Prevalence and correlates of sleep-related problems in adults receiving medical cannabis for chronic pain

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Abstract

Purpose—To examine the prevalence and correlates of sleep problems in a sample of medical cannabis patients.

Procedures—Adults ages 21 and older ($N = 801$, M age = 45.8) who were seeking medical cannabis certification (either for the first time or as a renewal) for chronic pain at medical cannabis clinics in southern Michigan completed baseline measures of cannabis use, sleep, pain, and other related constructs.

Findings—Over half of the sample (59%) met criteria for past 1-month sleep disturbance, defined as at least one sleep problem occurring on 15 or more nights in the past month. Most participants (86%) reported that sleep problems were due to their current pain. Approximately 80% of participants reported using cannabis in the past 6 months to improve sleep and, among these participants, cannabis was rated as helpful for improving sleep. Sleep-related cannabis side effects were rare (35%), but sleep-related cannabis withdrawal symptoms were relatively common (65%). Statistically significant correlates of past 1-month sleep disturbance included a) being female, b) being white, c) being on disability, d) not having a medical cannabis card, and e) frequency of using cannabis to help sleep.

Conclusions—Sleep problems are highly prevalent and frequent in medical cannabis patients and are closely tied to pain. Sleep-related cannabis withdrawal symptoms are relatively common

but their clinical relevance is unknown. The association between frequency of cannabis use to help sleep with higher odds of sleep problems will need to be clarified by longitudinal studies.

Keywords

medical cannabis; sleep; sleep disturbance; pain; correlates of sleep disturbance

1. Introduction

As of July 2017, twenty-nine US states and the District of Columbia have passed legislation legalizing cannabis for medicinal purposes (National Conference of State Legislatures, 2017). Epidemiological evidence has indicated that, among past-year cannabis users, about 10% reported using cannabis for medical reasons (Compton et al., 2017); among past-year cannabis users living in states where medical cannabis has been legalized, 17% reported using for medical reasons (Lin et al., 2016). The rapidly changing epidemiology of medical cannabis highlights the importance of research on the potential beneficial and adverse effects of cannabis use (Volkow et al., 2017). Although a long line of research has established associations between recreational cannabis use and adverse health outcomes (Wilkinson et al., 2016), the relationship between cannabis use and sleep appears to vary as a function of dose and timing of administration (Babson and Bonn-Miller, 2014; Conroy and Arnedt, 2014). Evidence indicated that cannabis has sedative and excitatory effects (Babson and Bonn-Miller, 2014), and cannabis withdrawal is associated with sleep disruptions (Bolla et al., 2010; Gates et al., 2016). One study showed that heavy (but not occasional) cannabis use was associated with sleep disturbance (Conroy et al., 2016).

Despite these potential adverse effects, emerging evidence indicated that cannabis is commonly sought as a sleep aid (Ferguson and Ware, 2015). For example, Bohnert et al. (under review) found that, among a sample of adult medical cannabis patients, sleep was the most highly endorsed motive for use on the Comprehensive Marijuana Motives Questionnaire (CMMQ). About 48% of participants recruited from a dispensary in California sought medical cannabis for insomnia (Bonn-Miller et al., 2014a), and a recent meta-analysis found low-quality evidence that medical cannabinoids were associated with better sleep outcomes (Whiting et al., 2015). Similarly, a recent report from the National Academies of Sciences concluded that there is "moderate" evidence to support that "cannabinoids…are an effective treatment to improve short-term sleep outcomes in individuals with sleep disturbance associated with obstructive sleep apnea syndrome, fibromyalgia, chronic pain, and multiple sclerosis" (NAS, 2017, p. 115). Some evidence from polysomnography (PSG) studies also showed that cannabis was associated with shorter sleep latency and increases in slow-wave sleep (Angarita et al., 2016).

These encouraging findings are tempered by concerns that chronic cannabis use could lead to increases in cannabis use disorders (Babson et al., 2017; Benbadis et al., 2014), exacerbation of sleep problems (Babson and Bon-Miller, 2014), and other adverse outcomes (D'Souza and Ranganathan, 2015). For example, using marijuana for sleep-related motives was correlated to greater frequency of use and marijuana-related problems among nonmedical cannabis users (Lee et al., 2009), and using cannabis to improve sleep was

associated with higher frequency of cannabis use among medical users with probable PTSD (Bonn-Miller et al., 2014b). There is also evidence that cannabis withdrawal has negative effects on self-reported and PSG measures of sleep (Angarita et al., 2016; Babson et al., 2017; Benbadis et al., 2014).

Although a growing body of evidence indicates strong bidirectional associations between substance use and sleep (Conroy and Arnedt, 2014; Arnedt et al., 2007), those who are seeking medical cannabis are an understudied and distinct group of individuals, and little is known about their sleep and patterns of cannabis use. In the state of Michigan, where the current research was conducted, the Michigan Medical Marihuana Act passed in 2008 legalized the use of cannabis for the treatment of debilitating medical conditions (e.g., cancer, glaucoma, severe or chronic pain). Qualifying patients or primary caregivers are required to obtain a registry identification card through a state registry program. As of January 2016, 182,091 patients and 34,269 caregivers have been approved for medical cannabis registry identification cards in Michigan (Gaedeke, 2016). In this research, we aimed to extend our knowledge about sleep-related problems among medical cannabis users with chronic pain. The two primary aims of this work were to 1) determine the prevalence of sleep-related problems and sleep-related cannabis use in medical cannabis users with chronic pain, and 2) identify the demographic and cannabis use correlates of sleep-related problems in medical cannabis users with chronic pain.

2. Methods

2.1. Participants

This paper is based on a larger project that is designed to identify patterns of cannabis use in medical cannabis patients with chronic pain in the state of Michigan. Adult patients (21 years old) attending a medical appointment for certification or recertification for a state medical cannabis card were eligible for screening. Patients were approached by trained research assistants (RAs) in clinic waiting areas. RAs provided a brief overview of the study and obtained written informed consent for screening. Consenting participants completed a 15 to 30-minute self-administered screening survey, and their responses were used to determine study eligibility. Inclusion criteria were: self-report of pain in the past month, of at least "usual pain" 5 or greater on a 0–10 numeric rating scale (NRS; Farrar et al., 2001), and self-reported chronic pain as a medical reason for seeking medical marijuana. Additional exclusion criteria were: seeking medical cannabis for Alzheimer's disease or cancer, and women who reported that they were pregnant. Of the 2,569 patients who presented to the study sites during the recruitment period, a total of 1,485 participants (58%) completed the screening survey. Of the 1,485 participants who completed the screening survey, a total of 801 participants (54%) met eligibility criteria, agreed to participate in the study, and completed the baseline questionnaire. Participants were financially compensated for completing the screening and baseline surveys. A previous report based on this project (Cranford et al., 2016) used data from the larger screening sample ($N = 1,485$). The current paper focuses on the baseline sample ($N = 801$) because that survey included expanded assessments related to sleep.

2.2. Measures

2.2.1. Demographics—included questions about sex, race/ethnicity, education (highest grade completed in school), current marital status, and current employment status, whether the participant was a first-time or returning patient (assessed with an item asking if the participant currently had a medical marijuana card), and reasons for seeking medical marijuana.

2.2.2. Sleep Disturbance in the Past Month—was assessed with the Jenkins Sleep Problems Questionnaire (Jenkins et al., 1988), which includes four items asking about frequency of a) trouble falling asleep; b) waking up several times per night; c) trouble staying asleep; and d) waking up feeling tired and worn out. A sample item is "How often in the past month did you wake up several times per night?" Response options for each item were: 0 = *Not at all*, 1 = *1–3 days*, 2 = *4–7 days*, 3 = *8–14 days*, 4 = *15–21 days*, 5 = *22–31 days*. Based on previous research (Lallukka et al., 2011), we classified participants who reported any of the four sleep problems occurring on 15 or more nights during the past 1 month as having a sleep disturbance.

2.2.3. Frequency of Past 6-Month Medical Cannabis—was assessed with the question "In the past 6 months, how often have you used marijuana for a medical reason?" Response options were: 0 = *I have not used marijuana for a medical reason in the past 6 months*, 1 = *Very seldom*, 2 = *Less then weekly*, 3 = *1–2 days/week*, 4 = *3–7 days/week*, 5 = *Several times a day*.

2.2.4. Average Quantity of Weekly Cannabis Use in the Past Month—was assessed with the question "During the past month, on average, how much marijuana (for medical or non-medical use) did you use per week?" Response options were: 0 = *None*, 1 = *Less than an eighth of an ounce*, 2 = *An eighth to slightly less than a quarter of an ounce*, 3 = *A quarter to slightly less than a half of an ounce*, 4 = *A half to slightly less than one ounce*, 5 = *One or more ounces*.

2.2.5. Duration of Cannabis Intoxication on an Average Day in the Past Month —was assessed with the question "During the past month, how many hours, on an average day, do you feel high or stoned?" Response options were: 1) *0 hours*, 2) *1–2 hours*, 3) *3–4 hours*, 4) *5–6 hours*, 5) *7–8 hours*, 6) *9 or more hours*.

2.2.6. Pain-Related Sleep Problems—were measured with items adapted from Hendler et al. (1979; also see Hendler et al., 1988). "These items ask about your current pain condition. Do you ever have trouble falling asleep or awaken from sleep?" Response options were: 0 = *No* and 1 = *Yes*. An affirmative response to this item led to two more questions: "How often do you have trouble falling asleep due to your pain?" Response options were 0 = *I do not have trouble falling asleep*, 1 = *I have trouble falling asleep which is not related to pain*, 2 = *Rarely*, 3 = *More than 3 times per week*, 4 = *Every night*, 5 = *Multiple times a night*. "How often do you awaken from sleep due to your pain?" This question had the same response options with the exceptions: 0 = *Never*, and 1 = *I have restless sleep or early morning awakenings with or without being able to return to sleep that are not related to pain*.

In addition, an item from the Back Pain Functional Scale (BPFS; Stratford et al., 2000) asked "Today, do you or would you have any difficulties at all with the following activities because of pain? Sleep." Response options were: 0 = *Unable to perform activity*, 1 = *Extreme difficulty*, 2 = *Quite a bit of difficulty*, 3 = *Moderate difficulty*, 4 = *A little bit of difficulty*, 5 = *No difficulty*.

2.2.7. Cannabis Use for Sleep Problems—Three items from the Comprehensive Marijuana Motives Questionnaire (CMMQ; Lee et al., 2009) asked about frequency of using cannabis in the past 6 months: 1) to help you sleep, 2) because it makes napping easier and more enjoyable, and 3) because you are having problems sleeping. Response options were: 1 = *Almost never/Never* to 5 = *Almost always/Always*. Also, as part of a longer assessment of cannabis use for symptom relief, participants were asked if they had used cannabis in the past 1 month "to improve your sleep." Those who responded affirmatively were then asked "during the past month, on average, how helpful was marijuana in improving your sleep?" Response options were: 0 = *Not at all* to 10 = *Very helpful*.

2.2.8. Sleep-Related Cannabis Side Effects—Participants were also asked if they had experienced a) insomnia or b) drowsiness during the past 6 months as a result of using cannabis or prescription pain medication.

2.2.9. Sleep-Related Cannabis Withdrawal Symptoms—were assessed with two items from the Marijuana Withdrawal Checklist (Budney et al., 1999) that asked about the experience and severity of a) sleep difficulty, and 2) strange dreams "the last time you went a significant time without using marijuana." Response options were: 0 = *None*, 1 = *Mild*, 2 = *Moderate*, 3 = *Severe*. Also, we included one item adapted from the Patient Health Questionnaire (PHQ-9; Kroenke and Spitzer, 2002) that asked "Over the last 2 weeks (when you have not been using marijuana), how often have you been bothered by trouble falling or staying asleep, or sleeping too much?" Response options were: 0 = *Not at all*, 1 = *Several days*, 2 = *More than half the days*, 3 = *Nearly every day*.

2.3. Statistical Analysis

To address our research questions, we calculated descriptive statistics and estimated the prevalence of past 1-month sleep disturbance. Correlates of sleep disturbance were tested with bivariate and multiple logistic regression analysis (Agresti, 2013). The multiple logistic regression analysis included eight covariates that were statistically significant correlates of sleep disturbance at the bivariate level. This analysis used listwise deletion of missing data and included $n = 701$ cases (87.5% of the cases with data on past 1-month sleep disturbance). The alpha level for all analyses was set at .05.

3. Results

3.1. Demographics and Cannabis Use Variables

As seen in Table 1, participants had a mean age of 45.8 years, were roughly evenly distributed by sex, and were mostly (86%) white. Most participants (66%) reported "at least some college" and 54% were married or in a long-term relationship, about 41% were

currently employed, and most (66%) were returning medical cannabis patients. Per our inclusion criteria, all participants reported seeking medical cannabis for "severe and chronic pain" with a usual past 1-month pain level of 7.1 on the NRS, and the other most frequently endorsed reason for seeking medical cannabis was for "severe and persistent muscle spasms" (29%). By comparison, the top two reasons for seeking medical cannabis in the state of Michigan during 2015 were "severe and chronic pain" (93%) and "severe and persistent muscle spasms" (23%) (Gaedeke, 2016). About 41% of participants reported medical cannabis use multiple times per day during the past 6 months, more than half indicated consuming ¼ ounce or more of cannabis during an average week, and about 50% of participants report feeling intoxicated for 3 hours or more on an average day in the past 1 month.

3.2. Prevalence of Past 1-Month Sleep Problems and Sleep Disturbance

Descriptive statistics for the individual sleep disturbance items are presented in Table 2. Results showed that the most frequent sleep problem was *waking up several times at night* (M = 3.0), followed by *having trouble staying asleep* (M = 2.6), *waking up feeling tired and worn out* (M = 2.6), and *having trouble falling asleep* (M = 2.4), $F(3, 2349) = 36.5$, $p < .05$. As shown in Table 2, it is notable that 30% of the sample reported *waking up several times at night* on at least 22 days during the previous month, and over half of the sample (59%) were classified as having past 1-month sleep disturbance. Results in Table 2 also show descriptive statistics for pain-related sleep variables. About 86% of participants reported ever having sleep problems due to their current pain; about the same proportion expected to have at least "moderate" difficulty sleeping today because of pain, and roughly 30% of participants indicated that their pain-related sleep problems occurred every night and/or multiple times per night.

3.3. Cannabis-Related Sleep Variables

Results in Table 2 indicated that, in this population of medical cannabis patients with chronic pain, sleep problems are relatively common and appear to be closely related to pain. In Table 3, we present descriptive statistics for the cannabis-related sleep variables. Consistent with the close relationship between pain and sleep problems, results showed that 80% of participants reported using cannabis in the past 1 month to improve sleep and, among these participants, cannabis was rated as relatively helpful for improving sleep. Similarly, results indicate about 80% of participants used cannabis to help sleep or because of sleep problems; by contrast, the use of cannabis to help with "napping" was reported by about 50% of participants. These results also show that cannabis-induced drowsiness was reported by about 35% of participants (cf. Whiting et al., 2015), but cannabis-induced insomnia was rare (~2%). By contrast, results in Table 3 indicate that sleep-related cannabis withdrawal symptoms were relatively common, with over 65% of participants reporting some form of sleep problem during the previous 2 weeks as a result of not using cannabis.

3.4. Correlates of Past 1-Month Sleep Disturbance

Table 4 includes the results from a series of bivariate and multiple logistic regression analyses of demographic and cannabis use correlates of past 1-month sleep disturbance. Results in Table 4 indicated that statistically significant demographic correlates of past 1-

month sleep disturbance at the bivariate level included a.) older age, b.) being female, c.) being white, d.) being divorced/separated/ widowed, and e.) being retired/unemployed or on disability (relative to being employed). Statistically significant pain and cannabis use correlates of past 1-month sleep disturbance at the bivariate level included a) severity of usual pain during the past 1-month, b) not having a medical cannabis card, c) using cannabis medically on a "seldom" basis (relative to no use), and d) greater frequency of using cannabis to help sleep. When all variables were tested simultaneously in the same model, statistically significant correlates of past 1-month sleep disturbance included a) being female, b) being white, c) being on disability (relative to being employed), d) not having a medical cannabis card, and e) greater frequency of using cannabis to help sleep.

4. Discussion

The purpose of this study was to examine the nature, prevalence, and correlates of sleep-related problems in a sample of adults who report medical cannabis use for chronic pain. Results support several conclusions. First, sleep problems were common in this sample, and more than half (59%) of participants were classified as having a significant sleep disturbance. By comparison, the prevalence of clinically significant insomnia in the US general population is about 20% (Roth et al., 2011). Although subsequent analyses focused on a binary sleep disturbance variable, results showed that "waking up several times a night" was the most frequently endorsed sleep problem. Similarly, previous work found that "difficulty maintaining sleep" was among the most common symptoms of insomnia, and may have the largest impact on perceived health at the population level (Walsh et al., 2011). Pain was a prominent feature of sleep problems, and a substantial proportion of participants (approximately 30%) reported sleep problems occurring every night or multiple times per night. These findings are consistent with a large literature indicating close connections between sleep disturbances and chronic pain (Ferguson and Ware, 2015), and also suggest that subgroups of medical cannabis patients might be identifiable based on sleep problems and pain severity (e.g., Palagini et al., 2016).

The majority of participants (63%) reported that they "often" or "almost always/always" used cannabis to help sleep during the past 6 months, and cannabis was rated as helpful for improving sleep. Despite this frequent use, side effects of cannabis use were rarely reported. Results are similar to those reported by Bonn-Miller et al. (2014a), who found that, while insomnia was a common reason for seeking medical cannabis, using cannabis for sleep/rest was not associated with cannabis use problems. Of greater concern is that sleep-related cannabis withdrawal symptoms were relatively common. These results are similar to those from other studies of nonmedical cannabis users showing negative effects of cannabis withdrawal on PSG measures of sleep architecture (Bolla et al., 2008; Vandrey et al., 2011). Although the long-term health implications of cannabis withdrawal symptoms are unknown (Gates et al., 2015), our results suggest the need for further research to determine clinical relevance in medical cannabis patients.

Statistically significant correlates of past 1-month sleep disturbance included being female, being Caucasian, being on disability (relative to being employed), not having a previous medical cannabis card, and greater frequency of using cannabis to help sleep. Frequency of

cannabis use for medical reasons, quantity of cannabis use, and cannabis intoxication were not associated with past 1-month sleep disturbance. These findings are generally consistent with research indicating that women appear to report more sleep problems than men (Krishnan and Collop, 2006), although previous work on race/ethnic differences in sleep problems has yielded mixed results (Adenekan et al., 2013). To our knowledge, this study is the first to report an association between disability status and sleep disturbance in medical cannabis patients with chronic pain. Compton et al. (2017) found that those who reported being "disabled for work" had higher odds of medical cannabis use compared to those who reported that they were working full-time, suggesting that sleep problems might be important to consider regarding the association between cannabis use and functional status. Although our cross-sectional design precludes inferences about temporal ordering of associations, other evidence showed that sleep problems predicted onset of disability (Friedman, 2016; Park et al., 2014).

Of particular interest is our finding that frequency of cannabis use to help sleep was associated with higher odds of sleep problems – even when other covariates were statistically controlled – whereas overall frequency and quantity of cannabis use and cannabis intoxication were not. Indeed, overall frequency of cannabis use for medical reasons and cannabis use to help sleep showed a statistically significant but weak positive relationship, $r = .23$. The magnitude of this correlation supports the discriminant validity of our measure of cannabis use to help sleep. In addition, the strong increase in the odds of sleep disturbance as a function of sleep-related cannabis use suggests several possible explanations.

One possible explanation for the findings is that more frequent sleep-related use of cannabis ultimately worsens sleep problems. This explanation is consistent with previous evidence for greater insomnia severity and lower sleep quality among daily cannabis users (Conroy et al., 2016), and with studies showing effects of cannabis on reductions in slow-wave and REM sleep (Conroy and Arnedt, 2014). It also seems plausible that those experiencing more severe sleep problems would be most likely to engage in sleep-related cannabis use. Another intriguing possibility is that sleep-related cannabis use is effective in the short-term but ineffective over the long term for reducing sleep disturbance (Angarita et al., 2016), and the results are indicative of more frequent sleep-related cannabis use aimed at reducing sleep problems that may have become intractable. This pattern of results could reflect a problematic cycle of cannabis use to reduce sleep problems, followed by exacerbation of sleep problems (perhaps due to cannabis cessation) and subsequent increases in use (Angarita et al., 2016; Babson et al., 2017). Importantly, because of the potential cyclical nature of sleep problems, increased cannabis use for sleep and greater frequency of sleep-related cannabis withdrawal symptoms, it is essential to examine longitudinal data to better understand how cannabis use and sleep interrelate over time.

We acknowledge several limitations to this study. First, the current research is based on cross-sectional data, making it impossible to discern the temporal direction of associations. Second, several of the measures we used were developed for this study and their psychometric properties have not been established. Third, we relied on self-report measures of sleep disturbance, and did not collect data on history of sleep problems prior to the pain

condition or on diagnosis of physiological sleep disorder. Thus, our findings will require replication with laboratory assessments of sleep quality. Relatedly, although the items on the SPQ partially overlap with DSM-5 criteria for Insomnia Disorder (APA 2013), our study was not designed to detect clinical diagnoses. Further, our study is based on a sample of adult medical cannabis users from clinics in one Midwestern state, and given the considerable variability in state laws related to medical cannabis, the results may not generalize to other locations. Fourth, in those participants who were seeking a recertification card, we did not obtain information on what strain of medical cannabis they had been using. A previous study (Belendiuk et al., 2015) showed that medical cannabis users with insomnia used strains of cannabis with significantly higher concentrations of CBD, which may have affected interpretation of our findings. Finally, recent work showed some differences between medical and recreational cannabis users (Lin et al., 2016; Pacula et al., 2016), but the present study was limited to medical cannabis patients with chronic pain who reported that they were seeking cannabis for medical reasons.

Some preliminary data from smaller and short-term randomized trials indicated that cannabis use is associated with reductions in pain-related sleep disturbance (Rog et al., 2005). To date, however, clinical trials examining medical cannabis use and sleep have been characterized by small sample sizes (Whiting et al., 2015), making it difficult to draw definitive conclusions. In addition, recent reviews highlighted the need for research on long-term effects of medical cannabis for a number of conditions (D'Souza and Ranganathan, 2015), including sleep problems (Ferguson and Ware, 2015). Further research on sleep problems in medical cannabis patients using prospective longitudinal designs with larger sample sizes will clarify the strength, direction, and temporal order of these associations and their public health significance.

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Highlights

- More than half of medical cannabis patients met criteria for sleep disturbance.

- Most participants reported that sleep problems were due to their current pain.

- 80% of participants used cannabis in the past 6 months to improve sleep.

- Sleep-related cannabis withdrawal symptoms were relatively common (65%).

- Disability status and using cannabis to help sleep were related to sleep problems.

Table 1

Demographic, Pain, and Cannabis Use Variables at Baseline ($N = 801$)[1]

	N (%) or Mean (SD)
Age	45.8 (12.8)
Gender	
Female	383 (48%)
Male	417 (52%)
Transsexual	1 (0.1%)
Race/Ethnicity	
African American	90 (11%)
White	686 (86%)
Other	25 (3%)
Education	
Some college/College graduate	527 (66%)
Less than high school/High school graduate	274 (34%)
Marital Status	
Married or long-term relationship	429 (54%)
Divorced/separated/widowed	184 (23%)
Never married	177 (22%)
Employment Status	
Work full-time or part-time	325 (41%)
Disability	271 (34%)
Retired	85 (11%)
Unemployed	63 (8%)
Other	45 (6%)
Usual Pain During the Past 1 Month	7.1 (1.4)
Currently Have a MMJ Card	
Yes	520 (66%)
No	272 (34%)
Past 6 Month Frequency of Marijuana Use for Medical Reasons	
No past 6-months medical use	65 (8%)
Very seldom	34 (4%)
Less than weekly	22 (3%)
1–2 days a week	65 (8%)
3–7 days a week	280 (35%)
Several times a day	328 (41%)
Past 1 Month Avg. Quantity of Cannabis Use per Week	
None	69 (9.0%)
Less than 1/8 of an oz.	130 (17%)

	N (%) or Mean (SD)
1/8 to slightly less than ¼ of an oz	156 (20%)
¼ to slightly less than ½ of an oz	179 (23%)
½ to slightly less than 1 oz	122 (16%)
One or more ounces	115 (15%)
Past 1 Month Number of Hours Felt High or Stoned on Avg. Day	
0 hours	98 (14%)
1–2 hours	262 (37%)
3–4 hours	191 (27%)
5–6 hours	78 (11%)
7–8 hours	41 (5%)
9 or more hours	45 (6%)

[1]Due to missing data and panned missingness, *N*s ranged from 715 to 801. Percentages do not always add to 100% due to rounding.

Table 2

Sleep-Related Variables at Baseline[1]

	N (%) or Mean (SD)
How often in past 1 month did you…	
1. Have trouble falling asleep?	
Not at all	146 (18%)
1–3 days	158 (20%)
4–7 days	111 (14%)
8–14 days	123 (16%)
15–21 days	115 (14%)
22–31 days	143 (18%)
2. Wake up several times per night?	
Not at all	82 (10%)
1–3 days	121 (15%)
4–7 days	126 (16%)
8–14 days	117 (15%)
15–21 days	109 (14%)
22–31 days	238 (30%)
3. Have trouble staying asleep?	
Not at all	129 (16%)
1–3 days	139 (18%)
4–7 days	117 (15%)
8–14 days	107 (13%)
15–21 days	116 (14%)
22–31 days	187 (24%)
4. Wake up feeling tired and worn out?	
Not at all	129 (16%)
1–3 days	139 (17%)
4–7 days	117 (15%)
8–14 days	132 (17%)
15–21 days	133 (17%)
22–31 days	148 (19%)
5. Past 1 Month Sleep Disturbance[2]	
Yes	472 (59%)
No	326 (41%)
6. Ever have trouble falling asleep/awaken from sleep related to current pain?	
Yes	666 (86%)
No	106 (14%)
7. How often do you have trouble falling asleep due to your pain?	

	N (%) or Mean (SD)
I do not have trouble falling asleep	25 (4%)
I have trouble falling asleep/not pain-related	68 (10%)
Rarely	90 (14%)
More than 3 times per week	267 (40%)
Every night	135 (20%)
Multiple times a night	79 (12%)
8. How often do you awaken from sleep due to your pain?	
Never	15 (2%)
I have restless sleep that is not pain-related	79 (12%)
Rarely	121 (18%)
More than 3 times per week	247 (37%)
Every night	104 (16%)
Multiple times a night	99 (15%)
9. Today, do you or would you have any difficulties at all with SLEEP because of pain?	
No difficulty	86 (11%)
A little bit of difficulty	132 (17%)
Moderate difficulty	168 (21%)
Quite a bit of difficulty	189 (24%)
Extreme difficulty	177 (23%)
Unable to perform activity	35 (4%)

[1] Percentages do not always add to 100% due to rounding.

[2] Based on cut-off score in Lallukka et al. (2011).

Table 3

Cannabis-Related Sleep Variables at Baseline[1]

	N (%) or Mean (SD)
1. Past 1 Month Use of Cannabis Use to Improve Sleep	
Yes	627 (80%)
No	157 (20%)
2. Past 1 Month Helpfulness of Cannabis Use to Improve Sleep	8.4 (1.8)
3. Past 6 Months Frequency of Cannabis Use to Help You Sleep	
Never/Almost never	91 (12%)
Rarely	48 (7%)
Sometimes	117 (16%)
Often	161 (22%)
Always/Almost always	316 (43%)
4. Past 6 Months Frequency of Cannabis Use because You Are Having Problems Sleeping	
Never/Almost never	135 (19%)
Rarely	65 (9%)
Sometimes	108 (15%)
Often	156 (21%)
Always/Almost always	262 (36%)
5. Past 6 Months Frequency of Cannabis Use because Napping Easier/More Enjoyable	
Never/Almost never	357 (49%)
Rarely	72 (10%)
Sometimes	85 (12%)
Often	81 (11%)
Always/Almost always	129 (18%)
6. Experienced Insomnia from Marijuana or Prescription Pain Pills/Past 6 Months?	
Yes	15 (2%)
No	767 (98%)
7. Experienced Drowsiness from Marijuana or Prescription Pain Pills/Past 6 Months?	
Yes	277 (35%)
No	505 (65%)
8. Experienced Sleep Difficulty When Reduced or Stopped Cannabis/Past 6 Months?	
None	275 (36%)
Mild	124 (16%)
Moderate	179 (23%)
Severe	197 (25%)
9. Experienced Strange Dreams When Reduced or Stopped Cannabis/Past 6 Months	
None	630 (82%)
Mild	78 (10%)

	N (%) or Mean (SD)
Moderate	40 (5%)
Severe	20 (3%)
10. Trouble Falling/Staying Asleep, or Sleeping Too Much When Not Using Cannabis/2 Weeks	
Not at all	248 (32%)
Several days	201 (26%)
Over half the days	138 (18%)
Nearly every day	180 (24%)

[1]Percentages do not always add to 100% due to rounding.

Table 4

Demographic, Pain, and Cannabis Use Correlates of Past 1-Month Sleep Disturbance

	Past 1 Month Sleep Disturbance[1]			
	No	Yes	OR (95% CI)	AOR (95% CI)
1. Age	44.5	46.7	1.01 *(1.0 – 1.02)	1.0 (0.9 – 1.03)
2. Gender				
Female	34%	66%	1.7 *(1.3 – 2.3)	1.7 *(1.2 – 2.4)
Male	47%	53%	—	—
3. Race/Ethnicity				
White	39%	61%	1.8 *(1.2 – 2.7)	2.7 *(1.6 – 4.6)
Non-White	53%	47%	—	—
4. Education				
Less than HS/HS grad	39%	61%	1.1 (0.8 – 1.5)	na
Some college/College grad	42%	58%	—	na
5. Current Marital Status				
Married/Relationship	42%	59%	1.3 (0.9 – 1.8)	1.0 (0.6 – 1.5)
Divorced/Separated/Widowed	31%	69%	2.1 *(1.3 – 3.2)	1.5 (0.9 – 2.5)
Never married	48%	52%	—	—
6. Employment Status				
Work full-time or part-time	49%	51%	—	—
Disability	33%	67%	1.9 *(1.4 – 2.7)	1.7 *(1.1 – 2.6)
Retired/Unemployed/Other	38%	62%	1.5 *(1.1 – 2.2)	1.1 (0.7 – 1.8)
7. Usual Pain Past 1 Month	7.0	7.2	1.1 *(1.02 – 1.2)	1.1 (0.99 – 1.3)
8. Currently Have a MMJ Card				
Yes	45%	55%	—	—
No	34%	66%	1.6 *(1.2 – 2.1)	1.7 *(1.2 – 2.6)
9. Past 6 Months Freq of Marijuana Use/Medical Reasons				
No past 6-months medical use	34%	66%	—	—
Very seldom	9%	91%	5.3 *(1.4 – 19.2)	6.8 (0.9 – 41.6)
Less than weekly	55%	45%	0.4 (0.2 – 1.1)	0.4 (0.1 – 1.7)
1–2 days a week	52%	48%	0.5 *(0.2 – 0.9)	0.5 (0.1 – 1.5)
3–7 days a week	45%	55%	0.6 (0.4 – 1.1)	0.6 (0.2 – 1.8)
Several times a day	38%	62%	0.8 (0.5 – 1.4)	0.6 (0.2 – 2.0)
10. Past 6 Months Freq of Marijuana Use/To Help Sleep				
Never/Almost never	60%	40%	—	—
Rarely	48%	52%	1.6 (0.8 – 3.3)	1.7 (0.8 – 3.8)
Sometimes	45%	55%	1.8 *(1.1 – 3.2)	2.3 *(1.2 – 4.3)

	Past 1 Month Sleep Disturbance[1]		OR (95% CI)	AOR (95% CI)
	No	Yes		
Often	39%	61%	2.3 * (1.4 – 4.0)	2.9 * (1.6 – 5.3)
Always/Almost always	35%	65%	2.8 * (1.7 – 4.5)	3.5 * (2.0 – 6.1)
11. Past 1 Month Avg. Quantity of Cannabis Use				
None	33%	67%	—	
Less than 1/8 of an oz.	38%	62%	0.8 (0.4 – 1.4)	na
1/8 to slightly less than ¼ of an oz	44%	56%	0.6 (0.3 – 1.1)	na
¼ to slightly less than ½ of an oz	40%	60%	0.7 (0.4 – 1.3)	na
½ to slightly less than 1 oz	42%	68%	0.7 (0.3 – 1.3)	na
One or more ounces	39%	61%	0.8 (0.4 – 1.4)	na
12. Past 1 Month Number of Hrs Felt High or Stoned on Avg. Day	2.8	2.7	0.9 (0.8 – 1.1)	na

[1] Percentages do not always add to 100% due to rounding.

OR = odds ratio. AOR = adjusted odds ratio.

*
 $p < .05$.