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Marijuana Use Patterns and Sleep among Community-Based Young Adults

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Abstract

Background—Marijuana (MJ) is the most commonly used recreational drug in the US. Research on the relationship between MJ and sleep is still in its infancy. The study examined the differences in sleep characteristics between a community sample of daily users, non-daily MJ users, and non-users.

Methods—A total of 98 subjects (45M; 53 F) participated. The mean age was 22.3 (SD=3.0). There were 53 females and 55% of the sample was Caucasian. Recruitment was through online and via print advertisements in the community. Groups were categorized as non-daily users (n=29), daily users (n=49), and non-user controls (n=20). Sleep was characterized by the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS) and Morningness Scale (MEQ).

Results—A standard cut off score of >10 for the ISI was found in 38.8% of daily users, 10.3% of non-daily users, and 20% of non-users. PSQI scores in daily users (7.0 +/− 3.8) was higher than non-daily (4.9+/−3.2) and non-user controls (5.0+/− 3.7), p=0.02. ISI scores in daily users (7.9 +/−6.1) were higher than non-daily (5.1 +/−4.3) and non-user controls (4.3+/−4.8), p=0.01. Covariate adjusted regression analyses revealed mean PSQI and ISI scores were significantly lower for non-daily users and controls relative to the daily users. When adjusting for depression and anxiety, these unique associations were not significant. There were no differences in ESS or MEQ.

Conclusion—Daily MJ users endorsed more sleep disturbance than non-daily users. Future studies should consider mood in the relationship between MJ use and sleep.

Keywords

marijuana; sleep; insomnia; community; young adult

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INTRODUCTION

Marijuana (MJ) is one of the most commonly used drugs in the United States. It is now well known that individuals report self-treating with MJ for a number of medical and psychiatric symptoms, most commonly PTSD, pain, anxiety, and insomnia[1-3]. The availability of MJ to treat these symptoms has been increasing, due in part to changes in laws related to MJ use. In the United States, MJ has been legalized in four states, decriminalized in 16 states, and there are now 23 states that have medical marijuana legalization. Many individuals using MJ medicinally or for recreational purposes use MJ for insomnia [2-4]. This is despite the research suggesting that treatment seeking[5] and non-treatment seeking [6] individuals report disturbed sleep when they stop using MJ and a only a small portion report a reduction of related symptoms as a primary benefit of use[7].

MJ use and sleep in young adults

Marijuana use is most prevalent in the United States among 18-25 year olds with approximately 32% of non-college and 35% of college-attending persons reporting past year use, and 19% of emerging adults (18-29 years old) reporting past month marijuana use[8]. Young adults use MJ for recreational reasons, but some also use MJ for sleep difficulties [9]. An estimated 7.3% of individuals aged 18-29 meet ICD-10 or DSM-IV criteria for the diagnosis of insomnia[10]. In a community sample of over four thousand 18-25 year olds, 29.3% scored above the clinical cut-off on the Pittsburgh Sleep Quality Index (PSQI)[11]. Thus, about 30% of individuals in this age group complain of sleep disturbance, although only one-fourth of these meet formal diagnostic criteria. Insomnia has been associated with both self-reported impairments in daytime functioning [12] and lost productivity [13].

The biopsychosocial changes of young adulthood affecting sleep are well known [14] and may contribute to MJ use. As individuals begin to live more independently, there may be fewer restrictions on sleep schedules, particularly parent-set bedtimes. Many choose to stay awake later at night to socialize or to meet academic demands. Individuals with an evening "chronotype," who prefer to be awake late into the evening, have been shown to have more problems with reward functioning (including sensation seeking and substance involvement)[15]. Evening chronotypes have also demonstrated higher depression scores [16], suicidal thoughts, more impaired work and other activities, higher paranoid symptoms, and higher anxiety, compared to a morningness-type group [17]. Thus, the pattern of MJ use in young adults may be influenced by an interplay between changes in sleep patterns, chronotype, and mood.

To date, literature on the effects of marijuana on sleep a young adult sample have been somewhat limited. While objective sleep indices have been studied in middle aged Veterans who are heavy MJ users [18-21], only one study has examined objective indices of nocturnal sleep and daytime sleepiness the following day in a community sample of young adults. In that study, 8 healthy volunteers participated in a double-blind and placebo-controlled study with either: 1) 15 mg D-9-tetrahydrocannabinol (THC), 2) 5 mg THC combined with 5 mg cannabidiol (CBD), 3) 15 mg THC combined with 15 mg CBD or 4) placebo [22] via oromucosal spray one hour before bedtime. THC in addition to CBD was used because of the different effects associated with each compound, i.e. CBD is not as centrally activating

like THC and has useful therapeutic/anticonvulsant properties. Participants underwent polysomnography and then sleep and morning functioning were evaluated. Nighttime sleep slightly worsened with 15 mg CBD and next day performance was impaired (deficits in memory, reduced sleep latency, and mood changes) with 15 mg THC. This study highlights the effect of MJ on both nighttime sleep and daytime functioning.

If the relationship between MJ use and sleep disturbance in persons who are not seeking treatment for substance use disorders is substantial and documented to affect daytime function, it could have major public health significance. Health officials could publicize the relationship of MJ and sleep, primary care and behavioral health workers could highlight this information during office visits for insomnia, and drug treatment providers could meaningfully target sleep among MJ users who do seek treatment.

MJ use patterns and insomnia over time

Epidemiological studies have found associations between MJ use and insomnia over time [23]. Adolescents, in particular, who used any illicit drug (most often MJ) were 2.6 times more likely to report a sleep problem than those who remained substance free [24]. In a nationally representative sample, adolescents with insomnia were 1.8 times as likely to report MJ use compared to adolescents without insomnia[25]. Across ages, about one in five persons who use MJ (and no other illicit drugs) report insomnia (e.g., have trouble going to sleep or staying asleep most or all of the time). This is significantly higher than the rate of insomnia diagnosed in persons not using MJ [25] which is approximately one in ten.[26] While these epidemiological studies are informative and suggest co-occurrence, they do not inform us regarding the relationship of level of MJ use to sleep effect, or as to common (i.e., a third factor causing both) versus reciprocal etiology.

Study aim

The majority of studies conducted on the influence of MJ on sleep have focused on heavy, chronic, and “problematic” users, and persons seeking substance use disorders treatment. The distinct effects of daily versus non-daily marijuana use on sleep remain unknown. Previous studies have also not considered insomnia severity with daytime effects in non-daily users. Therefore, the aim of the current study was to examine the effects of non-daily and daily MJ use patterns on sleep quality and patterns in young adults recruited from the community.

METHODS

Participants

Participants were co-recruited from a larger study on individuals who use alcohol and marijuana between March 2012 and September 2013 through on-line advertisements in Craig’s List, Facebook, flyers, word-of-mouth, radio advertisements, and newspaper advertisements targeted at the Rhode Island/southeastern Massachusetts area. These methods are free services, widely known and used, and easy to access from a computer or smartphone. The advertisement for this study read, **“**Adults between 18 and 29, do you use marijuana?” You may be eligible to participate in a research study,” and asked interested

persons to call the study telephone number listed. Exclusion criteria were: 1) past month cocaine, opioid, benzodiazepine, barbiturate, inhalant, PCP, hallucinogen, or stimulant use, 2) more than one episode of binge drinking (defined as 5 drinks within a 2-hour period for men, 4 drinks within a 2-hour period for women) in the past month. We permitted inclusion of one binge episode because of the small number of participants who had no episodes of binge drinking in the last month, 3) night shift work, 4) self-reported diagnosis of schizophrenia, bipolar disorder, or attention deficit hyperactivity disorder, 5) lack of stable housing, 6) current (past 2 weeks) suicidal ideation, and 7) past month use of sleep medication or antidepressants. We also recruited an age-matched control group who reported no MJ use in the last month.

A total of 1307 persons aged 18-29 who reported using marijuana at least once a month were screened by phone for eligibility. Of these, 1052 were ineligible, due to more than one recent binge drinking episode. Other reasons for exclusion included use of other drugs (n = 45), mental disorder diagnosis (n = 65), currently being treated for depression (n = 22), suicidal ideation (n = 27), and unstable housing (n = 5). Of the 146 eligible participants, 8 could not be reached to schedule a baseline appointment, 4 refused participation, and 35 did not come in for their baseline appointment. Ninety-nine consented to participate in the study; one person was excluded from participation after consent due to non-compliance with study protocols and limited cooperation with study staff. This study was approved by the Institutional Review Boards of Butler Hospital and the University of Michigan.

Procedures

At baseline, eligible participants provided informed consent and received a 40-minute face-to-face interview to assess demographics, and marijuana use. Participants also provided urine samples for toxicological analysis to rule out recent opioid, cocaine, amphetamine, or benzodiazepine use prior to this interview. The non-user control group was also required to have negative urine toxicology for THC at the time of the baseline interview.

Measures

Marijuana use

All participants were administered the patient version of the Structured Clinical Interview for DSM-IV (SCID)[27] at baseline to assess for current marijuana dependence only in the last year. During the baseline interview, a Time Line Follow Back [28]was conducted to assess for MJ use over the past 4 weeks. On each day of MJ use, participants were asked how many minutes they smoked MJ. Participants were provided with the following instructions: “We would like you to look on this calendar and let us know how much time you spent using marijuana each day so we can write that in. We are also interested in knowing what time each day you used marijuana.” The day was divided into 4 six-hour quadrants. Daily smokers were defined as persons smoking MJ at least six days per week, and non-daily smokers were persons who smoked on at least 1 day in the past month to up to 5 days per week. Non-users were participants who had not smoked MJ in the last month.

The basis for using minutes of marijuana as an outcome was because it is very difficult to ascertain in the naturalistic setting exactly how much THC the participant is ingesting. To clarify this measure further, we made frequency of use in days (daily vs. non-daily use) and meeting a diagnosis of dependence as our secondary measures.

In looking at the validity of our chosen outcome measure, we did find support from concurrent measures of MJ use frequency. The spearman rank correlation between average minutes of MJ use during the two-week evaluation period and the percentage of days using MJ during that same period was r=0.88 ($p<0.001$). The median was 25.18 and inter-quartile range was 12.90-62.91. The correlation between average minutes of MJ use during the two-week evaluation period and a baseline DSM-IV diagnosis of Cannabis Dependence was r=0.33 (p=0.10). Although not significant statistically, those with a diagnosis of Cannabis Dependence reported an average of 42 (SD= 32.8) as compared to an average of 24 (SD= 34.4) among those without a diagnosis, a moderate effect size (Cohen's d=0.53).

Sleep Disturbance Measures

Pittsburgh Sleep Quality Index (PSQI)[29]—The Pittsburgh Sleep Quality Index (PSQI) is a self-rated questionnaire which assesses general sleep quality and sleep disturbances over a 1-month time period. Nineteen individual items generate seven "component" scores: subjective sleep quality; sleep latency; sleep duration; habitual sleep efficiency; sleep disturbances; use of sleeping medication and daytime dysfunction. The sum of scores for these seven components yields one global score. A global PSQI score greater than 5 has been used to define sleep disturbance.[29]

Insomnia Severity Index[30]—The Insomnia Severity Index (ISI) is a seven-item self-report questionnaire assessing the nature, severity, and impact of insomnia in the past month. Dimensions evaluated are: severity of sleep onset, sleep maintenance, and early morning awakening problems, sleep dissatisfaction, interference of sleep difficulties with daytime functioning, noticeability of sleep problems by others, and distress caused by the sleep difficulties. A 5-point Likert scale is used to rate each item (e.g., 0 = no problem; 4 = very severe problem), yielding a total score ranging from 0 to 28. We used a cut off ≥10 because this score has been shown to be optimal (86.1% sensitivity and 87.7% specificity) for detecting insomnia cases in a community sample [31].

Epworth Sleepiness Scale[32, 33]—The Epworth Sleepiness Scale (ESS) is an 8-item questionnaire assessing the level of daytime sleepiness. Respondents rate their likelihood to fall asleep or doze off on a scale of 0-3 (0=none, 1=slight chance, 2= moderate chance, 3=high chance) in 8 different situations that may induce sleepiness (e.g., sitting and reading). A score of 10 or greater is considered problematic daytime sleepiness, with a score of 18 signifying severe daytime sleepiness.

The Morningness Eveningness Questionnaire (MEQ)[34]—Smith's MEQ is a 13-item questionnaire that assesses individual time of day preference for morning or evening activities, such as bed- and rise-times, and the clock time of becoming fully awake. This questionnaire measures behavioral temporal preference with high reliability, validity, and

cross-cultural utility [35]. Scores range from 13-52. Scores ≤22 indicate an eveningness preference, 23-43 indicated intermediate (no preference for time of day), and scores ≥44 indicate morningness.

Mood measures

Patient Health Questionnaire-9 (PHQ9)[36]—The PHQ9 is a 9- item questionnaire that inquires about how often mood symptoms were bothersome to the participant in the past two weeks. Participants respond on a Likert scale between 0-3, with 0 = not at all, 1=several days, 2=more than half the days, and 3=nearly every day. Total scores from 5-9 indicate mild symptoms of depression, 10-14 moderate symptoms, 15-19 moderately severe, and 20-27 severe. PHQ9 is a reliable and well validated scale[37, 38]

The Psychiatric Diagnostic Screening Questionnaire[39]—To obtain information about anxiety, we used the brief 10-item PDSQ scale to measure generalized anxiety disorder. The PDSQ refers to the past 2 weeks. Participants responded to 10 questions about their anxiety (e.g., were you a nervous person on most days) with either no (0) or yes (1). Higher scores reflect more anxiety symptoms.

Statistical Analysis

We conducted analyses on the enrolled participants that provided baseline interview responses. A hierarchical multiple regression analysis was performed to explore whether MJ use group predicted scores on sleep, daytime sleepiness, and chronotype questionnaires. All models evaluating sleep measures across MJ use groups included planned covariates. Given that the high rate of unemployment in the sample (54%) may impact sleep behaviors and the possibility of gender differences in MJ use patterns, all models included gender and employment status as planned covariates. Because anxiety [40] and depression [19] are related to both marijuana use and sleep, we followed up our initial evaluations with models that controlled for these potential confounds in our analyses. All statistical analyses were completed using R statistical software (R Core Team, 2013).

RESULTS

Participants

A total of 98 participants (53 female, 45 male) completed the baseline interview (Please see Table 1). Participants were predominantly in their early 20s with a mean age of 22.3 (SD=3.0). The distribution of males and females was approximately equal in each MJ use category. The sample was approximately half Caucasian, female, unemployed, and 27% reported at least a high school education (Table 1). None of these variables differed significantly between groups. Of the n=98 that were eligible to participate, one had one binge drinking episode in the past month. Daily users smoked MJ nearly four times longer (in minutes) than non-daily users on use days, and non-daily users smoked on average two days a week. Daily users typically used MJ across the day and night whereas non-daily users used primarily at night.

Sleep measures by MJ Use Category

PSQI: Table 2 lists descriptive statistics for sleep disruption measures within each marijuana use group. Sleep disturbance (PSQI>5) [29] was evidenced by 55.1% of daily MJ users, 34.5% of non-daily users, and 45.0% of non-users. Higher PSQI scores were associated with being female (b=2.3, SE=0.70, p=0.001). In covariate adjusted regression analyses (see Table 3), mean PSQI scores were significantly lower for non-daily users (p=0.001) than for the daily MJ users. PSQI scores in the non-user group also were significantly lower than among daily-users (p=0.04). When added after other terms, there was a significant influence of depression (p<0.001) and no influence from anxiety (p<0.09) on PSQI scores. When adjusting for depression and anxiety, the unique association between level of MJ use and PSQI was reduced when comparing the non-daily (p=0.16) and non-user groups (p=0.33) to daily MJ users. Please see Table 3.

ISI: The criterion for clinical insomnia (ISI≥10) was met in 38.8% of daily users, 10.3% of non-daily users, and 20.0% of non-users. In the covariate-adjusted regression model, higher ISI scores were associated with being female (b=2.4, SE=1.1, p=.03).

Across MJ use categories, when adjusting for gender and employment status (see Table 3), ISI scores in daily MJ users were higher than non-daily users (p=.03), and higher than non-users (p=0.01). When added to the model described above, we observed a signifiant positive association between higher levels of depression (p<.001), and no association between higher anxiety (p=0.56) and higher ISI scores. After adjusting for depression and anxiety, the differences between non-daily (p=.25) or non-user groups (p=0.09) and daily users on the ISI were not significant.

ESS: Average sleepiness ratings by all MJ use groups were less than 10, indicating normal daytime sleepiness. There were no significant influences of gender and employment status on levels of ESS scores. We observed similar levels of ESS when comparing non-daily (p=.65) and non-user groups (p=0.39) groups to daily MJ users (see Table 3). When added to the model, level of depression was significantly associated with ESS score (p<.001). Level of anxiety was not related to ESS (p=0.68).

MEQ: Overall, the cohort scored within the intermediate chronotype, that is, neither evening type nor morning type predominated. Gender, employment were not significantly associated with MEQ. We did not observe significant differences between non-daily (p=0.27) or non-user groups (p=0.44) when compared to daily MJ users (see Table 3). When added to models, levels of depression (p=0.01) and not anxiety (p=0.13) were related to higher MEQ scores.

DISCUSSION

The purpose of this pilot study was to examine the association between non-daily and daily MJ use patterns on sleep patterns in young adults recruited from the community. Daily MJ users endorsed more sleep disturbance on the PSQI and ISI than non-daily users. These results are consistent with previous studies showing an association between sleep

disturbance and heavy MJ use in adults [21, 24]. Of note, however, was our finding that non-daily MJ users and non-users had similar sleep indices. Daytime sleepiness and chronotype did not differ across our three groups. This study provides new information about the relationship between MJ use patterns, mood, sleep, and daytime functioning.

We found that the proportion of persons reporting a clinically significant PSQI threshold of >5, which distinguishes good from poor sleepers [29], was lowest among non-daily users and highest among the daily users (who also had a significantly higher mean PSQI). We also found that these non-daily users tended to use MJ mostly at nighttime, whereas daily users smoked considerably more MJ on use days and used during the day and the evening.

The effects of MJ on sleep in intermittent users may be similar, in part, to that of alcohol [41] where improvements in sleep continuity measures (e.g., decreased sleep onset latency and wake after sleep onset) have been reported with intermittent use, whereas daily use results in the worsening of sleep. However, methodological differences in previous marijuana studies limit definitive support. While a review of 39 research studies on the effects of cannabis on sleep revealed that cannabis may interrupt sleep patterns and result in non-restorative sleep[42], objective polysomnography in heavy MJ users show normal (on average) sleep patterns during periods of cannabis use [21, 43]. One possible explanation for the study findings is that individuals habituate to the sleep inducing effects of cannabis after continued use [44]. In addition, our finding that non-users had similar ISI scores to non-daily users, and that a lower proportion reached clinical criteria for insomnia, suggests that sleep disturbance, which is common in this age group, may not be increased by non-daily MJ use. Because this is not a MJ administration trial, this remains speculative. The clinical significance of the lower ISI score in non-daily users is likely minimal, as all scores <10 typically reflect sub threshold insomnia.

Our findings suggest that anxiety is significantly related to scores on the PSQI. Persons with anxiety may be using MJ to mitigate their sleep symptoms. This is consistent with the literature, where MJ is the most commonly used illicit substance in individuals with anxiety disorders [40] and where higher MJ use has been associated with higher rates of anxiety [45]. Lev Ran et al. (2012) found that when adjusting for any concurrent mood disorder, there was a significant impact of regular, but not occasional, use of cannabis on mental health-related quality of life in participants with anxiety disorders [46]. It remains possible that our ISI scores might have been higher in the daily MJ users because MJ was contributing to anxiety, which in turn may have exacerbated the severity of insomnia.

We found gender effects on our PSQI and ISI scores, but not on ESS or MEQ scores. The relationship between insomnia and gender was expected [47, 48] as insomnia is more common in females than in males in non-substance using populations[49]. Lev-Ran et al. (2012) found that compared to non-users, occasional MJ users (defined as less than weekly use) had poorer mental health scores in females, but not among males. These findings suggest that MJ use patterns may affect females differently given their increased risk of both insomnia and depression. MJ has been shown to affect women more significantly than men on neuropsychological tasks [50].

We expected that there would be more evening chronotypes in the daily MJ use category, because evening chronotypes have been shown to be more likely to use alcohol, to have poor impulse control, depression, and difficulty falling asleep [51]. However, our MEQ results did not differ between non-users, non-daily and, or daily users. This finding is consistent with results of one study which utilized the Horne Ostberg questionnaire to assess chronotype in MJ users and reported that there were no chronotype differences between heavy MJ users and non-users[21]. Our study is among others to examine chronotype among persons who are primarily MJ users where the influence of concurrent heavy alcohol use has been mitigated[21, 52, 53]. While the relationship between chronotype and substance use is likely multifactorial, future studies might consider exploring whether evening chronotypes may be more likely to use alcohol or MJ.

Our study had several limitations. First, daily MJ users in this study were heavy users, therefore, we are unable to know if the sleep reports of daily users are a result of frequency of use or quantity of use. Future studies might try to recruit daily MJ users who smoke minimally, perhaps only at night to “treat” sleep disturbance. Second, participants self-reported MJ use and sleep indices. Third, given the cross-sectional nature of this study, we are unable to assess causality. Fourth, the size of our sample increases the risk of Type 1 error, missing associations that might have been seen in a larger study. Fifth, the absence of significant difference between the non-user and user groups may have been due to low power, as the non-user group had a lower number than user groups. Sixth, we did not quantify the use patterns beyond the past month. Therefore there may have been users in our non-user groups that could have quit more than one month ago. Seventh, the sample may not be representative of this population for two reasons. Even though we recruited MJ users and non-user controls from a larger study on alcohol and marijuana, our exclusion criteria may have been too limiting. In addition, given the high rate of unemployment and low rate of high school graduates in our study sample, this study sample may not be representative of this demographic. Eighth, the non-using control sample in this study was recruited from a larger study, which may have affected statistical assumptions for comparing the MJ user group with the HC group. Lastly, a formal diagnosis of insomnia was not conducted in this study and therefore associations with insomnia based on the ISI should be interpreted cautiously.

With the increasing availability of MJ and an increasing number of individuals using it for insomnia with the belief that MJ use improves sleep, our study suggests that daily use may not in fact improve sleep, although this study cannot est. Large scale studies assessing the impact of MJ on sleep are warranted.

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Table 1

Demographic and marijuana use patterns for observed groups of Daily, Non-Daily, and Non-User marijuana groups.

	Daily users (n=49)	Non-daily users (n=29)	Non-users (n=20)	Test	p
Female n(%)	27 (55.1%)	15 (51.7%)	11 (55.0%)	$X^2(2)= 0.25$	0.88
Race n(%)				$X^2(4)=1.82$	0.77
White	28 (57.1%)	15 (51.7%)	11 (55.0%)		
Hispanic	12 (24.5%)	6 (20.7%)	3 (15.0%)		
Other	9 (18.4%)	8 (27.6%)	6 (30.0%)		
Education n(%)				$X^2(6)=6.22$	0.40
Less than High School	9 (9.2%)	3 (3.1%)	1 (1.0%)		
Grade 12	14 (14.3%)	8 (8.2%)	4 (4.1%)		
Grades 12-15	19 (19.4%)	9 (9.2%)	10 (10.2%)		
>16 years	7 (7.1%)	9 (9.2%)	5 (5.1%)		
Unemployed n(%)	61.2% (30/49)	51.7% (15/29)	50% (12/20)	$X^2(2)=0.7106$	0.70
Percent MJ Use Days	99.5%(+/−0.02)	34.0%(+/−0.21)	---	t(28.2)= 17.15	p<0.01
Minutes Of Use Days (median, 25th-75th)	52.8 (20.7− 78.0)	18.60 (5.0-18.3)	---	t(67.9)=4.62	p<0.01
Marijuana Dependence n (%)	20 (40.8 %)	1 (3.4%)	0 (100%)	$X^2(2)= 16.63$	p<0.01

Table 1: Male (M), Female (F), Caucasian (C), Hispanic (H), Asian (A), African American (AA) and other (O)

Table 2

Differences in current levels of sleep disturbance, circadian rhythm, and psychological distress observed among Daily, Non-Daily, Non-User marijuana groups.

	Daily n=49		Non-Daily n=29		Non-User n=20			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Test**	**p**
Pittsburgh Sleep Quality Index (PSQI)	6.96	3.79	4.86	3.19	5.00	3.74	F(2,95) =3.91	0.02
Insomnia Severity Index (ISI)	7.94[a]	6.06	5.07	4.34	4.25 [a]	4.81	F(2,95) = 4.47	0.01
Epworth Sleepiness Scale (ESS)	5.69	3.58	6.03	3.73	4.85	3.56	F(2,95) = 0.65	0.52
Morningness/Eveningness (MEQ)	30.22	6.80	31.90	8.23	31.65	5.72	F(2,95) = 0.61	0.54
ISI ≥10	38.8% [a]	--	10.3% [a]	--	20.0%	--	$X^2(2)$= 7.75	0.02
PSQI>5	55.1%		34.5%		45.0%		$X^2(2)$= 3.15	0.20
Patient Health Questionnaire-Depression	6.24	4.65	4.14	3.82	4.05	4.25	F(2,95) = 2.99	0.06
Generalized Anxiety Disorder	3.94	3.52	2.79	3.02	2.15	2.72	F(2,95) = 2.57	0.08

Note: a=Follow-up contrasts with same superscript are significantly different ($p<0.05$) after correction for multiple comparisons using a simultaneous generalized linear hypothesis test with Tukey contrasts.

Table 3

Results from covariate adjusted regression models of the relationship between levels of marijuana use and sleep disturbance measures with and without adjustment for levels of current symptoms of depressed and anxious mood.

	PSQI		ISI		ESS		MEQ	
	b (se)	b (se) [a]	b (se)	b (se) [a]	b (se)	b (se) [a]	b (se)	b (se) [a]
Marijuana Use Group								
Daily Use	--	--	--	--	--	--	--	--
Non-Daily Use	−1.93 *	−0.93	−2.70 *	−1.22	0.39	1.07	1.86	2.47
	(0.81)	(0.66)	(1.25)	(1.05)	(0.85)	(0.81)	(1.67)	(1.66)
No Use	−1.94 *	−0.74	−3.67 *	−2.02	−0.84	−0.14	1.45	1.82
	(0.91)	(0.75)	(1.40)	(1.17)	(0.96)	(0.91)	(1.87)	(1.89)
Mood Symptoms								
Depression (PHQ)		0.3 9 *		0.6 7 *		0.3 7 *		0.5 3 *
	--	(0.08)	--	(0.13)	--	(0.10)	--	(0.21)
Anxiety (GAD)		0.20 *		0.10		−0.06		−0.43
	--	(0.11)	--	(0.18)	--	(0.14)	--	(0.28)

Note: All models adjusted for gender and employment status.

PSQI= Pittsburg Sleep Quality Index; ISI= Insomnia Severity Index ; ESS= Epworth Sleep Scale; MEQ= Morningness and Eveningness Questionnaire; PHQ= Physicians Health Questionnaire-Depression; GAD= Physicians Health Questionnaire-Generalized Anxiety.

* = $p < 0.05$;

[a] = Model includes marijuana use group and mood symptom measures;