup>
Race (% Caucasian)	75.23 % <sup>a</sup>	77.24 % <sup>a,b</sup>	89.47 % <sup>b</sup>
Age	37.1 (16.76) <sup>a</sup>	32.31 (11.69) <sup>b</sup>	35.92 (16.23) <sup>a,b</sup>
Employment (% full time)	47.66 % <sup>a</sup>	56.91 % <sup>a</sup>	42.11 % <sup>a</sup>
Marital Status (% married or in a relationship)	51.64 % <sup>a</sup>	56.91 % <sup>a</sup>	65.79 % <sup>a</sup>
Education (% bachelors or higher)	39.25 % <sup>a</sup>	28.46 % <sup>a</sup>	47.37 % <sup>a</sup>
Alcohol use (% using)	58.89 % <sup>a</sup>	65.79 % <sup>a</sup>	52.85 % <sup>a</sup>
Cigarette use (% using)	17.99 % <sup>a</sup>	22.76 % <sup>a</sup>	26.67 % <sup>a</sup>
Opiate use (% using)	7.01 % <sup>a</sup>	10.81 % <sup>a</sup>	18.75 % <sup>a</sup>
Subjective Health	3.71 (.85) <sup>a</sup>	3.57 (.81) <sup>a</sup>	3.53 (.79) <sup>a</sup>
Migraine Severity	N/A	2.44 (1.17) <sup>a</sup>	1.91 (1.11) <sup>b</sup>

NM = non-migraineurs, M+CT = migraineurs who use cannabis to treat their migraines, M-CT = migraineurs who do not use cannabis to treat their migraines. Means and proportions with different superscripts are significantly different from one another,  $p < .05$ .

cannabis products ( $r(107) = -.22, p = .02$ ) and unrelated to relief from cannabis products ( $r(119) = -.14, p = .13$ ), such that participants endorsing more migraine symptoms experienced less relief from non-cannabis products.

Among all migraineurs (M+CT and M-CT), migraine severity was positively associated with daily topical use ( $r(119) = .52, p < .001$ ), such that participants endorsing more migraine symptoms reported using topicals more frequently throughout the day. Migraine severity was marginally associated with topical potency, both in terms of CBD ( $r(60) = .211, p = .11$ ) and THC ( $r(61) = .22, p = .08$ ), suggesting that participants with more severe migraines were using higher strength topical cannabis products. Additionally, migraine severity was positively associated with flower CBD levels ( $r(142) = .25, p = .002$ ) and concentrate CBD levels ( $r(97) = .29, p = .004$ ), such that participants endorsing more migraine symptoms reported using cannabis flower and cannabis concentrate products with higher CBD levels.

**Table 2**  
Cannabis use characteristics, frequency of cannabis use, and potency of cannabis products used among non-migraineurs (NM), migraineurs who use cannabis to treat their migraines (M+CT), and migraineurs who do not use cannabis to treat their migraines (M-CT).

	NM	M+CT	M-CT
N	428	123	38
<i>General Characteristics</i>			
Endorse Recreational Cannabis Use	88.84 % <sup>a</sup>	92.86 % <sup>a</sup>	80.85 % <sup>a</sup>
Medical Marijuana Cardholders	31.76 % <sup>a</sup>	34.96 % <sup>a</sup>	10.53 % <sup>b</sup>
Cannabis Use Disorder	2.15 (.33) <sup>a</sup>	2.18 (.22) <sup>a</sup>	2.06 (.26) <sup>a</sup>
<i>Symptoms</i>			
Age at First Cannabis Use	21.39 (12.03) <sup>a,b</sup>	19.21 (8.65) <sup>a</sup>	24.73 (15.23) <sup>b</sup>
<i>Frequency of Use</i>			
Monthly Flower Use	8.48 (3.84) <sup>a</sup>	9.76 (2.68) <sup>b</sup>	5.5 (4.49) <sup>c</sup>
Freq. of Flower Use on Use Days	3.65 (2.43) <sup>a</sup>	4.04 (2.49) <sup>a</sup>	2.23 (1.54) <sup>b</sup>
Monthly Topical Use	1.52 (3.11) <sup>a</sup>	2.85 (3.95) <sup>b</sup>	1.61 (2.78) <sup>b</sup>
Freq. of Topical Use on Use Days	1.8 (.99) <sup>a</sup>	2.29 (1.22) <sup>a</sup>	1.67 (.87) <sup>a</sup>
Monthly Concentrate Use	4.23 (4.35) <sup>a</sup>	5.41 (4.67) <sup>b</sup>	1.68 (3.39) <sup>c</sup>
Freq. of Concentrate Use on Use Days	3.43 (2.55) <sup>a</sup>	4 (2.33) <sup>a</sup>	3.5 (1.85) <sup>a</sup>
<i>Days</i>			
Monthly Edible Use	2.78 (3.09) <sup>a</sup>	3.76 (3.52) <sup>b</sup>	2.74 (3.44) <sup>a,b</sup>
Freq. of Edible Use on Use Days	1.39 (.76) <sup>a</sup>	1.89 (1.93) <sup>b</sup>	1.42 (.84) <sup>a,b</sup>
<i>Potency of Products Used</i>			
Flower THC %	21.34 (6.23) <sup>a</sup>	22.55 (5.92) <sup>a</sup>	22.41 (5.78) <sup>a</sup>
Flower CBD %	9.83 (9.53) <sup>a</sup>	9.49 (9.4) <sup>a</sup>	12.24 (10.3) <sup>a</sup>
Topical THC (mg)	24.58 (40.27) <sup>a</sup>	24.43 (29.15) <sup>a</sup>	6.5 (2.42) <sup>a</sup>
Topical CBD (mg)	9.83 (9.53) <sup>a</sup>	9.49 (9.4) <sup>a</sup>	12.24 (10.3) <sup>a</sup>
Concentrate THC %	69.54 (23) <sup>a</sup>	72.64 (23.19) <sup>a</sup>	59.18 (22.18) <sup>a</sup>
Concentrate CBD %	33.06 (26.96) <sup>a</sup>	33.3 (28.42) <sup>a</sup>	29.73 (25.86) <sup>a</sup>
Edible THC (mg)	46.19 (50.49) <sup>a</sup>	52.32 (58.15) <sup>a</sup>	33.26 (49.17) <sup>a</sup>
Edible CBD (mg)	19.44 (30.91) <sup>a</sup>	27.87 (43.37) <sup>a</sup>	16.36 (21.94) <sup>a</sup>

NM = non-migraineurs, M+CT = migraineurs who use cannabis to treat their migraines, M-CT = migraineurs who do not use cannabis to treat their migraines, Cannabis Use Disorder measured by the Marijuana Dependence Scale. Means and proportions with different superscripts are significantly different from one another,  $p < .05$ .

#### 4. Discussion

This study provides insight into the prevalence of cannabis use for migraine relief in a sample of cannabis users, and suggests that these migraineurs report a high level of migraine relief from cannabis. One-quarter of all survey participants (27.30 %) reported suffering from migraines, and three-quarters of migraine sufferers (76.40 %) reported using cannabis to alleviate their symptoms. Among migraineurs who relied on both cannabis and non-cannabis products, cannabis products led to significantly more migraine relief (90 % relief) than non-cannabis products (60 % relief), a finding that, to our knowledge, has not been reported previously.

Interestingly, 27.30 % of individuals reported migraines in our convenience sample of cannabis users, which is over 2 times the national average for migraines.<sup>5</sup> Our data raise the possibility that migraine sufferers are overrepresented among cannabis users. It is possible that migraineurs preferentially seek to treat their migraines with cannabis. Given the cross-sectional and correlational nature of the data, it is of course equally plausible that cannabis is associated with an increase in migraine occurrences. However, given that all migraineurs in our sample used cannabis recreationally—regardless of whether or not they reported using cannabis as a migraine treatment—the latter explanation seems less likely.

Notably, migraineurs who reported using cannabis to treat their migraines reported more severe migraines compared to those who did not. In addition, migraine severity was associated with frequency of topical use, as well as flower, concentrate, and topical potency. Migraines are often difficult to treat, and even the best treatments do not come close to eliminating migraines.<sup>8,38</sup> A number of migraine patients are refractory to conventional treatments (e.g., NSAIDs, tricyclic anti-depressants, and triptans), and as such, individuals with more severe, treatment-resistant migraines may be more likely to turn to alternative or complementary treatment strategies such as cannabis use. The finding that migraineurs using both cannabis and non-cannabis products to treat their migraines reported more relief from cannabis products lends credence to this explanation.

The finding regarding frequency of topical use and migraine severity is particularly interesting, as no studies have examined the effects of topicals on migraine relief and the broader literature on topical cannabinoids and pain relief is limited. While topical cannabinoids have led to analgesia in animal models of inflammatory and neuropathic pain,<sup>39–41</sup> clinical evidence is scarce. Furthermore, as topical cannabinoids are hydrophilic, they are not easily absorbed into the bloodstream due to low skin penetration.<sup>39</sup> Thus, while our results suggest that participants may be self-medicating their migraines with topical cannabis, it is unclear whether there is any biological mechanism by which localized administration of topical cannabis would directly mitigate migraine pain.

Not all participants using cannabis to treat migraines were medical cardholders. While migraines and headaches have been cited as a common reason for utilizing medical cannabis,<sup>7</sup> our findings suggest that some individuals who use cannabis for self-medication do not apply for a medical card, demonstrating the overlap between recreational and medical users, and replicating previous reports in other populations.<sup>28</sup> Our use of a more inclusive sample could account for the high proportion of migraine sufferers using cannabis to treat their symptoms in our data, as previous studies have mostly relied on samples of users with medical cannabis cards.<sup>7</sup>

The present study is not without limitations. Migraine experience was assessed with one yes-no question asking participants to self-report whether they experienced migraines, rather than classifying participants based on International Classification of Headache Disorders (ICHD-3) criteria which allows for a more rigorous classification of headache disorder type (e.g., migraine without aura, migraine with aura, tension-type headache, cluster headache).<sup>42</sup> Despite this limitation, it is important to note that studies have found agreement between

self-reported migraine and migraine classification based on ICHD criteria.<sup>43,44</sup> Future studies should employ a more detailed questionnaire assessing migraine characteristics, including physician diagnosis of migraine and details of migraine attacks (e.g., frequency and duration of migraine attacks, pain severity, pulsating quality, photophobia, phonophobia, nausea and/or vomiting).

In addition, although participants were asked whether they used cannabis to treat their migraines, the specific forms and cannabinoid content of the cannabis products they are using for this explicit purpose are unclear. The majority of migraineurs also reported using cannabis recreationally, and therefore, the products they endorsed using may not be used solely for migraine relief purposes. Prospective, placebo-controlled studies are needed to determine the cannabis forms, potencies, and dosages that are most effective at treating migraine pain, both acutely and prophylactically. Furthermore, future studies should examine *why* migraineurs are using cannabis to treat their migraines, as it is possible that migraineurs are turning to cannabis as a “last resort” medication for treatment-resistant migraines.<sup>8,38</sup> Future studies should also investigate whether recreational cannabis use influences migraine symptoms. Although participants in our study were able to self-report the THC/CBD potency of the products they use (due to testing and labeling requirements in States with legal cannabis access), future studies should validate this self-report measure by asking participants to upload a photograph of the THC/CBD potency labeled on the legal market products they are consuming.

Lastly, it is important to note the potential for recruitment bias in the present sample; these data came from a convenience sample of cannabis users, and thus may not generalize to the broader population. For instance, this sample likely excludes individuals who have tried cannabis in the past and experienced adverse effects. Future controlled studies are needed to experimentally determine whether a wide range of migraineurs experience relief from cannabis products.

#### 5. Conclusions

As the legal and cultural landscape surrounding cannabis use in the United States continues to evolve,<sup>1,2</sup> it is important to understand its therapeutic potential in the context of common ailments such as migraines. Our preliminary findings elucidate the experience of migraine and migraine severity in a large sample of cannabis users, provide evidence for the utility of cannabis for mitigating migraine-related pain, and present patterns of legal-market cannabis administration in users with and without migraines. As cannabis is widely available for purchase by consumers without requiring the consultation of a clinician, it is imperative to understand its potential in the context of self-medication, both in the context of migraines and beyond. Future placebo-controlled studies are needed to determine the cannabis forms, potencies, and dosages that are most effective at mitigating migraine symptoms.

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#### Ethics statement

This study was carried out in accordance with the recommendations of the University of Colorado Boulder’s Institutional Review Board. Informed consent was given by all participants in accordance with the Declaration of Helsinki and all procedures were approved by the University of Colorado Boulder’s Institutional Review Board.

#### CRediT authorship contribution statement

**Laurel P. Gibson:** Conceptualization, Formal analysis,

Visualization, Writing - original draft. **Leah N. Hitchcock**: Conceptualization, Methodology, Investigation, Writing - original draft. **Angela D. Bryan**: Conceptualization, Writing - review & editing. **L. Cinnamon Bidwell**: Conceptualization, Methodology, Investigation, Writing - review & editing.

## Declaration of Competing Interest

None.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ctim.2020.102619>.

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