



4/20 Cannabis Use is Greater than Other High-Risk Events: Identification of Psychosocial Factors Related to 4/20 Use

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Published online: 11 April 2019
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Abstract

Cannabis is the most commonly used federally illicit drug, yet little research has identified risk factors for high-risk use. Although April 20 (“4/20”) has been identified as a day on which cannabis users use more cannabis than they typically do, it remains unknown whether 4/20 is a high-risk event for greater use than other heavy use days (e.g., other holidays) and whether use on 4/20 is related to greater use-related problems. Such information has important implications for event-specific prevention efforts. Thus, the present study tested whether 4/20 is associated with greater cannabis use than other high-risk cannabis use events (e.g., Spring Break), whether 4/20 cannabis use is associated with event-specific use-related problems and subjective intoxication, and whether event-specific psychosocial factors (i.e., motives, normative beliefs) influence 4/20 use among 68 past-year cannabis using undergraduates who reported using cannabis on 4/20 (in a state where cannabis is legal for medical but not recreational purposes). A majority reported experiencing problems related to their 4/20 use and use was greater on 4/20 than on all other high-risk days. Quantity of 4/20 use was significantly, positively correlated with 4/20 cannabis use-related problems and subjective intoxication. 4/20-specific descriptive norms were a stronger predictor of 4/20 cannabis use and use-related problems than 4/20-specific cannabis use motives whereas 4/20-specific enjoyment motives were stronger predictors of subjective intoxication on 4/20. The current study identifies 4/20 as an especially high-risk cannabis use event and is the first to test psychosocial factors related to 4/20 use and use-related problems. Event-specific descriptive norms and enjoyment motives may be important targets for campus-wide efforts to prevent risky use on this high-use day.

Keywords High-risk substance use · Event-specific cannabis use · College students · Social norms · Motives

Introduction

Over one-third of college-age students endorse current cannabis use (Schulenberg et al. 2017) and over 90% of past-month cannabis-using undergraduates report experiencing at least one use-related problem (Pearson et al. 2017). The most common problems endorsed by students include problems that can negatively impact academic functioning, such as procrastination, lower productivity, lower energy, memory loss, and missing days of class or work (Buckner et al. 2010). Further, almost one-fourth of undergraduates who use cannabis meet DSM-IV criteria for cannabis use disorder (CUD; Caldeira et al. 2008). Although cannabis use is problematic on college campuses, few studies have identified high-risk

events that may be related to increases in cannabis use and use-related problems.

In the alcohol literature, several events have been identified as high-risk drinking events that result in greater drinking, even among students who do not typically engage in heavy drinking, such as St. Patrick’s Day (SPD), Mardi Gras, 21st birthdays, New Year’s Eve, and July 4th (Henslee et al. 2015; Neighbors et al. 2007, 2011). Less research has identified high-risk cannabis use events and nearly all have focused on events that are typically high-risk drinking events such as Spring Break (Buckner et al. 2015; Ragsdale et al. 2012). Notably, these events relate to greater use and use-related problems (Buckner et al. 2015). Yet little attention has been paid to cannabis-specific high-risk events, which may be associated with even greater cannabis use and related problems than traditionally alcohol-related events. April 20 (“4/20”) is a cannabis-specific event that holds cultural significance in the United States as a holiday celebrating cannabis and cannabis culture (Associated Press 2017; Lopez

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2018; Queally 2016), with some 4/20 organized events drawing thousands of celebrators (Associated Press 2017). However, only one known study tested whether 4/20 was related to greater cannabis use, more cannabis-related problems, and greater subjective intoxication compared to typical use days (Bravo et al. 2017). Cannabis use was greater on 4/20 than typical cannabis use days but subjective intoxication and cannabis-related problems were not.

There remain several gaps in our understanding of event-specific cannabis use. First, although 4/20 cannabis use is greater than typical use (Bravo et al. 2017), it is unknown whether 4/20 cannabis use is greater than use on other high-risk cannabis use days (Buckner et al. 2015; Ragsdale et al. 2012), such as weekends, Spring Break, and holidays (e.g., SPD). Second, there is a dearth of research on malleable psychosocial vulnerability factors that play a role in event-specific cannabis use, despite the utility of such data to inform event-specific interventions geared toward decreasing risky event-specific use (Neighbors et al. 2007). Although coping and enhancement motives tend to be the most endorsed reasons for cannabis use generally (e.g., Buckner et al. 2015), there is reason to believe that reasons for 4/20 use may differ from reasons for typical use and from reasons for use on other high-risk events. To illustrate, in the alcohol literature, students were more likely to endorse more fun/social drinking motives during Spring Break than typical use motives (Patrick et al. 2013). In the only known study of event-specific motives for cannabis use, event-specific motives differed across two campuses with specific celebratory traditions for SPD and Mardi Gras (Buckner et al. 2018), such that the campus with Mardi-Gras-specific celebratory traditions endorsed more socially, enhancement, coping, conformity, and expansion-motivated cannabis use on Mardi Gras than on SPD whereas the campus with SPD-specific celebratory traditions endorsed more socially and enhancement-motivated cannabis use on SPD than on Mardi Gras. Given that 4/20 is an event that specifically celebrates cannabis and cannabis culture (Associated Press 2017; Lopez 2018; Queally 2016), it is possible that people use on 4/20 to celebrate and because it is more available as a result of others using. Identification of motives that are unique to high-risk, cannabis-specific events such as a 4/20 can inform efforts to attenuate risky event-specific use by including intervention components that specifically target these motives.

Relatedly, no known studies have tested whether descriptive normative beliefs (an individual's perception of the frequency and quantity of others' substance use), one of the strongest predictors of both substance use generally (Borsari and Carey 2001; Kilmer et al. 2006) and event-specific alcohol use (Baer 1994; Buckner et al. 2015; Neighbors et al. 2006, 2011), are related to event-specific cannabis use. Importantly, normative beliefs about

cannabis use are malleable (Elliott and Carey 2012; Elliott et al. 2014; Lee et al. 2010; Riggs et al. 2018). Identification of malleable psychosocial factors related to 4/20 cannabis use is important, given that 4/20 may associated not only with greater use but with greater use-related problems. 4/20 was linked to a 12% increase in the relative risk of fatal traffic accidents (Staples and Redelmeier 2018), comparable to increases in fatal accidents on Super Bowl Sunday, a day traditionally associated with increased alcohol use (Redelmeier and Stewart 2003).

The present study set out to fill gaps in our understanding of event-specific cannabis use in several ways. First, we sought to extend the finding that 4/20 cannabis use is greater than typical weekday and weekend use (Bravo et al. 2017) by testing whether 4/20 use is greater than other high-risk events – specifically, heaviest past-month day, heaviest weekend day, SPD, and Spring Break. Given that 4/20 is the only known cannabis-specific high-risk event, we hypothesized that it would be related to greater use than these other high-risk events. Second, to understand the implications of 4/20 cannabis use, we tested whether 4/20 use would be positively related to more 4/20 use-related problems and to greater 4/20 subjective intoxication, given that subjective intoxication is a vulnerability factor for risky cannabis use and CUD (Scherrer et al. 2009; Zeiger et al. 2010). Third, this is the first known identification of vulnerability factors related to 4/20 cannabis use. We had three primary aims concerning these factors: (1) given the celebratory and social nature of 4/20, we hypothesized that students would endorse more celebration motives on 4/20 than past-year typical celebration motives and greater normative beliefs about 4/20 cannabis use than typical use; (2) we sought to identify high-risk 4/20 motives. Given that prior event-specific enjoyment-oriented motives and coping motives have been related to use on other high-risk cannabis use days (Buckner et al. 2018), that cannabis users report wanting to use cannabis during periods of elevated state social anxiety (Buckner et al. 2016), and that people use more on 4/20 than on typical use days (Bravo et al. 2017), we hypothesized that 4/20-specific enjoyment-oriented motives (e.g., celebration and enjoyment motives), coping motives, social anxiety motives, and availability motives would be associated with greater 4/20 cannabis use, subjective intoxication, and related problems; and (3) we tested whether normative beliefs concerning others' 4/20 use (but not normative beliefs about typical use) would be related to greater 4/20 use, subjective intoxication, and related problems. These hypotheses were tested among undergraduate students given that cannabis is the most commonly used federally illicit drug among college students (Johnston et al. 2016) and the likelihood of past-year cannabis use among college students is increasing (Schulenberg et al. 2017).

Methods

Participants and Procedures

Participants were undergraduate students recruited through the psychology department research participant pool from a large public university in the southern United States (in a state in which cannabis is legal for medical but not recreational purposes). Participants completed an online survey administered via Qualtrics from 4/21/17–4/25/17 and were compensated with research participation credits for completion of the survey. Eligibility criteria included being at least 18 years of age, being a current student at the university, endorsing past-year cannabis use, and endorsing cannabis use on 4/20/17. Of the 174 that started the survey, 106 were excluded due to being under 18 years of age ($n = 1$), denying cannabis use in the past year ($n = 54$), or denying cannabis use on 4/20/17 ($n = 51$). Thus, the final sample included 68 participants (70.6% female) who reported a mean age of 19.4 years ($SD = 1.3$). The racial/ethnic composition of the sample was 77.9% non-Hispanic/Latino white, 1.5% Hispanic/Latino white, 11.8% non-Hispanic/Latino Black/African American, 5.9% Asian, and 2.9% multi-racial. Participants were ethnically/racially representative of the university which included approximately 78.7% non-Hispanic white students. Compared with the larger university (50.8% women), more participants in our sample were female.

Regarding lifetime cannabis use, 16.2% ($n = 11$) endorsed using less than 4 times, 20.6% ($n = 14$) endorsed using one to eight times per year, 20.6% ($n = 14$) endorsed using once or twice per month, and 42.6% ($n = 29$) endorsed using weekly or more. Regarding past-month use, 47.0% ($n = 32$) endorsed using one to three times in the past month, 38.3% ($n = 26$) endorsed using one to eight times per week, 10.3% ($n = 7$) endorsed using 9 to 20 times per week, and 4.4% ($n = 3$) endorsed using 21 times per week or more.

The university's institutional review board approved this study and informed consent was obtained before data collection. Students were informed that their name would not appear with their responses and that their responses would be labeled only with a study identification number. A Certificate of Confidentiality was obtained from the National Institutes of Health to further ensure confidentiality.

Measures

The *Marijuana Use Form* (MUF; Buckner et al. 2007) was used to screen potential participants for study eligibility

and to describe cannabis use characteristics of the sample. Participants answered questions on lifetime cannabis use frequency (from 0 = *never* to 7 = *once or more every day*) and past-month cannabis use frequency (from 0 = *never* to 10 = *21 or more times per week*). This measure demonstrated good convergent validity with ecological momentary assessment of cannabis use (Buckner et al. 2012).

Participants completed a self-report version of the *Timeline Follow Back* (TLFB; Sobell et al. 1996) on which important campus events (e.g., campus closures, Spring Break) and other events (e.g., April Fool's Day, SPD) were labeled. The assessment timeframe was from 3/17/17 to 4/20/17 and thus included assessment of cannabis use on SPD, Spring Break, and 4/20. Participants reported the number of "joints" (i.e., cannabis cigarettes) used per day. If participants used methods other than joints (e.g., bong, bowl), they were asked to estimate the number of joints that they used would have equaled. Estimated number of joints measured by the TLFB demonstrates convergent validity with other measures of cannabis consumption (Cuttler and Spradlin 2017; O'Farrell et al. 2003). The TLFB is a valid and reliable self-report questionnaire of cannabis use (O'Farrell et al. 2003; Robinson et al. 2014). Retrospective reports of cannabis use correlate highly with ecological momentary assessments of cannabis use (Buckner et al. 2012) and prior event-specific substance use work did not find that number of days since a substance use event to be related to use on the event (Buckner et al. 2019).

The *Brief Marijuana Consequences Questionnaire* (B-MACQ; Simons et al. 2012) is a 21-item self-report questionnaire in which participants indicate (yes or no) whether they experienced problems due to cannabis use, with higher scores indicating more problems experienced. The original B-MACQ demonstrated excellent internal consistency ($\alpha = .95$; Simons et al. 2012). The B-MACQ was modified in this study to measure both problems experienced in the past year and on 4/20. Two questions were added to assess getting in trouble by the university and getting in trouble with the police. The modified 23-item B-MACQ demonstrated good internal consistency in the current sample (past-year, $\alpha = .89$, 4/20, $\alpha = .88$).

Motives for cannabis use were assessed using the *Comprehensive Marijuana Motives Measure* (CMMQ; Lee et al. 2009) a 36-item, 12-factor self-report questionnaire that measures the degree to which participants used cannabis for a specific reason (e.g., enjoyment, celebration, availability) on a 1 (*almost never/never*) to 5 (*almost always/always*) scale. The CMMQ has demonstrated acceptable internal consistency across all subscales ($\alpha = .78-.89$) in prior work (Lee et al. 2009). The CMMQ was modified in this study to measure past-year motives and 4/20 motives and these versions demonstrated acceptable internal consistency in this sample: Availability (past-year $\alpha = .83$, 4/20 $\alpha = .75$),

Altered State (past-year $\alpha = .86$, 4/20 $\alpha = .88$), Celebration (past-year $\alpha = .91$, 4/20 $\alpha = .93$), Coping (past-year $\alpha = .84$, 4/20 $\alpha = .81$), Enjoyment (past-year $\alpha = .89$, 4/20 $\alpha = .82$), and Social Anxiety (past-year $\alpha = .87$, 4/20 $\alpha = .90$).

The *Social Events Questionnaire* (SEQ; Battista and Kocovski 2010) was modified from prior work (Battista and Kocovski 2010; Buckner and Dean 2017) by asking participants to answer questions involving events they may have attended on 4/20. The modified SEQ was used to assess various aspects of events attended on 4/20 (i.e., event type, amount of cannabis consumed, subjective rating of intoxication). Subjective rating of event-specific intoxication was measured from 1 (*not at all high*) to 7 (*stoned*) and was only measured on 4/20, not other use days. The original questionnaire has been used successfully to assess alcohol use (Battista and Kocovski 2010), but has not been used previously to assess cannabis use.

Consistent with prior work on social norms concerning cannabis (Buckner et al. 2010, 2013; Perkins et al. 1999), *descriptive norms* were assessed by asking participants to estimate how often the average student consumes cannabis (8 = *daily*, 7 = *nearly every day*, 6 = *two to three times per week*, 5 = *one time per week*, 4 = *two to three times per month*, 3 = *one time per month*, 2 = *three to six times per year*, 1 = *one to two times per year*, and 0 = *never*). The measure was modified to include additional questions asking participants to estimate how many joints (0 to 25) the average student consumes on each day of a typical week, on Spring Break, and on 4/20.

Data Analytic Strategy

Zero-order correlations were conducted to test whether quantity of 4/20 cannabis use was associated with more 4/20 use-related problems and greater subjective intoxication on 4/20, whether 4/20-specific enjoyment-oriented, social anxiety, and coping motives were associated with greater 4/20 use, use-related problems, and subjective intoxication, and whether 4/20-specific descriptive norms were associated with greater 4/20 use, use-related problems, and subjective intoxication. Zero-order correlations were also conducted to test whether number of days between event (i.e., 4/20, SPD, Spring Break) and survey completion were correlated with estimated number of joints used on each event (per Buckner et al. 2019). Paired samples t-tests were conducted to test if cannabis use on 4/20 was greater than on other use days (e.g., maximum use day in past month), if 4/20-specific enjoyment-oriented, social anxiety, availability and coping motives were greater than corresponding past-year motives, and if 4/20-specific normative beliefs were greater than other normative beliefs (e.g., descriptive norms for maximum use day in past month, maximum use day over Spring break).

Finally, we tested unique predictors of 4/20 cannabis use quantity, 4/20 use-related problems, and subjective intoxication on 4/20. Separate regression analyses were conducted for each of these outcomes. Variables that were significantly correlated with each outcome were simultaneously entered as predictors. All variables were standardized to address multicollinearity.

Results

Cannabis Use on 4/20

Table 1 presents descriptive data concerning study variables. The mean number of joints used on 4/20 was 3.59 ($SD = 3.90$, $range = 1–20$) over a mean of 5.73 h ($SD = 7.27$, $range = 1–24$). Over half (54.5%) of 4/20 users rated their subjective intoxication as *high* or *very high* during the event, and 20.6% reported that they felt *stoned*. A majority of the sample (72.1%) reported experiencing problems as result of their 4/20 use. The most common 4/20-related problems endorsed included: feeling in a fog the day after 4/20 ($n = 29$, 42.6%), being less physically active ($n = 23$, 33.8%), feeling less energetic ($n = 23$, 34.8%), feeling less motivated ($n = 18$, 26.5%), and feeling less mentally sharp ($n = 17$, 25.0%), whereas 4.4% of the sample ($n = 3$) reported getting in trouble with the police due to 4/20 cannabis use and 1.5% ($n = 1$) reported getting in trouble with the university due to 4/20 cannabis use. The majority (89.7%) reported attending at least one cannabis-use event ($M = 1.19$, $SD = .74$); events included “smoke outs” (51.5%), house parties (39.7%), bars/pubs (19.1%), concerts (17.6%), and “other” events (e.g., dinner, 10.3%).

Participants reported using more cannabis on 4/20 than their heaviest past-month day ($M = 2.40$, $SD = 2.24$); $t(67) = 2.84$, $p < .001$, $d = 0.34$, heaviest past-month weekend day ($M = 2.11$, $SD = 2.18$); $t(67) = 3.34$, $p = .001$, $d = 0.41$, heaviest Spring Break day ($M = 1.79$, $SD = 2.00$); $t(67) = 4.46$, $p < .001$, $d = 0.54$, and SPD ($M = 0.60$, $SD = 1.01$); $t(67) = 7.39$, $p < .001$, $d = 0.90$. Number of days between event and survey completion were not correlated with estimated number of joints on 4/20, $r = -.031$, $p = .805$, last day of Spring Break, $r = -.103$, $p = .404$, or SPD, $r = -.141$, $p = .253$.

Cannabis-Related Motives on 4/20

Cannabis use quantity on 4/20 was significantly and positively correlated with enjoyment, coping, celebration, and altered state 4/20 motives (Table 1). Subjective intoxication on 4/20 was significantly correlated with 4/20-specific enjoyment and celebration motives. 4/20-use related

Table 1 Bivariate correlations among study variables

	M	SD	Skewness	Kurtosis	1	2	3	4	5	6	7	8	9	10	11
1. Quantity of cannabis	3.59	3.90	2.77	8.67	–										
2. Number of cannabis problems	3.41	4.57	2.02	5.14	.29*	–									
3. Subjective intoxication	4.35	1.93	–.25	–.79	.51***	.28	–								
4. 4/20 norms	6.65	5.17	2.04	4.21	.31**	.44***	.06	–							
5. Typical norms	2.54	1.52	1.08	.50	.19	.21	–.05	.64***	–						
6. Enjoyment motives	3.55	1.20	–.63	–.53	.46***	.12	.61***	–.17	–.27*	–					
7. Coping motives	1.77	1.02	1.28	.79	.25*	.33**	.22	.12	.10	.34**	–				
8. Celebration motives	3.51	1.34	–.46	–1.06	.41***	.12*	.49***	.09*	.05	.57***	.29*	–			
9. Altered state motives	2.09	1.18	.82	–.61	.34**	.15	.21	.07	.09	.47***	.54***	.36**	–		
10. Social anxiety motives	1.78	1.07	1.49	1.52	.35**	.34**	.24	.15	.03	.35**	.51***	.27*	.41***	–	
11. Availability motives	2.93	1.25	–.08	–1.10	.19	.10	.20	–.03	.02	.52***	.34**	.45***	.42***	.45***	–

Note All variables are 4/20-specific except for typical descriptive norms
* $p < .05$; ** $p < .01$; *** $p < .001$

problems were significantly correlated with coping, celebration, and social anxiety 4/20-specific motives.

Celebration motives on 4/20 ($M = 3.51, SD = 1.34$) were significantly greater than typical past-year celebration motives ($M = 2.67, SD = 1.17$), $t(66) = 5.81, p < .001, d = 0.71$. Availability motives on 4/20 ($M = 2.93, SD = 1.25$) were significantly greater than typical availability motives ($M = 2.75, SD = 1.21$), $t(67) = 2.28, p = .026, d = 0.28$. Typical altered state motives ($M = 2.26, SD = 1.15$) were significantly greater than 4/20 altered state motives ($M = 2.09, SD = 1.18$), $t(67) = 3.05, p = .003, d = 0.37$. Typical coping motives ($M = 1.96, SD = 1.09$) were significantly greater than 4/20 coping motives ($M = 1.77, SD = 1.02$), $t(67) = 3.65, p < .001, d = 0.45$. Typical social anxiety motives ($M = 1.88, SD = 1.04$) were significantly greater than 4/20 social anxiety motives ($M = 1.78, SD = 1.07$), $t(65) = 2.41, p = .019, d = 0.29$. Enjoyment motives were not significantly different on 4/20 ($M = 3.55, SD = 1.20$) than for typical past-year use ($M = 3.48, SD = 1.27$), $t(66) = 1.38, p = .172, d = 0.17$.

4/20-Specific Descriptive Normative Beliefs

Students reported that they believed other students used significantly more cannabis on 4/20 than they themselves used on 4/20, $t(67) = 4.66, p < .0001, d = 0.57$. They also reported that they believed that other students used more on 4/20 than other students’ typical use ($M = 2.54, SD = 0.18$), $t(67) = 7.78, p < .0001, d = 0.94$, and maximum use day over the past month ($M = 3.13, SD = 5.17$), $t(67) = 7.25, p < .0001, d = 0.88$, but not Spring Break maximum use day ($M = 6.18, SD = 4.22$), $t(67) = 1.25, p = .217, d = 0.15$.

4/20 descriptive normative beliefs (but not typical normative beliefs) were significantly and positively correlated with quantity of cannabis consumed on 4/20, number of 4/20 use-related problems, and 4/20 celebration motives, whereas typical normative beliefs were significantly and negatively correlated with 4/20 enjoyment motives (Table 1).

Unique Predictors of 4/20 Cannabis Use Quantity, Subjective Intoxication, and Problems

First, we tested whether variables significantly related to 4/20 cannabis use quantity (4/20 descriptive norms, 4/20 enjoyment motives, 4/20 celebration motives, 4/20 altered state motives, and 4/20 coping motives were entered simultaneously as independent variables) uniquely predicted 4/20 cannabis use quantity; this model was significant ($p < .0001$; Table 2). Independent variables together accounted for 34% of the variance in 4/20 cannabis use quantity, with 4/20 enjoyment motives ($p = .003$) and 4/20 descriptive norms ($p = .001$) remaining significantly, positively related to 4/20 cannabis use quantity, accounting for 10% and 13% of the unique variance, respectively.

Table 2 Linear regression models predicting 4/20 cannabis use quantity, related problems, and subjective intoxication

Variable	<i>F</i>	<i>R</i> ²	<i>B</i>	β	<i>t</i>	<i>P</i>	<i>Sr</i> ²
DV: 4/20 cannabis use quantity							
Overall model	7.78	.34	–	–	–	<.0001	–
4/20 descriptive norms			.29	.38	3.57	.001	.13
4/20 enjoyment motives			1.38	.42	3.08	.003	.10
4/20 celebration motives			.28	.10	.76	.448	.01
4/20 altered state motives			.32	.10	.73	.469	.01
4/20 coping motives			.02	.01	.04	.968	.00
DV: 4/20 cannabis use-related problems							
Overall model	5.54	.32	–	–	–	<.0001	–
4/20 cannabis quantity			.20	.15	1.15	.256	.01
4/20 descriptive norms			.32	.36	3.18	.002	.11
4/20 coping motives			.87	.20	1.55	.126	.03
4/20 celebration motives			–.24	–.07	–.59	.560	.00
4/20 social anxiety motives			.68	.16	1.23	.223	.02
DV: 4/20 subjective intoxication							
Overall model	17.88	.44	–	–	–	<.0001	–
4/20 cannabis quantity			.13	.26	2.42	.018	.23
4/20 enjoyment motives			.67	.43	3.57	.001	.33
4/20 celebration motives			.19	.14	1.17	.245	.11

Second, we tested whether variables significantly related to 4/20 problems (4/20 cannabis quantity, 4/20 descriptive norms, 4/20 coping motives, 4/20 celebration motives, 4/20 social anxiety motives) were uniquely related to 4/20 use-related problems; the overall model was also significant ($p < .0001$; Table 2). Independent variables together accounted for 32%; the only variable robustly related to 4/20 problems was 4/20 descriptive norms ($p = .002$), accounting for 11% of the unique variance.

Third, we tested whether variables significantly related to 4/20 subjective intoxication (4/20 cannabis quantity, 4/20 enjoyment motives, 4/20 celebration motives) were uniquely related to subjective intoxication on 4/20. The overall model was significant ($p < .0001$; Table 2). Independent variables accounted for 44% of the variance in 4/20 subjective intoxication. The only variable robustly related to 4/20 subjective intoxication was 4/20 enjoyment motives ($p = .001$), accounting for 33% of the unique variance.

Discussion

Results from this study add several unique insights to the literature on event-specific cannabis use generally and 4/20 use specifically. First, results corroborate the finding that 4/20 is a high-risk day for cannabis use (Bravo et al. 2017) and extend this work by determining that 4/20 cannabis use was not only greater than typical use per Bravo et al. (2017), but it was greater than use on other high-risk events (SPD, Spring Break) and high-risk days (e.g., heaviest past month

use day). Second, this study adds to the scant literature on 4/20 problems and results indicate that the majority of 4/20 users experienced problems related to their 4/20 use. Third, this is also the first known study to identify important psychosocial factors (i.e., 4/20-specific motives and descriptive norms) related to 4/20 use and 4/20 use-related problems that may be important treatment targets for prevention and intervention efforts.

Consistent with the notion that 4/20 is a cannabis-specific holiday, 4/20 cannabis use was greater than heaviest past-month use and use on other high-risk events (SPD, Spring Break). The moderate to large magnitude of the size of these effects suggests that the difference in use on 4/20 compared to other high-risk days may be especially clinically meaningful (Abelson 1985). Importantly, this is also the first known study to test whether quantity of 4/20 use was related to experiencing 4/20 use-related problems. It is notable that the majority of 4/20 users endorsed problems related to their 4/20 use and that the mean number of 4/20-use related problems was five, indicating that use on 4/20 is not without negative consequences. The severity of problems ranged from feeling in a fog the day after 4/20 to getting in trouble with the police or university due to 4/20 cannabis use. Notably, commonly endorsed problems included less motivation and feeling less mentally sharp; an important next step will be to investigate the impact of these negative consequences on students' academic and occupational performance.

This study adds to the very limited literature on event-specific substance use motives by determining that particular 4/20-specific motives were associated with more 4/20

cannabis use, subjective intoxication, and related problems. Consistent with our hypotheses, 4/20-specific enjoyment-oriented (e.g., celebration), coping, and social anxiety motives were related to more 4/20 use. Enjoyment motives were uniquely, robustly related to 4/20 use and subjective intoxication. This is consistent with prior work finding that event-specific enjoyment-oriented motives are related to cannabis use on other holidays (e.g., Mardi Gras; Buckner et al. 2018). We extend prior work by identifying additional motives (i.e., celebration and availability motives) related to 4/20, a day that specifically celebrates cannabis use and cannabis culture (Associated Press 2017; Lopez 2018; Queally 2016). We further extended prior work on event-specific cannabis use by identifying that 4/20-specific use motives differ from typical use motives such that there is more use on 4/20 for celebration and availability reasons than on typical use days. Taken together, these data indicate that cannabis is used more on 4/20 to celebrate and/or because it is available, perhaps due to others' celebrating. Identification of motives specific to risky 4/20 use may inform event-specific prevention and intervention efforts.

Several 4/20-specific motives (coping, celebration, social anxiety) were related to 4/20 use-related problems. This is consistent with work finding that typical coping motives and social anxiety to be robustly related to cannabis-related problems (Buckner et al. 2007, 2013). However, only 4/20 normative beliefs were robustly related to 4/20 use-related problems, highlighting the importance of beliefs about others' use in college student substance use (Borsari and Carey 2001). Notably, this is the first known investigation of event-specific normative beliefs regarding cannabis. Participants believed that other students use more on 4/20 than they themselves used and that others use on other high-risk use days. The magnitude of these differences was moderate to large. That 4/20 descriptive normative beliefs were related to 4/20 use and use-related problems is consistent with prior work on typical cannabis use in which typical descriptive norms are linked to greater typical cannabis use frequency (Buckner et al. 2013; Kilmer et al. 2006; Pearson et al. 2017) and more use-related problems (Buckner et al. 2013; Kilmer et al. 2006). However, results highlight the importance of event-specific normative beliefs in understanding risky, event-specific use given that typical normative beliefs were not related to 4/20 outcomes.

Thus, an important next step will be to test whether providing corrective normative feedback about 4/20 use of other cannabis users results in less 4/20 use and related problems. Targeting normative beliefs via online, personalized feedback interventions (PFIs) successfully reduces risky alcohol use in college populations, both generally (for review, see Miller et al. 2013) and for specific high-risk events, such as 21st birthday celebrations (Neighbors et al. 2009). Yet PFIs to reduce risky college cannabis use have had limited

success and appear to only reduce cannabis use frequency or use-related problems among certain subgroups of students, such as those with family history of substance use (Lee et al. 2010), higher readiness to change at baseline (Palfai et al. 2016), or heavy users (Riggs et al. 2018). Currently, there are no known event-specific cannabis PFIs for college students. High-risk substance use events may be especially desirable times to intervene because (Neighbors et al. 2012): (1) universities can anticipate specific times when students will use, (2) specific events are time-limited so campuses can intervene prior to the event and cease intervention at the event's termination, (3) students overestimate the amount that other students use cannabis during 4/20, which was related to greater 4/20 use and related problems, and (4) PFIs can be used as an adjunct to campus efforts to reduce risky use more broadly. In light of the current study's findings, university-wide prevention efforts may consider including 4/20-specific corrective normative feedback as a component of such efforts.

Findings must be considered in light of limitations that can inform future work. First, the sample was comprised predominately of non-Hispanic white female undergraduates. Given that cannabis use is more common among male than female students (Schulenberg et al. 2018) and white students are more likely to report cannabis use than non-white students (Cruz et al. 2018), an important next step will be to test whether results generalize to a more diverse sample of undergraduate students. Second, the study was cross-sectional in nature, permitting an initial examination of factors related to 4/20 use, but prospective research (e.g., ecological momentary assessment) will be an important next step. Third, participants were asked to quantify their cannabis use in estimated number of joints used via the TLFB. Recent evidence suggests that cannabis users may have difficulty accurately quantifying their cannabis use and that type of consumption method used may vary based on context (Prince et al. 2018). Although the majority of our sample (72.1%) reported using joints, we attempted to control for this potential confound by also examining subjective intoxication and our pattern of findings was similar. However, future work on event-specific cannabis use may want to incorporate other methods of measurement as well as measuring method of consumption. Fourth, data relied on self-report and biological verification of use in future studies will be useful. Fifth, this study took place in a state in which recreational cannabis use remains illegal. It will be important to test whether observed relations replicate in states in which it has been legalized.

Despite these limitations, the current study replicates the only other known study (Bravo et al. 2017) that 4/20 is a high-risk cannabis-specific event and adds to the literature identifying high-risk cannabis use events (Buckner et al. 2015a; Ragsdale et al. 2012). Importantly, findings

also extend this work by identifying malleable psychosocial vulnerability factors associated with greater 4/20 use and related problems (enjoyment motives, descriptive norms). It is our hope that continued identification of high-risk cannabis use events and associated vulnerability factors can inform prevention and intervention protocols geared toward reducing risks associated with use on these events.

Compliance with Ethical Standards

Conflict of Interest Katherine Walukevich-Dienst and Julia D. Buckner declare that they have no conflict of interest.

Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (national and institutional). Informed consent was obtained from all individual subjects participating in the study. If any identifying information is contained in the paper the following statement is also necessary – Additional informed consent was obtained from any subjects for whom identifying information appears in this paper.

Research Involving Animal Rights No animal studies were carried out by the authors for this article.

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