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Abstract

Background: The present study investigated the mediating role of protective behavioral strategies for marijuana (PBSM) on the relationship between posttraumatic stress disorder (PTSD) and marijuana outcomes (i.e. marijuana use frequency, marijuana use quantity, cannabis use disorder (CUD) symptoms, and marijuana-related problems).

Methods: Participants were 1,107 traditional age college students ($M_{age} = 20.26$, $SD = 3.32$; 66.5% White, non-Hispanic; 68.8% female), who reported consuming marijuana at least once in the last 30 days and completed measures of PTSD symptoms, PBSM, and marijuana-related outcomes.

Results: PBSM significantly mediated the positive relationships between PTSD symptoms and both CUD symptoms and marijuana-related problems. More specifically, PTSD symptoms were negatively associated with PBSM, which in turn was negatively associated marijuana use frequency and marijuana use quantity, which were in turn positively associated with CUD symptoms and marijuana-related problems.

Conclusion: Taken together, the associations between higher PTSD symptoms and greater experience of CUD symptoms and marijuana-related problems may occur because students use fewer PBSM and thus engage in larger quantity and frequency of marijuana use. These findings lend support to the utility of targeting PBSM as a harm reduction effort for students with PTSD symptoms who use marijuana.

Keywords

college students; marijuana protective behavioral strategies; posttraumatic stress disorder; marijuana

Introduction

Marijuana (or cannabis) is the most commonly used illegal substance on college campuses.[1] In fact, college student marijuana use is on the rise, with 38% of students reporting use in the past year and 21% reporting use in the past month.[2] These rates of use are particularly concerning because increased marijuana use is associated with marijuana-related problems[3] and escalates one's risk for developing a cannabis use disorder (CUD).[4]

Pearson and colleagues found the average college student marijuana user experiences approximately eight marijuana-related problems per month.[5] This includes instances such as driving a car while high, saying or doing embarrassing things, using on a night not originally intending to use, and feeling sluggish or in a fog the next day. More severe but less frequently occurring marijuana-related problems include getting in a fight, having unprotected sex, or damaging property.[5] Specific to the college setting, more frequent marijuana use has been associated with increased academic impairment as evidenced by lower grade point averages.[3] Of concern, marijuana use has been associated with experiencing more general psychological distress[3,6] and specific mental health problems, such as depression,[7,8] anxiety,[8] and posttraumatic stress disorder (PTSD).[9,10]

According to the American College Health Association, over 57% of college students report experiencing more than average or tremendous stress.[11] A specific form of stress, PTSD, is a mental health problem that has been associated with greater substance use[12] and can specifically exacerbate one's marijuana use.[9] PTSD is the clinical manifestation of traumatic stress symptoms in response to a traumatic event meeting DSM-5 diagnostic criteria.[13] However, college students may also experience traumatic stress at subclinical levels such that the symptoms are distressing, but not do not meet full PTSD diagnostic criteria.[14] Thus, it is important to examine how variations in levels of traumatic stress symptoms are related to experiences with marijuana. Positive associations exist between trauma exposure and marijuana use, as well as between PTSD symptom severity and cannabis use disorder (CUD).[10] It is important to examine other variables that may help account for the associations between PTSD symptoms and marijuana-related outcomes. We consider use of protective behavioral strategies to be one plausible explanatory variable.

Protective behavioral strategies (PBS) are behaviors individuals can engage in while using substances that reduce overall substance use and/or decrease substance use-related problems. PBS for marijuana (PBSM) include behaviors such as buying less marijuana at a time to

ultimately use less, only using marijuana among trusted peers, avoiding mixing marijuana and other substances, and avoiding using marijuana before work, school, or when spending time with family.[24] Recently, researchers found that increased use of PBSM was negatively correlated with frequency of marijuana use and marijuana-related problems.[15,16] Because PBSM appear linked to less marijuana use and fewer marijuana-related problems yet are not abstinence-focused, they could be considered a potential intervention target for individuals who would benefit from harm reduction related to marijuana use but wish to continue using to some degree, which is common among college student marijuana users.

Additionally, using PBSM tends to enhance the benefit of protective factors and weaken the impact of risk factors (e.g., male sex) associated with experiencing marijuana-related problems.[15] Further, use of PBSM has been identified as a mediator between myriad factors (e.g., sex, motives for use) and marijuana outcomes (i.e. use and problems).[17] For example, the positive associations coping marijuana use motives had with marijuana use frequency and problems was explained by less PBSM use, which highlights that targeting PBSM as an intervention strategy could help diminish the associations between various predictors and marijuana outcomes.[17] When looking at the role of PBS in the context of mental health predictors of substance use outcomes, alcohol PBS have been shown to weaken the positive association between PTSD symptoms and alcohol-related problems in a sample of college students.[18] Although PBSM use has been identified as a proximal predictor of marijuana use and experience of marijuana-related problems (similar to the relationship between alcohol PBS and alcohol outcomes), it is unclear how more distal factors such as mental health may be associated with PBSM use. Given the concerning relationship between mental health problems such as PTSD and marijuana use,[9,10] it is important to further explore factors such as PBSM that may play a protective role for those with traumatic stress who also use marijuana. To our knowledge, no studies have examined the role of PBSM in the established relationships between PTSD symptoms and marijuana outcomes. As college students using marijuana appear to be at risk of experiencing myriad related problems[5] and nearly one in five (i.e. 18%) students in a national sample reported rates of self-reported PTSD symptoms meeting DSM-5 PTSD diagnostic criteria,[18] it is particularly important to understand if PBSM may be a worthwhile intervention target as it is a generally effective intervention[37] which could be further leveraged for the student population simultaneously experiencing PTSD symptoms and using marijuana.

The purpose of the current study was to examine the relationships between PTSD symptoms and marijuana outcomes (i.e. marijuana use frequency, marijuana use quantity, CUD symptoms, and marijuana-related problems) as well as to examine the mediating role of PBSM among college student marijuana users. Understanding how PBSM may be responsible for the relationship between PTSD symptoms and marijuana outcomes would provide useful information for those providing services to college students regarding potential protective strategies that can be learned and implemented when using marijuana.

Method

Participants/Procedures

Participants were college students (n=7,307) recruited to complete an online survey via Psychology Department Participant Pools at ten universities across ten U.S. states (for more information, see Bravo, Villarosa-Hurlocker, Pearson, & Protective Strategies Study Team).[19] To minimize burden on participants, we utilized a planned missingness design, or matrix sampling.[20,21] To test our study aims we limited the analytic sample for the present study to 1,107 students who disclosed their gender, reported consuming marijuana at least once in the last 30 days, and completed the measures used in our analyses. Among our analytic sample, the majority of participants identified as being either White, non-Hispanic (n=736; 66.5%) or of Hispanic/Latino ethnicity (n=186; 16.8%), female (n=762; 68.8%), and reported a mean age of 20.26 (*Median*=19.00; *SD*=3.32) years. Participants received research participation credit for completing the study. This protocol was approved by institutional review boards at each participating university.

Measures

Posttraumatic stress disorder.—Past month PTSD symptoms were assessed using the 20-item PTSD Checklist for DSM-5 (PCL-5)[22] measured on a 5-point response scale (0=*not at all*, 4=*extremely*). Example items include, "Repeated, disturbing, and unwanted memories of the stressful experience" and "Trouble remembering important parts of the stressful experience" (items were summed to create a total score; α=.97). Of note, 21.6% of the sample exceeded the cut-off for probable PTSD (based on a PCL-5 score ≥ 33).[23]

PBSM.—Past 30-day PBSM use was assessed using the 17-item version[24] of the Protective Behavioral Strategies-Marijuana Scale (PBSM)[16] on a 6-point response scale (1=*never*, 6=*always*). Example items include, "Avoid mixing marijuana with other drugs" and "Only use one time during day/night" (items were averaged to create a total score; α=.92).

Marijuana use.—Typical marijuana use frequency and quantity was assessed using the Marijuana Use Grid (MUG),[25] a measure patterned from the Daily Drinking Questionnaire.[26] Specifically, each day of the week was broken down into 6 4-hour blocks of time (12a-4a, 4a-8a, 8a-12p, etc.), and participants were asked to report at which times they used marijuana during a "typical week" in the past 30 days as well as the quantity of grams consumed during that time block. We calculated typical frequency of marijuana use by summing the total number of time blocks for which they reported using during the typical week (ranges: 0-42). We calculated typical quantity of marijuana use by summing the total number of grams consumed across time blocks during the typical week.

CUD Symptoms.—CUD symptoms were assessed using the 8-item Cannabis Use Disorders Identification Test-Revised (CUDIT-R).[28] The CUDIT-R assesses the domains of consumption, cannabis problems (abuse), dependence, and psychological features (items were summed to create a total score; α=.83). Of note, 21.4% of the sample exceeded the cut-off for probable cannabis use disorder (based on a CUDIT-R score ≥ 13).[28]

Marijuana-related problems.—Past 30-day marijuana-related problems were assessed using the 21-item Brief Marijuana Consequences Questionnaire (B-MACQ).[27] Each item was scored dichotomously to reflect presence/absence of the marijuana-related problem (0=*no*, 1=*yes*). Example items include, "I have been very unhappy because of my marijuana use" and "I have tried to quit using marijuana because I thought I was using too much" (items were summed to create a total score; α=.89).

Data analysis plan.—To test study aims, two saturated path models (see Figure 1) were conducted using M*plus* 7.4[29], such that double-mediated paths (i.e. sequential indirect effects) were examined for the association between PTSD symptoms and both CUD symptoms and marijuana-related problems via PBSM and marijuana use frequency/quantity (e.g., PTSD symptoms → PBSM → marijuana use frequency → marijuana problems). Two models were estimated to corroborate findings across marijuana use frequency and quantity of use. As gender differences exist for marijuana use and PBSM use,[17] gender was modeled as a predictor of all variables in the models (i.e. covariate). Missing data were handled using full information maximum likelihood.[29] We examined the total, direct, and indirect effects using bias-corrected bootstrapped estimates[30] which provides a powerful test of mediation[31] and is robust to small departures from normality.[32] Given our large sample size, statistical significance was determined by 99% bias-corrected bootstrapped confidence intervals not containing zero.

Results

Bivariate correlations and descriptive statistics of all study variables are presented in Table 1. The total, total indirect, specific indirect, and direct effects of the mediation models are summarized in Table 2 and Figure 1. It is important to note that two additional models were conducted controlling for possible site differences, but results did not change and thus we present the more parsimonious models.

Mediation Effects

Across both models, PBSM use significantly mediated the associations between PTSD symptoms and all marijuana use outcomes (i.e. marijuana use frequency, marijuana use quantity, CUD symptoms, and marijuana-related problems). Further, all double-mediated associations (i.e. PTSD symptoms predicting PBSM use, then PBSM use predicting marijuana use frequency/quantity, then marijuana use frequency/quantity predicting CUD symptoms and marijuana-related problems) were significant such that higher PTSD symptoms were associated with lower PBSM use which in turn was associated with higher marijuana use frequency/quantity, which in turn was associated with more CUD symptoms and marijuana-related problems. As a measure of effect size for mediated effects, we calculated the relative indirect effect using unstandardized values by dividing the specific indirect effect from the total effect.[33]

In Model 1, PBSM use accounted for 70.3% of the total effect of PTSD symptoms on marijuana use frequency, 8.0% of the total effect of PTSD symptoms on marijuana-related problems, and 8.8% of the total effect of PTSD symptoms on CUD symptoms. Further, the double mediated effect via PBSM use and marijuana use frequency accounted for an

additional 12.5% of the total effect of PTSD symptoms on CUD symptoms and 8.0% of the total effect of PTSD symptoms on marijuana-related problems.

In Model 2, PBSM use accounted for 51.6% of the total effect of PTSD symptoms on marijuana use quantity, 16.3% of the total effect of PTSD symptoms on CUD symptoms, and 14.0% of the total effect of PTSD symptoms on marijuana-related problems. Further, the double mediated effect via PBSM use and marijuana use quantity accounted for an additional 5.0% of the total effect of PTSD symptoms on CUD symptoms and 2.0% of the total effect of PTSD symptoms on marijuana-related problems. It is important to note that even when accounting for the effects of PBSM and marijuana use quantity/frequency, there still remained significant positive direct effects between PTSD symptoms and both CUD symptoms (β=.17) and marijuana-related problems (β=.17) .

Discussion

The purpose of this study was to test whether PBSM mediated the relationships between PTSD symptoms and marijuana-related outcomes. Although PTSD symptoms were not significantly associated with marijuana use frequency or quantity, they were significantly associated with CUD symptoms and marijuana-related problems, which is consistent with past research examining the associations between PTSD symptoms and CUD.[10] One explanation for the lack of association between PTSD symptoms and marijuana use frequency/quantity may be that these individuals are not necessarily using more marijuana or using marijuana more frequently than their peers with fewer PTSD symptoms, but rather they are using in more hazardous ways (e.g., with other substances, at inappropriate times such as before work or school) which contributes to greater CUD symptoms and marijuana-related problems. PBSM did significantly mediate the relationships PTSD symptoms had with each marijuana use outcome (i.e. marijuana use frequency, marijuana use quantity, CUD symptoms, and marijuana-related problems). When examining double mediations, PBSM significantly predicted marijuana use frequency/quantity, which in turn significantly predicted CUD symptoms and marijuana-related problems. Thus, the association between higher PTSD symptoms and greater experience of CUD symptoms and marijuana-related problems may be explained in part by using fewer PBSM and subsequently using marijuana more frequently and in larger amounts. PBSM use thus appears to be a factor that, if enhanced, could help mitigate the potentially harmful effects of marijuana outcomes. This interpretation is consistent with past literature showing PBSM appear to strengthen the impact of protective factors and weaken the impact of risk factors.[15]

These results provide preliminary support for the utility of assessing for marijuana and PBSM use when students are presenting for mental health services – in this case, PTSD symptoms. College students have some of the lowest rates of help seeking[1] and they are even less likely to seek help for substance use behaviors.[34,36] Thus, there appears to be an unmet need for interventions that address coexisting mental health and substance use problems on college campuses.[36] We believe our findings support integrated screening for and addressing marijuana misuse when college students seek counseling for psychological distress such as PTSD symptoms. Tailoring intervention efforts to address both problems simultaneously is likely to improve outcomes for those with PTSD symptoms by helping

students appreciate the potential links between their PTSD symptoms and marijuana misuse. This approach could allow for the promotion of harm reduction practices such as PBSM and consequently help students learn healthier behaviors to cope with their negative affect. There is existing evidence supporting the utility of an easily accessible electronic marijuana intervention including PBSM education for college students such that the intervention was associated with less marijuana use for among heavy marijuana users.[37] Our results highlight the importance of continuing to incorporate PBSM into marijuana education and prevention efforts in various media (e.g., electronically, clinical contexts) on college campuses as well as extending these interventions to specific subsets of the college student population, including those with PTSD symptoms.

Our results highlight some future directions for investigation. As this study is the first to investigate the mediating effects of PBSM on the relationship between PTSD symptoms and marijuana outcomes, replication is important. It may be valuable to examine other factors known to predict marijuana use (e.g., marijuana use motives, norms) in models of PTSD symptoms and PBSM use as this would provide a more nuanced understanding of these relationships. For example, the link between PTSD and using substances to cope has been established.[38] However, the relationship between using marijuana to cope with PTSD symptoms and students' PBSM use has yet to be investigated. Similarly, it would be valuable to study how the relationships explored in this study may be influenced by demographic variables such as gender and race. Further exploration of the links between marijuana outcomes, PBSM, and other mental health problems (e.g., depression, anxiety) is needed in light of our results.

There are several limitations to the present study. First, the cross-sectional, correlational study design does not allow for interpreting causality in relationships. Further, we did not obtain a nationally representative sample, which limits the generalizability of our findings. Additionally, a technical diagnosis of PTSD requires the presence of a Criterion A trauma,[13] which was not assessed for in this study. Future studies should incorporate measures such as the Life Events Checklist (LEC-5) or a clinical interview to accurately assess for PTSD symptoms through establishing whether Criterion A is met.

Overall, this study provided additional evidence that PTSD symptoms are associated with CUD symptoms and marijuana-related problems. Further, this study demonstrated that use of PBSM might help explain this relationship. Understanding that PBSM use does impact the relationship between PTSD symptoms and marijuana outcomes provides important information for those coordinating and implementing prevention and intervention strategies for college students reporting PTSD symptoms and endorsing marijuana use.

Acknowledgments:

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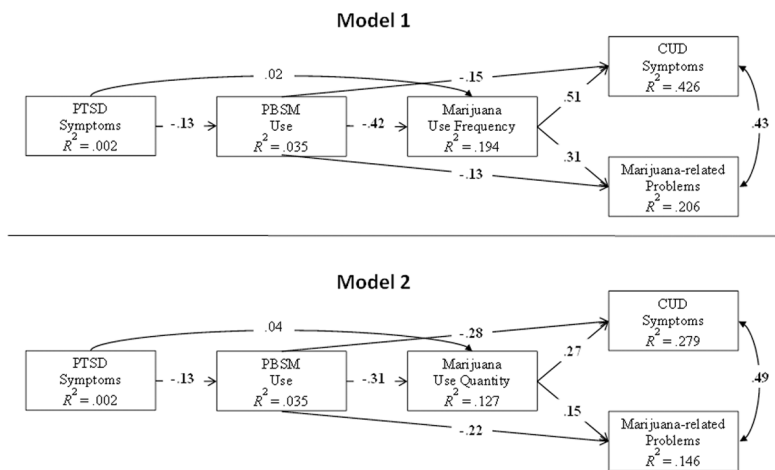
Model 1

Model 2

Figure 1.
Depicts the standardized effects of the two mediation models. Significant associations are in bold typeface for emphasis and were determined by a 99% bias-corrected standardized bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. The direct effects of PTSD symptoms on CUD symptoms/problems are not shown in the figure for parsimony but are shown in Table 2. Effects of gender as a covariate are available from the authors upon request.

Table 1.

Bivariate correlations and descriptive statistics among all study variables

	1	2	3	4	5	6	7	M	SD
1. PTSD Symptoms	---							16.95	17.38
2. PBSM	−.13	---						4.32	1.11
3. Marijuana Use Quantity	.08	−.31	---					7.49	14.04
4. Marijuana Use Frequency	.07	−.43	.65	---				6.55	8.37
5. CUD Symptoms	.22	−.41	.39	.60	---			8.16	6.15
6. Marijuana-related Problems	.20	−.30	.24	.39	.58	---		3.43	1.85
7. Gender	.04	.14	−.16	−.15	−.19	−.13	---	0.69	0.46

Note. Gender was coded 0 = male, 1 = female. Significant correlations are in bold typeface for emphasis and were determined by a 99% bias-corrected bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. PBSM = Protective Behavioral Strategies for Marijuana. CUD = Cannabis Use Disorder.

Table 2.

Summary of total, indirect, and direct effects of mediation models

Model 1: PTSD → PBSM Use → Marijuana Use Frequency → CUD Symptoms/Problems

Outcome Variables:	Marijuana Use Frequency		CUD Symptoms		Marijuana-related Problems	
Predictor Variable: *PTSD Symptoms*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**
Total	0.08	−0.01, 0.16	0.23	0.14, 0.31	0.21	0.13, 0.29
Total indirect [a]	0.05	0.02, 0.09	0.06	0.01, 0.11	0.04	0.01, 0.08
PBSM Use	0.05	0.02, 0.09	0.02	0.01, 0.04	0.02	0.004, 0.04
Marijuana Use Frequency	---	---	0.01	−0.03, 0.06	0.01	−0.02, 0.03
PBSM Use – Marijuana Use Frequency	---	---	0.03	0.01, 0.05	0.02	0.01, 0.03
Direct	0.02	−0.06, 0.11	0.17	0.10, 0.24	0.17	0.08, 0.24
Predictor Variable: *PBSM Use*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**
Total	−0.42	−0.49, −0.34	−0.36	−0.44, −0.28	−0.26	−0.34, −0.19
Total indirect (Marijuana Use Frequency)	---	---	−0.21	−0.26, −0.17	−0.13	−0.18, −0.08
Direct	−0.42	−0.49, −0.34	−0.15	−0.23, −0.08	−0.13	−0.24, −0.04
Predictor Variable: *Marijuana Use Frequency*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**
Direct	---	---	0.51	0.43, 0.59	0.31	0.20, 0.43

Model 2: PTSD → PBSM Use → Marijuana Use Quantity → CUD symptoms/Problems

Outcome Variables:	Marijuana Use Quantity		CUD Symptoms		Marijuana-related Problems	
Predictor Variable: *PTSD Symptoms*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**
Total	0.08	−0.02, 0.19	0.23	0.14, 0.31	0.21	0.13, 0.29
Total indirect [a]	0.04	0.02, 0.07	0.06	0.02, 0.10	0.04	0.02, 0.07
PBSM Use	0.04	0.02, 0.07	0.04	0.02, 0.07	0.03	0.01, 0.05
Marijuana Use Quantity	---	---	0.01	−0.01, 0.04	0.01	−0.01, 0.03
PBSM Use – Marijuana Use Quantity	---	---	0.01	0.004, 0.02	0.01	0.002, 0.01
Direct	0.04	−0.06, 0.14	0.17	0.09, 0.24	0.17	0.08, 0.25
Predictor Variable: *PBSM Use*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**
Total	−0.31	−0.38, −0.24	−0.36	−0.44, −0.28	−0.26	−0.34, −0.19
Total indirect (Marijuana Use Quantity)	---	---	−0.08	−0.12, −0.05	−0.05	−0.08, −0.02
Direct	−0.31	−0.38, −0.24	−0.28	−0.36, −0.20	−0.22	−0.31, −0.13
Predictor Variable: *Marijuana Use Quantity*	**β**	**99% CI**	**β**	**99% CI**	**β**	**99% CI**

Model 1: PTSD → PBSM Use → Marijuana Use Frequency → CUD Symptoms/Problems

Outcome Variables:	Marijuana Use Frequency		CUD Symptoms		Marijuana-related Problems	
Predictor Variable: *PTSD Symptoms*	β	99% CI	β	99% CI	β	99% CI
Direct	---	---	**0.27**	**0.17, 0.37**	**0.15**	**0.05, 0.25**

Note. Significant associations are in bold typeface for emphasis and were determined by a 99% bias-corrected standardized bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero.

[a] Reflects the combined indirect associations via PBSM use, marijuana use frequency/quantity, PBSM use via marijuana use frequency/quantity. For both models, PTSD symptoms was significantly associated with lower PBSM use (β=−.13, 99% CI [−0.21, −0.05]. Effects of gender as a covariate are available from the authors upon request.