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Marijuana use in the context of alcohol interventions for mandated college students

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Abstract

Objective—Concurrent use of marijuana and alcohol among college students is highly prevalent and associated with negative consequences. It remains unclear whether marijuana use is influenced by or lessens the efficacy of alcohol interventions delivered within a stepped-care approach.

Method—Participants were 530 college students who violated campus alcohol policy and were mandated to an alcohol-focused brief advice (BA) session. Participants who reported continued risky alcohol use (4+ heavy drinking episodes and/or 5+ alcohol-related consequences in the past month) six weeks following the BA session were randomized to a brief motivational intervention (BMI; n = 211) or assessment only (AO; n = 194) condition. Follow-up assessments were conducted 3, 6, and 9 months' post-intervention.

Results—Multiple regression analyses revealed that marijuana user status did not influence drinking outcomes following the BA session. However, hierarchical linear models suggested that marijuana users who were randomized to BMI or AO reported higher levels of binge drinking, pBAC and consequences compared to non-users, regardless of condition. Despite this, heavy drinking marijuana users and nonusers had equivalent reductions on alcohol use outcomes following the BMI sessions. Marijuana users who received a BMI did not significantly reduce marijuana use frequency compared to participants in the AO group.

Conclusion—Use of marijuana did not lessen the efficacy of the BA session on alcohol use or consequences. Findings suggest that marijuana users respond similarly to alcohol interventions as

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do non-users and can benefit from brief or more intensive alcohol interventions. A marijuana-focused intervention may be warranted to facilitate changes in marijuana use.

Keywords

Motivational Interventions; Alcohol; Marijuana; Stepped-care

1. Introduction

College students often drink alcohol and use drugs simultaneously during parties and other social events (Murphy et al., 2006; Stinson et al., 2005). Dual marijuana and alcohol use is especially prevalent, with 47% of marijuana users reporting simultaneous use of alcohol (Haas et al., 2015). Furthermore, individuals who have a cannabis use disorder (CUD) are at increased likelihood for the development of an alcohol use disorder (AUD; Stinson et al., 2006, Agosti et al., 2002; Regier et al., 1990), and rates of substance use disorders and treatment admissions are highest among individuals that use marijuana or alcohol compared to other substances (SAMHSA, 2011). Approximately 68% of individuals with current CUD and over 86% of those with a history of CUD meet criteria for an AUD (Agrawal et al., 2007; Stinson et al., 2006). Cannabis dependence doubles the risk for long-term persistent alcohol consequences (Copeland et al., 2012) and dual marijuana and alcohol users consume higher levels of alcohol and experience more alcohol-related consequences than only drinkers (Shillington & Clapp, 2001, 2006; Simons & Carey, 2006; Simons et al., 2010). Despite these additional risks, 60% of college students do not perceive regular marijuana use to be harmful (Miech et al., 2015).

The combination of low perceived risk, policy changes surrounding marijuana legalization, and the rise in marijuana use over the past 10 years (SAMHSA, 2014) heightens the importance of effective interventions for alcohol and marijuana use. In the adult substance use treatment literature, it is relatively well-established that alcohol use negatively impacts treatment of other substances (e.g., cigarette smoking, cocaine; Fiore et al., 2008; Kahler et al., 2010; Leeman et al., 2008; Pulido et al., 2014). In contrast, literature examining the impact of marijuana use on the treatment of other substances is mixed. With the exception of a few studies that do not show marijuana use to negatively influence alcohol or smoking cessation outcomes (Magill et al., 2009; Metrik et al., 2011), many studies have demonstrated that using marijuana before or during alcohol treatment is associated with higher levels of drinking at follow-up (Alessi et al., 2011; Mojarrad et al., 2014; Subbaraman et al., 2016). For example, among alcohol dependent individuals, those who used marijuana during alcohol treatment reported fewer days abstinent from alcohol one year following treatment than those who did not use marijuana (Subbaraman et al., 2016). Thus, marijuana use seems to have a negative impact on alcohol treatment outcomes.

A number of studies have also examined secondary changes in marijuana use following receipt of an alcohol-specific intervention. A recent integrative data analysis study indicated that alcohol BMIs may not facilitate changes in marijuana use among college students (White et al., 2015); instead, regardless of treatment condition, college students who successfully reduced their drinking at short- and long-term follow-ups were more likely to

be non-users of marijuana or reduce their marijuana use at follow-up. This complementary relationship between marijuana and alcohol use is also supported by research indicating that the risk factors for initiation and maintenance of problematic use are similar across substances (Simons et al., 2005). Together, these studies suggest that interventions for alcohol may lead to secondary changes in marijuana use. Consistent with this hypothesis, young adults who participated in an in-person BMIs for alcohol use in an emergency department (ED) setting reported greater decreases in marijuana use at the 6-month follow-up than those who received feedback only (Magill et al., 2009). Similarly, weekly marijuana users who were seeking treatment for cigarette smoking and completed a brief alcohol intervention within the context of the smoking cessation intervention, demonstrated reductions not only in heavy drinking and tobacco smoking but also in marijuana use (Metrik et al., 2011). In the college setting, BMIs that target multiple substances have also been associated with reductions in poly-drug use (McCambridge & Strang, 2004; White et al., 2006, 2007).

One explanation for the differential influence of alcohol interventions on marijuana use across these studies may be related to the populations examined. Thus far, alcohol interventions delivered to acute-risk populations (ED patients and treatment-seeking individuals) have had an impact on marijuana use outcomes, while collectively, interventions delivered to ‘college students’ have not. However, college students are a heterogeneous population, and not all require the same level of intervention (Barnett et al., 2008; Barnett & Read, 2005). To our knowledge, no one has examined the influence of an alcohol intervention on marijuana use when alcohol interventions are provided sequentially in the context of stepped care, in which individuals who do not respond to an initial, low-intensity level of treatment are provided a more intensive treatment (Borsari, 2012; McKellar et al., 2012; Sobell & Sobell, 2000).

The purpose of the current study was to examine marijuana use in the context of a stepped care intervention for alcohol use. We conducted a secondary analysis of data from a randomized clinical trial implementing stepped care with mandated college students (Borsari et al., 2012). In this study, all participants received a brief advice (BA) session (Step 1) administered by a peer counselor. Participants who continued to drink in a risky manner (4 or more heavy episodic drinking [HED] incidents and/or 5 or more alcohol-related consequences in the past month) six weeks following the BA session were randomly assigned to either BMI or AO conditions (Step 2). Step 2 participants who completed the BMI as opposed to AO reported greater reductions in alcohol-related consequences (but not alcohol use) at all follow-up assessments (3-, 6-, and 9-months).

We tested three hypotheses to examine whether interventions that reduce alcohol-related outcomes may also reduce marijuana use. First, because dual marijuana and alcohol users consume higher levels of alcohol use and experience more alcohol-related consequences (Simons et al., 2010), we hypothesized that marijuana users (compared to non-users) would report higher HED frequency, peak blood alcohol content (pBAC), and alcohol related consequences in the 6 weeks following a BA session, after controlling for their pre-BA drinking behavior. Second, we hypothesized that heavy-drinking marijuana users who did not respond to the BA session and, therefore, were randomized to a Step 2 BMI or AO

would report worse alcohol-related outcomes at 3-, 6-, and 9-month follow-ups than non-users. Third, we examined whether marijuana users changed their marijuana use frequency at any of the three assessment time points following the Step 2 BMI. Examination of marijuana use in this context will improve our understanding of whether marijuana use lessens the efficacy of alcohol interventions, even when delivered sequentially in stepped care. Furthermore, it will inform future intervention efforts aimed at reducing both alcohol and marijuana use.

2. Method

2.1 Participants and procedures

Participants were 530 undergraduate students (67% male; 96% Caucasian) age 18 years and older who violated the campus alcohol policy at a four-year, private, liberal arts university in the Northeast (Borsari et al., 2012). Students were referred to the student health office for mandatory counseling following adjudication by campus judicial affairs staff, agreed to participate in the study and provided informed consent. All students received Step 1, a manualized, 10 to 15-minute Brief Advice (BA) session that was administered by a peer counselor (fellow college student). Six weeks after the BA session, participants completed an online assessment. Higher risk students (i.e., those who reported 5 or more alcohol-related consequences and 4 or more HED occasions in the past month) were eligible to receive the next step of care and were randomly assigned to BMI (n = 211) or AO (n = 194). Lower-risk drinkers (4 or fewer alcohol-related consequences and 3 or fewer HED episodes; n = 125) were not randomized to Step 2 nor were provided additional intervention, but completed follow-up assessments at 3- 6- and 9-months.

2.2 Interventions

Step 1: BA session—The manualized BA was administered by a peer counselor and was mostly didactic psychoeducation (Cunningham et al., 2001). In addition, counselors solicited personal information from participants using open-ended questions and gave participants the opportunity to ask questions or discuss their personal alcohol use. The average time of the BA session was 14.07 minutes (SD = 4.59).

Step 2: BMI—This manualized BMI (adapted from Dimeff, Baer, Kivlahan, & Marlatt, 1999) has resulted in significant reductions in alcohol use and consequences with both mandated and non-mandated students in similar trials (Borsari & Carey, 2000, 2005; Carey et al., 2009; Hustad et al., 2014). During the BMI, participants reviewed a personalized feedback report of their responses to the baseline and six-week follow-up assessments, including perceived descriptive norms, BAC and tolerance, alcohol-related consequences, influence of setting on drinking, and alcohol expectancies. The BMIs were delivered by PhD students or postdoctoral fellows (n = 11), and subsequent transcription coding analysis of BMI sessions revealed high Motivational Interviewing fidelity (MI; see Miller & Rollnick, 2002) and consistent delivery of intervention components (see Borsari et al., 2015). The average length of the BMIs was 52.54 minutes (SD = 12.12).

2.3 Measures

Demographic information—Participants provided information regarding their gender, age, weight, year in school, race/ethnicity, and current residence.

Marijuana use frequency—Participants indicated how many times they used marijuana in the past 30 days at baseline and at each follow-up assessment time point. Because marijuana use was highly zero-inflated (58.3% at baseline, 41.8% at first follow-up reported no use), and due to our interest in whether being a marijuana user influenced intervention outcomes, dichotomous variables were created to group individuals into user (at least one day of marijuana use in the past month) versus non-user for use in analyses to compare these subgroups.

Alcohol use—Alcohol use was assessed using the *Alcohol and Drug Use Measure* (Borsari & Carey, 2000, 2005) at baseline and each follow-up. To determine if participants who completed Step 1 of the intervention would also complete Step 2, participants reported the number of times they engaged in heavy episodic drinking (HED), defined as consumption of 5+ drinks for males (4+ for females), in the past month. The maximum number of drinks consumed during their highest drinking event in the past month and the amount of time spent drinking during this episode were used to calculate the students' estimated peak blood alcohol concentration (pBAC) using the Matthews & Miller (1979) equation and an average metabolism rate of 0.017 g/dL per hour.

Alcohol-related consequences—Alcohol-related consequences were assessed using the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler et al., 2005), a 24-item subset of the 48-item Young Adult Alcohol Consequences Questionnaire (YAACQ: Read et al., 2006). Dichotomous items (yes/no) are summed for a total number of consequences experienced in the past month. The B-YAACQ is reliable and sensitive to changes in alcohol use over time (Kahler et al., 2008) and has demonstrated high internal consistency in research with college students (Kahler et al., 2005). In this study, the B-YYACQ demonstrated good internal consistency at baseline, 6-week and follow-up assessments (Cronbach alphas ranged from .85 -.89).

2.4 Data Analytic Plan

First, distributions of outcome variables (HED, pBAC, alcohol-related consequences, and marijuana use frequency) were examined, and outliers falling three standard deviations above the mean were recoded to the highest non-outlying value plus one (Tabachnick & Fidell, 2012), resolving initial non-normality in outcomes. Demographic information and descriptive statistics for the outcome variables were calculated (see Tables 1-2).

To examine marijuana users' (vs non-marijuana users') drinking behavior following BA for alcohol misuse (hypothesis 1), multiple regression models were run to predict each alcohol outcome variable at the 6-week assessment from baseline marijuana user status (yes/no), controlling for gender and the corresponding alcohol outcome assessed at baseline.

To test hypotheses 2 and 3, hierarchical linear models (HLM) were run in the HLM 7.01 program (Raudenbush et al., 2013), using full maximum likelihood estimation. HLM is ideal for data nested within participants across time, for testing between-person (Level 2) effects (i.e., treatment condition, marijuana user status) and within-person (Level 1) effects (i.e., time) on outcomes. An additional advantage of HLM is its flexibility in handling missing data at the within-person level, allowing us to retain for analysis any participant that contributed at least one follow-up assessment. We interpreted models that relied on robust standard errors in the determination of effect significance. All intercepts and slopes were specified as random in order to account for individual variation in both mean levels of the outcomes and time-varying associations.

Fully unconditional HLM models (i.e., no predictors) were run first in order to determine intraclass correlations (ICCs) for each outcome. ICCs provided information on the percentage of variation in each outcome at both the between- and within-person level. Next, three dummy coded time components were created for inclusion at Level 1. The first was coded (0, 1, 0, 0) and therefore allowed examination of the impact of effects on change in the outcome variable from baseline to the first follow-up, the second was coded (0, 0, 1, 0) to model the impact of effects on change in the outcome variable from baseline to the second follow-up (6-months), and the third was coded (0, 0, 0, 1) in order to estimate the impact of effects on change in the outcome variable from the first to the third follow-up (9- months). In the context of these three dummy codes, effects on the intercept represent effects when all time effects are equal to 0 (i.e., at baseline). Of note, as all participants received a BA session in the interim between the true baseline and 6-week (pre-BMI) assessment, marijuana user status at the 6-week assessment was used as the baseline for these analyses (rather than using the true study baseline and is henceforth referred to as the pre-BMI assessment).

To address hypothesis 2 (i.e., whether marijuana use status moderated the effect of treatment on HED frequency, pBAC, consequences at each follow-up), Level 2 effects for marijuana user status, treatment condition, and the interaction between marijuana user status and treatment condition were regressed on the three time components. Following recommendations of Aiken and West (1991), prior to forming interactions, marijuana user status and treatment condition were recoded using effects coding (i.e., centered at the mean value of the dichotomous variable), to remove collinearity with interaction terms so that all main effects of time could be evaluated in the context of models including interactions. To control for potential baseline group differences, we also regressed marijuana user status and treatment condition on the intercept.

To address hypothesis 3 [i.e., whether treatment group (BMI vs AO) impacts marijuana use frequency at any of the three follow-up time points, among those who reported marijuana use at 6-week pre-BMI assessment], at Level 2, treatment condition was regressed on the Level 1 intercept (baseline levels) and all three time effects (change from pre-BMI assessment to the first, second, and third follow-ups) of marijuana use frequency. In models for both hypotheses 2 and 3, at Level 2, gender also was included as a covariate.

3. Results

3.1 Preliminary Analyses

Descriptive statistics for the full sample of 530 are presented in Tables 1-2. Among participants randomized to BMI or AO in Step 2 (n = 405), the person-period data set was represented by 392 participants with complete baseline data (necessary for estimation of the HLM models), each with up to 3 follow-up assessments. Across these participants, we have complete data for a total of 1084 out of 1176 assessments (92%). Specifically, 368 (94%) participants completed the 3-month follow-up, 349 (89%) completed the 6-month follow-up, and 367 (94%) completed the 9-month follow-up. The ICC for alcohol consequences was . 63 meaning that 63% of the variance in consequences is due to between-person differences, while 37% is due to within-person differences across the follow-ups. The ICCs for HED frequency and pBAC were .53 and .52, respectively. In the subset of participants (n = 228) who reported marijuana use at the pre-BMI assessment and were therefore included in hypothesis 3 analyses, the ICC of marijuana frequency was .59. In all cases, a two-level model was appropriate.

3.2 Associations of Marijuana User Status and Alcohol Outcomes following BA Session

Multiple regression models indicated that baseline marijuana user status was not associated with changes in HED frequency, pBAC, or alcohol consequences following the BA session (all p's > .05; see Table 3).

3.3 Associations of Marijuana User Status and Alcohol Outcomes following BMI

Results of the HLM models predicting three alcohol outcomes at each follow-up by marijuana user status, treatment condition, and marijuana user status by condition interactions (hypothesis 2) are displayed in Table 4. In the prediction of HED frequency, marijuana user status was associated with higher baseline HED frequency; however, being a marijuana user was not associated with more or less change in HED frequency between the pre-BMI assessment and any of the three follow-ups. There were no interactions between marijuana user status and treatment condition at any follow-up, suggesting that the BMI was not more or less effective for marijuana users. In the prediction of pBAC, marijuana user status was associated with higher pre-BMI pBAC. Additionally, those in the BMI condition had significantly lower pre-BMI pBACs. Controlling for these pre-BMI differences, being a marijuana user, treatment condition, and their interaction were all non-significantly associated with change in pBAC from pre-BMI to each of the follow-ups. In the prediction of alcohol consequences, being a marijuana user was associated with higher pre-BMI levels of consequences. There were no significant effects of marijuana user status, treatment condition, or their interaction on change in consequences between baseline and either the 3- or the 6- month follow-ups. At the 9-month follow-up, those in the BMI reported fewer alcohol consequences[1]; however, this was not moderated by marijuana user status. Overall, these findings suggest that collapsing across treatment condition, marijuana users had

[1]Results of the parent study (Borsari et al., 2012) found a reduction in alcohol related problems 3-months following receipt of the BMI that was maintained at 9-months. The delay in the effect of the BMI on alcohol related consequences found in the current study may be a result of having a smaller sample size due to the need to have complete baseline (pre-BMI) data to estimate HLM models and/or differences in variables controlled for in the model such as marijuana user status.

heavier alcohol consumption and consequences compared to non-users at the pre-BMI assessment, but they did not increase or decrease their consumption or consequences (compared to non-users) between pre-BMI and any of the follow-ups. Additionally, marijuana users responded to the BMI similarly to non-marijuana users at each time point (i.e., we did not observe any marijuana user x condition interactions).

3.4 Relationship of BMI and Marijuana Use Frequency among Users

Table 5 presents the results of the model examining the effect of treatment condition on marijuana use frequency among participants who were randomized to treatment or AO conditions and who reported marijuana use at the pre-BMI assessment. Controlling for gender, receiving a BMI was not associated with differences in marijuana use frequency at any of the three follow-ups.[2]

4. Discussion

The purpose of the current study was to examine whether heavy drinking marijuana users demonstrate poorer response to two different alcohol-focused interventions compared to non-users and to examine the efficacy of an alcohol-focused BMI on marijuana use frequency among marijuana users receiving stepped care for alcohol use. Our findings indicated that marijuana users and nonusers evidenced equivalent treatment responses to the alcohol-focused Step 1) BA session and reported similar alcohol-related outcomes following the (Step 2) BMI. Consistent with prior research (White et al., 2015), the alcohol-focused BMI did not significantly reduce marijuana use frequency in comparison to the assessment-only group. In our sample, marijuana users did report higher alcohol consumption and problems at baseline/pre-BMI regardless of condition, and these differences between users and non-users persisted over time.

The findings of the current study are somewhat consistent with studies indicating that marijuana use does not decrease the efficacy of alcohol interventions (Magill et al., 2009; Metrik et al., 2011). Although marijuana use did not necessarily lessen the efficacy of the BA and BMI sessions on alcohol use and consequences, regardless of condition, marijuana users reported higher levels of alcohol consumption (HED frequency and pBAC) and consequences at baseline and the pre-BMI assessment. These patterns suggest that heavy drinking marijuana users may still benefit from alcohol use interventions. This is especially noteworthy because dual users typically report increased consequences related to their alcohol use (Simons et al., 2010) and may have a higher likelihood of being referred to alcohol-focused treatment or mandated to receive intervention for alcohol-related sanctions.

Although heavy drinking marijuana users may demonstrate reductions in alcohol consequences following an alcohol-focused intervention (at the 9-month follow-up), their frequency of marijuana use did not change as a result of receiving a BMI. We can posit

[2]Though not a part of the primary aims of this study, an additional exploratory model was run to better understand change in marijuana use. Specifically, among marijuana users, we tested for linear change in marijuana use frequency over the course of all 4 time points. This effect was significant (B=-0.99, *SE*=0.32, *t*=-3.06, *p*<.01), suggesting that across conditions, marijuana frequency declined over time. This may be due to a natural decline in use across time or assessment reactivity (Lee et al., 2013; Walters, Vader, Harris, & Jouriles, 2009).

several reasons for the participants' continued use of marijuana, despite a decrease in alcohol-related consequences. First, the parent study found a reduction in alcohol consequences following the alcohol-focused BMI, but not a decrease in alcohol consumption. Prior research examining secondary effects of alcohol BMIs have noted a decrease in marijuana use when there was also a decrease in alcohol consumption (White et al., 2015). It could be that factors that result in students' experiencing fewer alcohol-related consequences without changing their drinking (e.g., increases in protective behavioral strategies) differ from ones that would lead to reductions in alcohol or marijuana use. Although our study did not include a measure of marijuana-related consequences, future research should examine changes in marijuana consequences to investigate whether changes in alcohol-related consequences correspond with changes in marijuana consequences following alcohol-focused BMIs. Second, a lack of effects may be due to the fact that our BMI was focused solely on changing alcohol-related behaviors and did not discuss the participant's marijuana use. Future research should examine process coding in BMIs that do discuss marijuana use to explore possible in-session processes that may be related to changes in marijuana use and can be targeted in future interventions[3] (Apodaca & Longabaugh, 2009). Similarly, although alcohol and marijuana use share similar predictors (Simons et al., 2005), they may differ in their mechanisms of change. For example, the underlying motives that drive these two behaviors may vary so changing one will not ultimately lead to changes in the other and existing BMIs may not be targeting or altering both.

Third, the referral incident in this study may not have been severe enough to warrant an overall re-evaluation of substance use, as may have been the case for those who required a visit to the ED as a result of their alcohol use (Magill et al., 2009). Marijuana users may require a more focused intervention or a supplemental session that targets alternative substance free activities to facilitate changes in marijuana use (Yurasek et al., 2015). Finally, with growing trends in decriminalization and legalization of marijuana in the US, the perceived risk of marijuana has decreased among college students (Miech et al., 2015). Marijuana use may be more entrenched in the college social environment and more difficult to change without a targeted marijuana specific intervention.

The results of this study should be interpreted within the context of its limitations. First, our study is restricted by our measure of marijuana use, which was limited to frequency (times used in the past 30 days) and did not assess for marijuana-related consequences. Future studies may include assessments of quantity, days smoked, and consequences to get a better of understanding of the severity of participants' marijuana use. Although daily marijuana use is on the rise, with almost 6% of college students reporting daily use (Johnston et al., 2014), marijuana users in our study were using about 13.7 times in the past month. This is fairly low compared to those seeking treatment for marijuana use (Roebke et al., 2014) or being seen in an emergency department. Findings may be different in those populations where marijuana use is greater. For example, Metrik and colleagues (2011) found that compared to

[3]Although not presented in this study, a secondary data analysis was conducted to examine transcripts of the BMI sessions (Borsari et al., 2015). Examination of the transcripts of each of the BMI sessions revealed that marijuana use of the participants was not discussed.

lighter users, those who reported weekly marijuana use demonstrated a significant decrease in use following treatment. Furthermore, our measure of pBAC was derived from participants' reported heaviest drinking event and may not be the best way to capture peak BAC levels. Additionally, the study sample was predominantly white which may limit our ability to generalize findings to other populations of interest. Finally, we relied on self-reported data collection that did not include corroborating measures. Research using collateral informants indicated that mandated students may under-report alcohol use (Borsari & Muellerleile, 2009).

Despite these limitations, this study adds to the existing literature on the secondary effects of alcohol-focused BMIs. To our knowledge it is the first study to examine the influence of two different alcohol interventions on marijuana use in the context of stepped care. Furthermore, findings indicate that heavy drinking college students who also use marijuana may still benefit from alcohol treatment especially in reducing their alcohol related consequences. From a theoretical perspective, our results suggest that changing one behavior does not necessarily mean changes in another will occur, at least with respect to marijuana. However, future work should examine other health behaviors that might change as a result of reducing alcohol consequences. For example, it may be that increases in substance free activities like exercising, volunteering, or academic related behaviors occur alongside changes in alcohol-related behaviors (Murphy et al., 2015). Future research examining marijuana focused interventions of different intensity implemented in a stepped care approach may enhance our understanding of which interventions are most effective for college students with varying levels of involvement with marijuana.

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Highlights

- Marijuana use did not lessen the efficacy of brief advice on alcohol outcomes.
- Marijuana users in both groups reported higher levels of drinking behavior over time.
- Despite overall heavier drinking, marijuana users had comparable decreases in alcohol use as non-users after BMI.
- The BMI did not reduce marijuana use compared to the assessment-only group.
- A marijuana-focused intervention may be needed to reduce marijuana use.

Table 1

Descriptive statistics for the full sample (at true baseline) and marijuana users and non-users (as classified at 6-week pre-BMI assessment)

		Marijuana Users			Non-Users		
	Full sample (N = 530)	**BMI (*n* = 118)**	**AO (*n* = 116)**	**Total (*n* = 234)**	**BMI (*n* = 88)**	**AO (*n* = 82)**	**Total (*n* = 170)**
	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**
Gender							
Male	355 (67)	75 (64)	83 (72)	158 (68)	60 (68)	54 (66)	114 (67)
Female	175 (33)	43 (36)	33 (28)	76 (33)	28 (32)	28 (34)	56 (33)
Race							
White	509 (96)	116 (98)	108 (93)	224 (96)	87 (99)	75 (92)	162 (95)
Non-White	21 (4)	2 (2)	8 (7)	10 (4)	1 (1)	7 (9)	8 (5)
Year in School							
Freshman	360 (68)	76 (64)	88 (76)	164 (70)	56 (64)	55 (67)	111 (65)
Sophomore	126 (24)	34 (29)	19 (16)	53 (23)	22 (25)	20 (24)	42 (25)
Upperclassman	41 (8)	8 (7)	8 (7)	16 (7)	9 (10)	6 (7)	15 (9)
	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**
Age	18.68 (0.79)	18.65 (0.77)	18.60 (0.77)	18.69 (0.83)	18.68 (0.88)	18.70 (0.78)	18.69 (0.83)

Note. There were no significant baseline demographic or substance use group differences. AO = Assessment Only condition. BMI = Brief Motivational Intervention condition.

Table 2

Patterns of substance use for the full sample (at true baseline) and marijuana users and non-users (as classified at the 6-week pre-BMI assessment)

		Marijuana Users			Non-Users		
	Full sample (N = 530)	**BMI (*n* = 118)**	**AO (*n* = 116)**	**Total (*n* = 234)**	**BMI (*n* = 88)**	**AO (*n* = 82)**	**Total (*n* = 170)**
	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**
HED[1]							
Baseline	6.67 (4.86)	8.36 (4.81)	8.39 (4.59)	8.37 (4.69)	7.33 (4.57)	7.33 (4.57)	6.64 (4.60)
Pre-BMI (6 weeks)	6.38 (5.07)	8.59 (4.80)	8.47 (5.04)	8.53 (4.91)	5.91 (4.59)	7.39 (4.65)	6.62 (4.67)
3 months	5.99 (5.13)	7.58 (5.05)	7.86 (5.60)	7.72 (5.33)	5.04 (4.61)	6.41 (5.06)	5.68 (4.86)
6 months	5.70 (4.86)	7.21 (5.27)	6.96 (4.75)	7.08 (4.99)	4.78 (3.69)	6.65 (5.35)	5.69 (4.65)
9 months	5.97 (5.09)	7.67 (5.50)	7.14 (5.55)	7.41 (5.52)	5.17 (3.83)	6.49 (5.28)	5.81 (4.62)
Peak BAC[1]							
Baseline	.18 (.10)	.21 (.10)	.21 (.09)	.21 (.09)	.20 (.10)	.20 (.10)	.19 (.10)
Pre-BMI (6 weeks)	.18 (.10)	.22 (.09)	.22 (.10)	.22 (.09)	.17 (.09)	.22 (.10)	.19 (.10)
3 months	.17 (.10)	.20 (.09)	.20 (.10)	.20 (.09)	.15 (.08)	.19 (.10)	.16 (.10)
6 months	.16 (.10)	.19 (.10)	.18 (.10)	.18 (.10)	.14 (.09)	.19 (.11)	.17 (.10)
9 months	.16 (.10)	.18 (.09)	.18 (.10)	.18 (.10)	.15 (.09)	.18 (.11)	.16 (.10)
Alcohol consequences[1]							
Baseline	6.20 (4.58)	7.74 (4.73)	7.62 (4.51)	7.68 (4.61)	6.99 (4.38)	6.99 (4.38)	6.31 (4.33)
Pre-BMI (6 weeks)	5.96 (5.15)	8.09 (4.96)	8.39 (5.04)	8.24 (4.99)	5.33 (4.04)	6.32 (5.28)	5.80 (4.69)
3 months	5.29 (5.00)	6.33 (4.62)	7.71 (5.77)	7.03 (5.26)	4.24 (3.96)	5.72 (5.06)	4.94 (4.55)
6 months	5.01 (5.10)	6.22 (5.03)	7.05 (5.71)	6.65 (5.39)	3.59 (4.04)	5.85 (5.49)	4.69 (4.92)
9 months	5.15 (5.07)	5.89 (4.63)	7.43 (5.49)	6.65 (5.12)	3.64 (3.99)	6.12 (5.92)	4.84 (5.15)
Frequency MJ use[1]							
Baseline	5.42 (18.34)	10.73 (30.27)	8.79 (12.24)	9.76 (23.06)	.70 (3.70)	.70 (3.70)	.67 (2.9)
Pre-BMI (6 weeks)	7.08 (16.29)	14.14 (19.58)	13.19 (16.90)	13.67 (18.26)	0 (0.0)	0 (0.0)	0 (0.0)
3 months	6.25 (13.87)	10.12 (16.02)	10.19 (14.80)	10.16 (15.38)	2.09 (11.44)	2.03 (7.58)	2.06 (9.79)
6 months	6.01 (13.84)	11.22 (16.01)	8.96 (17.70)	10.04 (16.91)	1.78 (6.63)	1.19 (3.81)	1.49 (5.44)

		Marijuana Users			Non-Users		
	Full sample (N = 530)	**BMI (*n* = 118)**	**AO (*n* = 116)**	**Total (*n* = 234)**	**BMI (*n* = 88)**	**AO (*n* = 82)**	**Total (*n* = 170)**
	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**
9 months	6.56 (18.69)	11.37 (18.53)	10.27 (20.92)	10.82 (19.72)	0.96 (3.44)	1.51 (7.00)	1.23 (5.45)

Note. AO = Assessment Only condition. BAC = blood alcohol concentration. BMI = Brief Motivational Intervention condition. HED = heavy episodic drinking.

[1]In the past month. MJ = Marijuana

Table 3

Multiple regression models examining MJ user status as a predictor or 6-week (post-BA) values on alcohol consequences, HED frequency, and peak BAC

Predicting Alcohol Consequences	**B**	***B***	***p***
MJ user status	-.03	-.00	.93
Gender	.13	.01	.72
Baseline Consequences	.78	.70	<.001
Adj R^2		.49	
F		154.50, p<.001	
Predicting HED Frequency			
MJ user status	.55	.06	.09
Gender	.38	.04	.41
Baseline HED Frequency	.65	.63	<.001
Adj R^2		.41	
F		116.24, p<.001	
Predicting Peak BAC			
MJ user status	.01	.04	.26
Gender	-.004	-.02	.64
Baseline Peak BAC	.65	.62	<.001
Adj R^2		.40	
F	112.43, p<.001		

Note. BA = Brief Advice Session. BAC = blood alcohol concentration. BMI = Brief Motivational Intervention condition. HED = heavy episodic drinking. MJ = Marijuana. Gender was coded as 0 for males and 1 for females

Table 4

Hierarchical linear models examining 6-week (pre-BMI) marijuana use status as a predictor of alcohol outcomes following the BMI

	HED Frequency				Peak BAC				Alcohol Consequences			
	B	***SE***	***t*-ratio**	***p***	***B***	***SE***	***t*-ratio**	***p***	***B***	***SE***	***t*-ratio**	***p***
Intercept (Baseline) (β_{00})	8.05	0.28	28.51	<.001	0.21	0.01	36.96	<.001	7.26	0.31	23.79	<.001
Gender (β_{01})	-0.68	0.53	-1.28	.20	0.004	0.01	0.41	.69	0.12	0.50	0.24	.81
Condition (β_{02})	-0.59	0.48	-1.22	.22	-0.02	0.01	-2.17	.03	-0.70	0.49	-1.43	.15
MJ user (β_{03})	1.81	0.48	3.75	<.001	0.02	0.01	2.58	.01	2.33	0.49	4.73	<.001
3-month follow-up (β_{10})	-0.71	0.31	-2.25	.03	-0.02	0.01	-3.75	<.001	-0.92	0.27	-3.43	<.001
Gender(β_{11})	-0.66	0.52	-1.26	.21	-0.01	0.01	-0.86	.39	-0.57	0.51	-1.10	.27
Condition (β_{12})	-0.07	0.50	-0.13	.90	0.004	0.01	0.41	.69	-0.75	0.46	-1.61	.11
MJ user (β_{13})	0.15	0.52	0.29	.77	0.01	0.01	1.07	.29	-0.27	0.47	-0.57	.57
MJ user*Condition (β_{14})	0.14	0.92	0.15	.88	0.01	0.02	0.83	.41	-0.46	0.84	-0.55	.58
6-month follow-up (β_{20})	-0.81	0.31	-2.64	.01	-0.03	0.01	-4.44	<.001	-1.13	0.29	-3.86	<.001
Gender (β_{21})	-1.37	0.49	-2.76	.01	-0.02	0.01	-1.59	.11	-0.76	0.51	-1.48	.14
Condition (β_{22})	0.19	0.49	0.40	.69	0.01	0.01	0.54	.59	-0.76	0.48	-1.57	.12
MJ user (β_{23})	-0.39	0.49	-0.80	.42	-0.01	0.01	-0.71	.48	-0.37	0.49	-0.77	.44
MJ user*Condition (β_{24})	1.62	0.87	1.86	.06	0.03	0.02	1.45	.15	1.08	0.89	1.22	.23
9-month follow-up (π_{3i})	-0.47	0.34	-1.39	.17	-0.03	0.01	-5.05	<.001	-1.04	0.28	-3.75	<.001
Gender (β_{31})	-2.00	0.54	-3.67	<.001	-0.02	0.01	-1.74	.08	-0.98	0.51	-1.93	.06
Condition (β_{32})	0.51	0.53	0.95	.34	0.01	0.01	1.34	.18	-1.18	0.47	-2.51	.01
MJ user (β_{33})	-0.27	0.53	-0.50	.62	-0.01	0.01	-0.69	.49	-0.51	0.47	-1.08	.28
MJ user*Condition (β_{34})	1.17	0.94	1.25	.21	0.01	0.02	0.40	.69	0.36	0.87	0.42	.68

Note. Degrees of freedom in all models = 388 for intercept (pre-BMI) effects and 387 for follow-up effects. BAC = blood alcohol concentration. HED = heavy episodic drinking. MJ = Marijuana. Gender was coded as 0 for males and 1 for females Example HLM model equation (predicting consequences) is shown below, with coefficients corresponding to those listed in the table.

Level-1 Model

$$Consequences_{ti} = \pi_{0i} + \pi_{1i}*(3moFU_{ti}) + \pi_{2i}*(6moFU_{ti}) + \pi_{3i}*(9moFU_{ti}) + e_{ti}$$

Level-2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}*(GENDER_i) + \beta_{02}*(CONDITION_i) + \beta_{03}*(MJ\ USER_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11} * (GENDER_i) + \beta_{12} * (CONDITION_i) + \beta_{13} * (MJ\ USER_i) + \beta_{14} * (MJ\ USERxCONDITION_i) + r_{1i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21} * (GENDER_i) + \beta_{22} * (CONDITION_i) + \beta_{23} * (MJ\ USER_i) + \beta_{24} * (MJ\ USERxCONDITION_i) + r_{2i}$$

$$\pi_{3i} = \beta_{30} + \beta_{31} * (GENDER_i) + \beta_{32} * (CONDITION_i) + \beta_{33} * (MJ\ USER_i) + \beta_{34} * (MJ\ USERxCONDITION_i) + r_{3i}$$

Table 5

Hierarchical linear model testing impact of an alcohol-focused BMI on marijuana use frequency

	B	*SE*	*t*-ratio	*p*
Intercept (pre-BMI)	13.60	1.14	11.95	<0.001
Gender	-3.68	1.76	-2.10	0.04
Condition	0.73	1.77	0.41	0.68
3-month follow-up	-2.00	0.90	-2.22	0.03
Gender	-1.65	1.36	-1.22	0.22
Condition	-0.35	1.38	-0.25	0.80
6-month follow-up	-2.24	1.23	-1.82	0.07
Gender	-2.13	1.74	-1.23	0.22
Condition	2.04	1.84	1.11	0.27
9-month follow-up	-2.38	1.32	-1.81	0.07
Gender	-2.16	1.82	-1.19	0.24
Condition	0.90	1.96	0.46	0.64

Note. Degrees of freedom = 225. BMI = Brief Motivational Intervention condition. MJ = marijuana. Assessment only was coded as 0; BMI was coded as 1. Gender was coded as 0 for males and 1 for females. HLM model equation is shown below, with coefficients corresponding to those listed in the table.

Level-1 Model

$$MJfrequency_{ti} = \pi_{0i} + \pi_{1i}^{*}(3moFU_{ti}) + \pi_{2i}^{*}(6moFU_{ti}) + \pi_{3i}^{*}(9moFU_{ti}) + e_{ti}$$

Level-2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}^{*}(GENDER_i) + \beta_{02}^{*}(CONDITION_i) + r_{0i}$$
$$\pi_{1i} = \beta_{10} + \beta_{11}^{*}(GENDER_i) + \beta_{12}^{*}(CONDITION_i) + r_{1i}$$
$$\pi_{2i} = \beta_{20} + \beta_{21}^{*}(GENDER_i) + \beta_{22}^{*}(CONDITION_i) + r_{2i}$$
$$\pi_{3i} = \beta_{30} + \beta_{31}^{*}(GENDER_i) + \beta_{32}^{*}(CONDITION_i) + r_{3i}$$