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Prevalence and Correlates of Concurrent and Simultaneous Cannabis and Cigarette Use among Past-Year Cannabis-Using US College Students

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ABSTRACT

Background: Cannabis and tobacco use are significant public health concerns among young adults, with concurrent (in the same time period) and simultaneous (at the same time so the effects overlap) use of both substances on the rise. Few studies have examined these behaviors among college students. **Objective:** We examined the prevalence of concurrent and simultaneous cannabis and cigarette (combustible or electronic) use among a sample of college students and characterized the psychosocial predictors of concurrent and simultaneous use compared to using cannabis alone. **Methods:** Data on past-3 months cannabis and cigarette use were collected on 1352 college students who were past-year cannabis and alcohol users yielding four groups: cannabis-only users ($n = 686$), concurrent cannabis and cigarette users (CCAC; $n = 235$), simultaneous cannabis and cigarette users (SCAC; $n = 293$), and non-recent users of either substance ($n = 138$). Multinomial logistic regression analyses were utilized to predict group membership. **Results:** Relative to the cannabis-only group, White, compared to Non-White students, males, compared to females, frequent, compared to infrequent, alcohol users, including those who used alcohol simultaneously with cigarettes, and illicit drug users were more likely to belong to the CCAC or SCAC group. **Conclusions:** Findings suggest the need for unique intervention efforts to prevent onset or reduce co-use among male and White students as well as illicit drug users and frequent alcohol users.

KEYWORDS

Cannabis; tobacco; cigarettes; concurrent use; simultaneous use; college students

Although tobacco prevention efforts have led to significant reductions in cigarette smoking among youth, smoking continues to be a significant public health concern among young adults and in particular college students (Cooke et al., 2016; Wang et al., 2018). Recent data show the rate of tobacco use among college students is high. One study found over one-third (32.9%) of college students were current tobacco users (Rigotti, Lee, & Wechsler, 2000) and another showed that 35.5% of incoming college freshman reported using at least one alternative tobacco product within the past 30 days (Cooke et al., 2016). Alongside combustible cigarette use, is the alarming rise of electronic cigarette (e-cigarette) use among adolescents and young adults (Gentzke et al., 2019; Littlefield, Gottlieb, Cohen, & Trotter, 2015), which the US Surgeon General recently described as an epidemic (U.S. Department of Health and Human Services (HHS) Office of the Surgeon General, 2016). The negative health effects of tobacco use during the adolescent/young adult years are well-documented and include harmful effects on brain development, attention, memory, and learning and increased risk of engagement in harmful behaviors

such as other substance use and early sexual intercourse (Busen, Modeland, & Kouzekanani, 2001; U.S. Department of Health and Human Services (HHS) Office of the Surgeon General, 2012).

Alongside the growing concerns about combustible and e-cigarette use is the increasing use of cannabis/marijuana among young adults (Mauro et al., 2018). The annual prevalence rate of cannabis use among full-time college students reached a 30-year high of 39% (41% for males, 38% for females) in 2016, up from 29% in 1990 (Schulenberg et al., 2018), sparking significant concern. Approximately 5% of college students used cannabis daily within the last month (6.6% for males, 3.9% for females) (Schulenberg et al., 2018). The changing legal landscape and reduced perceptions of cannabis-related harm are among some of the factors associated with increased cannabis use among college students (Okaneke, Vearrier, McKeever, LaSala, & Greenberg, 2015; Salas-Wright, Vaughn, Todic, Córdova, & Perron, 2015; Sarvet et al., 2018).

For college students, short- and long-term heavy cannabis use poses physical and psychosocial risks (Ansell et al., 2015;

Brook et al., 2011; Crean et al., 2011; Hall & Degenhardt, 2014; Volkow et al., 2016). Depending on dosage, cannabis use has been associated with acute psychological effects, including anxiety, panic reactions, and psychotic symptoms among those predisposed (Ansell et al., 2015; Hall & Degenhardt, 2014). Heavy, long-term cannabis use is associated with deficits in attention, working memory, and verbal learning (Crean et al., 2011) as well as increased risk of anxiety, depression, and problematic use of other illicit drugs (Hall & Degenhardt, 2014; Volkow et al., 2016).

Adult tobacco smokers are approximately 4 to 8 times more likely to report past 30 days cannabis use than non-smokers (Strong et al., 2018). Similarly, adolescent cannabis users are more likely to smoke tobacco than cannabis non-users (Okoli, Richardson, Ratner, & Johnson, 2008). Indeed, a significant proportion of adolescents and young adults use these substances either concurrently or simultaneously. *Concurrent use* refers to the use of two substances within a given time period (e.g., 1 month, or week), whereas *simultaneous use* (which is a subset of concurrent use) is the use of both substances at the same time so that the effects overlap (Terry-McElrath, O'Malley, & Johnston, 2013; Terry-McElrath & Patrick, 2018). Simultaneous use of tobacco and cannabis may take multiple forms including through the use of spliffs (a cannabis joint with tobacco mixed in), blunts (mixing tobacco and cannabis in a hollowed out tobacco paper), vaping a combination of cannabis product and tobacco containing nicotine, or chasing (smoking a cigarette after using cannabis in order to enhance its psychoactive effects). Regardless of method, concurrent/simultaneous use is common. One study of young adult past-month cigarette smokers revealed that 53% of them also reported past-month cannabis use (Ramo & Prochaska, 2012) and 47.9% of polysubstance-using students reported consuming tobacco during their last cannabis use (Barrett, Darredeau, & Pihl, 2006).

Concurrent and simultaneous use entail harmful consequences, yet few studies have examined predictors or correlates of such use patterns. One study found that simultaneous-using women were more likely to meet diagnostic criteria for cannabis abuse and report daily cannabis use than concurrent-using women (Agrawal et al., 2009). Concurrent users were also less likely to attempt to or successfully quit smoking than single-substance users (El-Khoury Lesueur, Bolze, & Melchior, 2018; Okoli et al., 2008). In addition, concurrent users reported elevated anxiety symptoms (Bonn-Miller, Zvolensky, Leen-Feldner, Feldner, & Yartz, 2005), and increased probability of respiratory disease (Strong et al., 2018) than exclusive tobacco users. These studies indicate that concurrent use exacerbates the problems associated with each substance, with simultaneous use being particularly harmful for some outcomes. Understanding the factors associated with concurrent/simultaneous use, especially among college students, is critical to identify who is vulnerable to engage in these use patterns and inform prevention and intervention efforts within educational settings.

The purpose of this study was twofold: (1) to estimate the prevalence rate of concurrent and simultaneous cannabis and cigarette (combustible and electronic) use among a sample of college students who had used cannabis at least once in the past year; and (2) to characterize psychosocial predictors of concurrent and simultaneous cannabis and combustible and e-cigarette use.

Materials and methods

Design and sample

Data came from the first wave of the 3-Campus Alcohol and Marijuana (3CAM) Study – a prospective study that examined simultaneous alcohol and cannabis use among 1390 full-time college students, ages 18–24, at three state universities each with different state laws regarding recreational cannabis use. Initially, a random sample of students from each of the three universities was invited by e-mail to participate in a screening survey to determine study eligibility, which included: being a full-time student between ages 18 and 24, and being a past-year user of alcohol and cannabis. The screening sample was fairly representative of the invited sample in terms of demographic characteristics (see White et al., 2019 for greater detail).

A random sample of eligible students stratified by university and oversampled for past-month alcohol and marijuana users was invited to take the baseline survey online in the fall semester of 2018. Overall, 1390 of those who responded were eligible based on their survey responses. The baseline sample was 62.4% female with a mean age of 19.8 ($SD=1.3$); 63.8% were non-Hispanic white, 2.7% non-Hispanic black, 12.5% Asian, 12.4% Hispanic, 0.1% Native American, 0.2% Pacific Islander, 0.1% other, and 1.7% multi-racial. All participants provided informed consent and all procedures were approved by the Institutional Review Board of the coordinating university. For additional details on study design, see White et al. (2019). Of the 1390 participants, 38 were excluded due to low baserates of those who smoked combustible cigarettes and/or e-cigarettes but did not report past-3 month cannabis use. The final sample ($N=1352$) did not differ from the original sample in terms of gender or racial/ethnic distribution.

Measures

Demographics

Age, birth sex, self-identified race/ethnicity, and family socioeconomic status (SES; coded 1 if the family ever received welfare or free school lunch and 0 if not) were collected.

Cannabis use

Number of days of cannabis use in a typical week in the past month (0–7), in the past 30 days (0–30) and in the past 3 months (0–90) were assessed. Past 3-month frequency of cannabis use was also dichotomized as 0 or 1 (no/yes, respectively).

Tobacco and nicotine use

Number of days of cigarette and e-cigarette use in the past 30 days (0–30) was assessed. We dichotomized past 3-month use of any combustible cigarette or e-cigarette as 0 or 1 (no/yes, respectively). We also dichotomized lifetime (ever) use of any tobacco/nicotine products as 0 or 1 (no/yes, respectively).

Alcohol use

Participants reported the number of days they drank alcohol in the past 30 days (range 0–30).

Illicit drug use

Participants reported whether they have ever used 11 illicit drugs in their lifetime: methamphetamine, heroin, opiates, sedatives/tranquilizers, cocaine, ecstasy, hallucinogens, inhalants, steroids, and other stimulants. Yes, was coded as 1 and No was coded as 0.

Simultaneous use

For every substance that students reported using, they were asked how often it was used with cannabis at the same time so that their effects overlapped. Items were presented on a 5-point Likert scale ranging from 0 (*never*) to 4 (*weekly or more*). This question was asked separately for combustible cigarettes and e-cigarettes; never was coded 0 and any frequency was coded 1.

Type of substance user

Based on self-reported past 3-months frequency of simultaneous use of cannabis and combustible/electronic cigarettes, we created four mutually exclusive user groups as follows: Non-recent users (includes those who never used cigarettes (electronic/combustible) and those who did not use either cannabis or cigarettes (electronic or combustible) in the past 3 months); Cannabis-only users; Concurrent Cannabis and Cigarette (combustible or electronic) users (i.e., those who reported cannabis and cigarette use during the same time period but not simultaneously; CCAC); and Simultaneous Cannabis and Cigarette (combustible or electronic) users (SCAC; those who reported cannabis and cigarette use at the same time so that their effects overlapped). Of note, although the SCAC users are technically considered a subset of concurrent users, the CCAC users are non-simultaneous concurrent users, whereas the SCAC users are simultaneous concurrent users.

Anxiety

The seven-item Generalized Anxiety Disorder-7 (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) was used to assess anxiety. Respondents are asked how often during the previous 2 weeks they were bothered by various symptoms (e.g., feeling nervous, anxious, or on edge; trouble relaxing). Total scores ranged from 0 to 21, with higher scores representing more severe anxiety (Cronbach's $\alpha=.92$). Each item is rated on a 4-point scale (0 = *not at all*; 1 = *several days*; 2 = *more than half the days*; and 3 = *nearly every day*).

Stress

Participants rated their overall level of stress during the past 12 months on a Likert scale ranging from 0 (*no stress*) to 4 (*tremendous stress*).

Health

Participants rated their general health on a Likert scale ranging from 1 (*poor*) to 5 (*excellent*).

Analytical methodology

Associations between the four substance user groups (Non-recent, Cannabis-only, CCAC, and SCAC) and demographic characteristics were assessed using Chi-square tests of independence for categorical variables and Analysis of Variance (ANOVA) for continuous variables followed by Bonferroni corrections for multiple comparisons. Multinomial (polytomous) logistic regression predicted the probability of belonging to any user group as a function of all covariates and the psychosocial measures. The cannabis-only category was the reference group because it was the largest. Unstandardized coefficients (*b*), as well as their corresponding 95% confidence intervals (*CI*) and relative risk ratios (*RR*) are reported for logistic regressions predicting membership to a user group. Due to small sample sizes of Non-White participants, race/ethnicity was coded as White and Non-White (i.e., individuals who identified as Black, Asian, Hispanic, Native American, Pacific Islander, Mixed, or Other) in the logistic regressions. Prior to conducting analyses, we made sure that no outliers, excessive skewness or kurtosis were present using recommended guidelines (Ghasemi & Zahediasl, 2012). Variance inflation factors were less than 2 ruling out multicollinearity. Finally, a poor fit to Harman's single factor test suggests that common method variance (CMV), a common source of bias in self-report studies, was not a significant source of bias for our data ($\chi^2(27) = 238.65, p < .001, RMSEA = .07, CFI = .83, TLI = .77, SRMR = .06$).

Results

Descriptive statistics and prevalence

In this sample of 1352 past-year cannabis users, 528 individuals (39.1%) reported cigarette or e-cigarette use as follows: 121 (22.9% of cigarette or e-cigarette users) were past 3-month cigarette users exclusively, 211 (40.0%) were e-cigarette users exclusively, and 196 (37.1%) used both. The cannabis-only group had the largest number of individuals ($n = 686$; 50.7%), followed by the SCAC ($n = 293$; 21.7%) and the CCAC ($n = 235$; 17.4%) groups. The smallest group was the non-recent user group, which comprised 10.2% of the sample ($n = 138$). For both CAC groups, exclusive use of combustible cigarettes was less common than exclusive use of e-cigarettes or use of both e- and combustible cigarettes. More specifically, 41.3% and 32.3% (CCAC) as well as 38.9% and 41.0% (SCAC) reported using e-cigarettes exclusively or in addition to combustible cigarettes, respectively.

Table 1. Prevalence and frequency (mean number of days) of cigarette (combustible/electronic) and cannabis use by user groups.

	Total sample (N = 1352)	CO (n = 686)	CCAC (n = 235)	SCAC (n = 293)	NR (n = 138)
Ever used tobacco products	64.3%	43.9%	100.0%	100.0%	29.0%
Cigarette/e-cigarette use past 3 months	39.1%	0.0%	100.0%	100.0%	0.0%
Cigarette/e-cigarette use past month	11.2%	0.0%	37.5%	21.5%	0.0%
Any cannabis use past 3 months	89.8%	100.0%	100.0%	100.0%	0.0%
Any cannabis use past month	77.5%	84.0%	81.3%	95.9%	0.0%
Any cigarette use past 3 months	23.5%	0.0%	58.7%	61.1%	0.0%
Any cigarette use past month	19.1%	0.0%	42.1%	54.3%	0.0%
Any e-cigarette use past 3 months	46.8%	0.0%	73.6%	79.9%	0.0%
Any e-cigarette use past month	27.0%	0.0%	59.2%	77.1%	0.0%
Mean days of cannabis use past 3 months	2.90	2.75	2.84	4.64	0
Mean days of cannabis use past month	7.97	6.91	6.95	15.04	0
Mean days of cigarette use past month	1.21	0	1.60	4.31	0
Mean days of e-cigarette use past month	2.43	0	3.03	8.78	0

Note: All respondents reported cannabis use in the past year.

CO: cannabis-only; CCAC: concurrent cannabis and cigarette/e-cigarette users; SCAC: simultaneous cannabis and cigarette/e-cigarette users; NR: Non-recent users.

In contrast, 26.4% (CCAC) and 20.1% (SCAC) reported exclusive combustible cigarette use.

Table 1 presents the prevalence and frequency (mean number of days) of cannabis and cigarette (combustible or electronic) use for the full sample and by user groups at various time frames. As indicated, both CAC groups reported higher lifetime and recent cigarette use than the other groups, with SCAC individuals reporting more days of cigarette use (combustible or electronic), on average, than CCAC individuals. Prevalence rates of cannabis use was similar for the cannabis-only, CCAC and SCAC groups, however, SCAC users reported substantially more days of cannabis use, on average, than those in cannabis-only and CCAC groups.

Sample characteristics by user groups appear in Table 2. On average, non-recent users were older than all other groups, and had lower days of alcohol consumption than the cannabis-only group and both CAC groups. These latter two groups had significantly higher mean days of alcohol consumption than the cannabis-only group. In addition, White participants were more likely to be in either CAC group than in other groups, and Non-White participants were more likely to be in the non-recent or cannabis-only groups than otherwise. Also, the SCAC group had a larger proportion of males relative to all other groups. Differences among groups in these variables were small according to the measures of effect size. Differences in the number of days of cannabis use between the groups were large; individuals in the SCAC group had the highest frequency of cannabis use, whereas the CCAC and the cannabis-only groups did not differ. Individuals who reported simultaneous use of alcohol and electronic or combustible cigarettes (SALC) were more prevalent in either the CCAC group (54.5%) or the SCAC group (64.5%) than in other groups. In terms of illicit drug use (IDU), 26.6% ($n = 360$) of the sample reported lifetime use of any of the 11 illicit drugs. The most commonly used drug category was hallucinogens, which was reported by 8.8% ($n = 122$) of the sample. Individuals who reported any IDU during the past 3 months were more likely to belong to either the CCAC (35.3%) or the SCAC (51.5%) groups than other groups. There were no significant differences among groups for socioeconomic status (SES), general health ratings, anxiety, and stress levels.

Multinomial logistic regressions

Results for the multinomial logistic regression predicting the probability of membership in either CCAC, SCAC, or the non-recent user group relative to the cannabis-only group appear in Table 3. Holding all other variables constant, White respondents, relative to non-White respondents, were more likely to belong to the SCAC group than the cannabis-only group. Males were more likely than females to belong to the SCAC group than cannabis-only group. Older individuals were more likely than younger ones to belong to the non-recent user group than the cannabis-only group, but were more likely to belong to the cannabis-only group than either CAC group. Individuals who reported SALC were between two to three times more likely than those who did not report SALC to belong to either CAC group than to the cannabis-only group. Individuals with higher number of days of alcohol consumption were more likely to belong to the CCAC group, than to the cannabis-only group. Finally, participants who reported recent IDU were more likely to belong to either CAC group than to the cannabis-only group, but less likely to be in the non-recent user group. This logistic regression model yielded a better fit than a model with no predictors ($\chi^2(30) = 651.23, p < .001$).

Frequency of cannabis use was higher for the SCAC group than for the CCAC group [$b = 0.29, p < .001, 95\% CI (0.21, 0.37), RR = 1.3$] and no differences in such were found between the cannabis-only and the CCAC groups. We re-ran the logistic model using CCAC as the reference user group, while controlling for cannabis frequency, in addition to all other variables controlled previously. This approach allows for the direct comparison between CAC groups and clarifies whether differences found above were, in part, influenced by cannabis frequency. While the analyses were conducted for all four groups, below we only report the results comparing the CAC groups with each other and to the cannabis-only group, as these are the groups for which frequency of cannabis use is relevant. Controlling for cannabis use, males were more likely than females to belong to the SCAC group than the CCAC group [$b = 0.52, p = .009, 95\% CI (0.13, 0.92), RR = 1.7$]. Also, older individuals were more likely to belong to the cannabis-only group than to the CCAC group [$b = 0.38, p < .001, 95\% CI (0.24, 0.53), RR = 1.5$]. As observed prior, days of alcohol consumption was lower for the cannabis-only group than the CCAC group [$b = -0.04, p < .001, 95\% CI (-0.08, -0.01)$,

Table 2. Demographic characteristics of the sample by user group over the last 3 months ($N = 1352$).

	Total Sample ($N = 1,352$)	CO ($n = 686$)	CCAC ($n = 235$)	SCAC ($n = 293$)	NR ($n = 138$)	ANOVA or Chi-square statistic		
	Mean (SD) or %					F/χ^2	p	η^2/V
White	63.8%	58.5%	68.1%	74.7%	59.4%	26.68	< .001	0.14
Black	2.7%	3.5%	1.7%	0.7%	5.1%	9.91	.02	0.09
Hispanic	12.4%	14.4%	11.5%	9.6%	9.4%	6.11	.11	0.07
Asian	12.3%	12.8%	11.9%	8.9%	17.4%	6.72	.08	0.07
Mixed	7.8%	9.2%	6.4%	5.8%	7.3%	4.18	.24	0.06
Other	1.1%	1.6%	0.4%	0.3%	1.5%	4.25	.24	0.06
Male	37.0%	32.9%	36.2%	52.2%	30.4%	36.30	< .001	0.16
Low SES	21.2%	23.5%	19.6%	17.4%	21.0%	5.01	.17	0.06
Simultaneous alcohol and cig use	28.2%	8.2%	54.5%	64.5%	5.8%	441.23	< .001	0.57
Other substance use	26.6%	17.2%	35.3%	51.5%	5.8%	163.98	< .001	0.35
Age	19.85 (1.34)	19.86 (1.30)	19.77 (1.36)	19.64 (1.36)	20.36 (1.33)	4.64	< .001	0.02
General health ^a	3.48 (0.93)	3.52 (0.94)	3.49 (0.91)	3.39 (0.95)	3.42 (0.93)	0.55	.70	0.00
Anxiety	5.71 (5.40)	5.69 (5.45)	5.37 (5.12)	6.11 (5.61)	5.57 (5.18)	0.62	.91	0.01
Stress level (last year)	2.49 (0.81)	2.50 (0.82)	2.43 (0.81)	2.48 (0.80)	2.54 (0.74)	0.34	.85	0.00
Days alcohol consumed	6.23 (5.30)	5.39 (4.66)	7.71 (5.82)	7.68 (5.79)	4.62 (4.98)	4.49	< .001	0.09

Note: η^2 = Eta-squared measure of effect size for ANOVA's Omnibus test; V = Cramer's V measure of effect size for χ^2 tests corresponding to contingency tables larger than 2×2 ; $p = p$ -value corresponding to F or χ^2 statistic. CO = cannabis-only users; CCAC = concurrent cannabis and cigarette/e-cigarette users; SCAC = simultaneous cannabis and cigarette/e-cigarette users; NR = Non-recent users. Simultaneous alcohol and cig use corresponds to an indicator variable for individuals who reported using alcohol simultaneously with cigarettes or e-cigarettes. Other substance use corresponds to an indicator for recent (i.e., in the past 3 months) use of any of the following substances: methamphetamine, heroin, opiates, sedatives, cocaine, ecstasy, hallucinogens, inhalants, steroids, and other stimulants. Anxiety was assessed over the past 2 weeks (range of scores = 0–21); Stress level was assessed over the past 12 months (ratings ranged from 0 = no stress to 4 = tremendous stress). Days of alcohol consumed correspond to the number of days over the past month in which the respondent consumed any alcoholic beverage(s). General health ratings (ranged from 1 = poor to 5 = excellent) had four missing cases. According to Little's test, missing data were completely at random ($\chi^2(9) = 13.58, p = .14$). We therefore, analyzed all complete cases.

^aBased on 1348 cases.

Table 3. Multinomial logistic regression predicting user group over the last 3 months ($N = 1348$).

Predictor variables	CCAC ($n = 235$)			SCAC ($n = 293$)			NR ($n = 138$)		
	b	95% CI	RR	b	95% CI	RR	b	95% CI	RR
Non-White	−0.28	(−0.66, 0.10)	0.75	−0.50*	(−0.90, −0.10)	0.61	−0.09	(−0.50, 0.31)	0.91
Male	−0.03	(−0.39, 0.33)	0.97	0.68***	(0.32, 1.03)	1.97	−0.14	(−0.56, 0.28)	0.87
Low SES	0.11	(−0.32, 0.53)	1.11	−0.01	(−0.44, 0.43)	0.99	−0.30	(−0.78, 0.18)	0.74
Age	−0.37***	(−0.51, −0.23)	0.69	−0.52***	(−0.67, −0.37)	0.59	0.34***	(0.20, 0.48)	1.41
General health rating	−0.03	(−0.23, 0.16)	0.97	−0.09	(−0.28, 0.11)	0.92	−0.16	(−0.38, 0.06)	0.85
Anxiety	−0.02	(−0.06, 0.02)	0.98	0.01	(−0.03, 0.05)	1.01	−0.03	(−0.07, 0.02)	0.98
Stress level	−0.04	(−0.29, 0.21)	0.96	0.00	(−0.26, 0.25)	1.00	0.07	(−0.22, 0.36)	1.07
Sim alc and cig/e-cig use	2.72***	(2.29, 3.14)	15.16	3.04***	(2.61, 3.46)	20.89	−0.48	(−1.27, 0.31)	0.62
Days alcohol consumed	0.04*	(0.01, 0.08)	1.04	0.03	(−0.01, 0.06)	1.03	−0.05	(−0.09, 0.00)	0.96
Other substance use	0.53**	(0.13, 0.93)	1.70	1.16***	(0.78, 1.54)	3.18	−1.28**	(−2.31, −0.52)	0.28

Note: * $p < .05$. ** $p < .01$. *** $p < .001$.

CCAC: concurrent cannabis and cigarette/e-cigarette users; SCAC: simultaneous cannabis and cigarette/e-cigarette users; NR: non-recent users.

The reference user group is the cannabis only group ($n = 686$). Demographic reference categories include White individuals, females, individuals who did not meet the criteria of low SES, and individuals who did not report simultaneous alcohol and e- or combustible cigarette use and who did not report use of any other illicit substances in the last 3 months. Anxiety was assessed over the last 2 weeks. Stress level was assessed over the last month and year. Days of alcohol consumed correspond to the number of days over the past month in which the respondent consumed any alcoholic beverage(s). Sim alc and cig/e-cig use corresponds to an indicator variable for individuals who reported using alcohol simultaneously with cigarettes or e-cigarettes. Other substance use corresponds to an indicator for recent (i.e., in the last 3 months) use of either methamphetamine, heroin, opiates, sedatives, cocaine, ecstasy, hallucinogens, inhalants, steroids and other stimulants. Unstandardized (b) coefficients, and their 95% confidence intervals (CI) as well as relative risk ratios (RR) reported. The final sample for the regression analysis is lower than the original sample due to missing values for self reported health status.

RR = 0.95] and individuals who reported SALC use were more likely to belong to the CCAC group than to the cannabis-only group [$b = -2.74, p < .001, 95\% \text{ CI } (-3.16, -2.31), RR = 0.06$]. Finally, individuals who reported IDU were less likely to belong to the cannabis-only group than to the CCAC group [$b = -0.55, p = .008, 95\% \text{ CI } (-0.96, -0.14), RR = 0.58$]. No differences in the likelihood of belonging to the CCAC versus the SCAC group were detected at the 95% confidence level for SES, age, health ratings, anxiety, stress levels, SALC use, days of alcohol consumption, and IDU.

Discussion

Tobacco and cannabis use continue to be significant public health concerns among young adults and, in particular

college students, with concurrent and simultaneous use of both substances on the rise (Ramo, Liu, & Prochaska, 2012; Schauer, Berg, Kegler, Donovan, & Windle, 2015). We estimated the prevalence of CCAC and SCAC use among a sample of college students in the US who had used cannabis at least once in the past year, and characterized the psychosocial predictors of concurrent and simultaneous use compared to cannabis-only use and relative to each other. In our sample of past-year cannabis users, the majority were current (past 3-months) users of cannabis exclusively (51% of sample). Seventeen percent of the sample used cannabis and cigarettes (combustible or electronic) concurrently and 22% of the sample used both substances simultaneously. In terms of use behaviors, the simultaneous users had a higher prevalence rate of electronic or combustible cigarette use in

the past month than the concurrent users and the majority of the various user groups (except for the non-recent users) reported using cannabis over the last month. For the majority of individuals in the SCAC group, the frequency of their simultaneous cannabis and cigarette use was between less than monthly and monthly.

Relative to cannabis-only users, White, compared to Non-White, students were more likely to be SCAC users. This finding is generally inconsistent with general population studies indicating that racial/ethnic minorities in general, and Black Americans in particular, are more likely to be simultaneous users than Whites (Ramo et al., 2012; Schauer et al., 2015) perhaps due to cultural norms/influences related to use of cannabis via *blunts* (mixing tobacco and cannabis in a hollowed out tobacco paper (Ramo et al., 2012; Schauer et al., 2015). However, as individuals in the CAC groups reported high use of e-cigarettes, either exclusively or in addition to combustible cigarettes, it is also possible that the present study findings are driven by the greater use of e-cigarettes by White students relative to racial/ethnic minority students, which is in line with findings from other studies (Hooper & Kolar, 2016). Alternatively, the combining of racial/ethnic minorities into the category of Non-Whites may have obscured any differential findings by specific racial/ethnic minority groups (e.g., potentially showing that Blacks may have higher rates of concurrent/simultaneous use than individuals from other racial/ethnic minority groups or ignoring higher rates of cigarette use among certain Asian subgroups; Chae et al., 2006). Therefore, future studies identifying differences in use among different racial/ethnic minority students (i.e., Asian, Black, and Latinx) are warranted.

Compared with the cannabis-only group, SCAC users were more likely to be male than female, which is consistent with existing literature (Schauer et al., 2015). When compared to simultaneous users, concurrent users were more likely to be females than males. The greater likelihood of males being in the SCAC group, relative to the cannabis-only group, aligns with the broader literature that shows sex differences in the prevalence rates of, biological effects of, and psychosocial factors associated with cannabis and tobacco use (Cuttler, Mischley, & Sexton, 2016; O'dell & Torres, 2014; Schulenberg et al., 2018). For example, studies indicate sex differences in the rewarding and aversive effects of both cannabis and tobacco (Cuttler et al., 2016; O'dell & Torres, 2014), with women being more sensitive to these effects than men (Calakos, Bhatt, Foster, & Cosgrove, 2017). Given simultaneous use of cannabis and cigarettes is thought to reinforce or enhance the effects of both substances (Rabin & George, 2015), females may be less likely to use these substances simultaneously to prevent any untoward effects or because they can achieve desired effects from using only one. Thus, they may be more likely to opt for concurrent than simultaneous use. It is also possible that the risk factors (genetic and environmental/social influences) associated with more men than women using licit and illicit substances may also underlie men's greater likelihood of using cannabis and tobacco simultaneously (Agrawal, Budney, & Lynskey, 2012).

Older students were more likely to be non-recent users or cannabis-only users than either CCAC or SCAC users. Increasing age may be associated with various transitions (e.g., changes in housing and peer groups), greater responsibilities and structure, or shifts in social/environmental influences that contribute to lower likelihood of using concurrently or simultaneously (Derefinko et al., 2016). For example, as students age and progress in their academic trajectory, concurrent/simultaneous use may be incompatible with a more rigorous academic schedule (Haller, Handley, Chassin, & Bountress, 2010). Likewise, student aging may be associated with personality maturation (e.g., reductions in impulsivity and sensation seeking), shifts away from peer groups who are using concurrently/simultaneously, or the development of intimate relationships that may influence substance use and reduce risk for co-use of cannabis and tobacco (Fleming, White, & Catalano, 2010; Gates, Corbin, & Fromme, 2016; Haller et al., 2010).

Finally, individuals with greater days of alcohol use (within the past 30 days), who reported SALC use, and any IDU were more likely to belong to the CCAC or SCAC group than to the cannabis-only group, which is consistent with findings of higher frequency of alcohol use, and co-use of all three substances (alcohol, tobacco, and cannabis) among polysubstance-using individuals (Cohn, Abudayyeh, Perreras, & Peters, 2019; Lipperman-Kreda, Paschall, Saltz, & Morrison, 2018; Subbaraman & Kerr, 2015) and may reflect a common underlying vulnerability to polysubstance use among those who drink alcohol or use tobacco/cannabis.

Limitations

Some limitations are important to highlight. First, this study was based on a college sample of past-year cannabis users from three campuses across the US, which limits the generalizability of the findings to broader populations. Second, the study was based on self-reported substance-use data which are subject to memory biases, social-desirability effects, and/or fears of stigmatization. Biochemical verification of cannabis and tobacco use can contribute to increased validity of self-report data. Third, the study population included only individuals with a history of using cannabis and alcohol, which resulted in a higher concentration of cannabis users than in the general population. Future studies should attempt to replicate our findings in general population samples. Finally, the cross-sectional nature of our data prevents us from drawing causal conclusions about temporal relations among the variables. Longitudinal studies are needed to examine whether and how the prevalence rates, predictors and consequences of co-use change and influence each other over time.

Clinical implications

Despite these limitations, our findings have important clinical implications for college student populations. The finding that White and male students were more likely to be concurrent or simultaneous users than Non-White or female

students suggests the need for unique intervention efforts targeting these subgroups. Similarly, the greater days of alcohol consumption, SALC use, and IDU reported among simultaneous and concurrent users suggest biopsychological correlates of and consequences from concurrent and simultaneous use that should be further studied. These findings can inform intervention efforts to prevent onset, or reduce concurrent/simultaneous use, of cannabis and cigarettes among college students who use cannabis.

Disclosure statement

No potential conflict of interest was reported by the authors.

Author notes

Ethical Standards: The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Data statement

The data that support the findings of this study are available from the corresponding author, L. R., upon reasonable request.

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