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## Associations between Marijuana Use and Tobacco Cessation Outcomes in Young Adults

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## Abstract

Marijuana and tobacco co-use is common among young adults, and findings are mixed regarding the association between marijuana use and smoking cessation outcomes. This study examined the longitudinal relationships between marijuana use and smoking cessation outcomes among young adults (aged 18-25 years;  $N=500$ ) enrolled in a 3-month smoking cessation intervention trial on Facebook. At baseline and 3, 6, and 12 months, participants reported their marijuana use and their smoking behaviors (seven-day point prevalence abstinence from smoking, cigarettes per day, quit attempts) and readiness to quit. Longitudinal analyses controlled for experimental condition and adjusted for baseline stage of change, baseline average cigarettes per day, sex, alcohol use, and age participants began smoking regularly. Use of marijuana by young adult smokers was associated with a lower likelihood of reduced smoking ( $OR=.71$ , 95% CI[.51, .98],  $p=.036$ ) and a lower likelihood of abstaining from smoking ( $OR=.56$ , 95% CI[.35, .90],  $p=.017$ ) in the past seven days, as assessed over 12 months of follow-up. Use of marijuana was not significantly associated with perceptions of or engagement in the smoking cessation intervention, stage of change for quitting smoking, or tobacco quit attempts (all  $p$ 's > .08). Study findings indicate that while marijuana use is unrelated to motivation to quit tobacco and engage in cessation interventions, marijuana use is associated with less success in reducing and abstaining from tobacco. Additional support and targeted tobacco cessation strategies to address challenges associated with marijuana co-use may be needed.

*Keywords:* marijuana; cannabis; tobacco; smoking; young adult

## 1. Introduction

Marijuana and tobacco co-use is common among young adults (Ramo, Liu, & Prochaska, 2012b). On average, young adults perceive marijuana as less harmful to health, less addictive, and more socially acceptable than tobacco (Berg et al., 2015), and are less ready to quit marijuana than cigarettes (Ramo, Delucchi, Liu, Hall, & Prochaska, 2014). While a few studies have found that marijuana users were less likely to quit smoking than non-users (Ford, Vu, & Anthony, 2002; Gourlay, Forbes, Marriner, Pethica, & McNeil, 1994), others have found no significant differences in smoking outcomes between marijuana co-users and non-marijuana users (Hendricks, Delucchi, Humfleet, & Hall, 2012; Humfleet, Muñoz, See, Reus, & Hall, 1999; Metrik, Spillane, Leventhal, & Kahler, 2011).

Previous research focused on general adult populations, collected data in-person, and was conducted before the advent of widespread changes in marijuana legalization and social norms (Ford et al., 2002; Gourlay et al., 1994; Hendricks et al., 2012; Humfleet et al., 1999; Metrik et al., 2011). It is unclear whether and to what extent marijuana use interferes with smoking cessation and related outcomes among young adults in an era of rapidly shifting laws and attitudes regarding marijuana. It is particularly important to study young adults in this context, because they are less likely to seek smoking cessation treatment (Curry, Sporer, Pugach, Campbell, & Emery, 2005) and are more likely to use marijuana (Center for Behavioral Health Statistics and Quality, 2017) than are older adults. Moreover, due to the stigma around marijuana use and its illegal status in many states, collecting data online may be a useful strategy to improve accuracy of self-reported marijuana use (Ramo & Prochaska, 2012) and to further examine its relationship with smoking cessation. Lastly, marijuana use has become increasingly accepted in society (Schulenberg et al., 2017) and increasingly common among cigarette

smokers (Goodwin et al., 2018). Given the widespread availability and acceptability of marijuana among young adults, current tobacco smokers may experience more difficulty quitting than those surveyed in previous decades. As such, this study uses data from a randomized controlled trial of the Tobacco Status Project (Ramo et al., 2018), a smoking cessation intervention for young adults delivered on Facebook, to examine differences in smoking outcomes between marijuana users and non-marijuana users.

## **2. Material and Methods**

### **2.1 Participants and Procedure**

Participants were young adult smokers (aged 18-25 years,  $N=500$ ) who reported smoking 100+ cigarettes in their lifetime, currently smoking 1+ cigarettes per day 3+ days per week and using Facebook 4+ days per week, and who were English literate. Recruitment consisted of a paid Facebook ad campaign from October 2014 to July 2015 (details reported elsewhere (Ramo, Rodriguez, Chavez, Sommer, & Prochaska, 2014)). Clicking on an ad redirected participants to a confidential eligibility survey. Eligible, consented participants were randomly assigned to one of two conditions: 1) the Tobacco Status Project (TSP) intervention, or 2) referral to the National Cancer Institute's Smokefree.gov website (control). Participants in both conditions were included in all analyses except treatment engagement and perceptions (described below). TSP included assignment to a private Facebook group tailored to participants' readiness to quit smoking, daily Facebook contact with study staff, weekly live counseling sessions, and six additional Cognitive Behavioral Therapy counseling sessions for those ready to quit. Study staff posted once a day for 90 days and participants were asked to comment on the posts. Post content varied by readiness to quit smoking and included strategies informed by the Transtheoretical Model and the U.S. Clinical Practice Guidelines for smoking cessation (DiClemente et al., 1991; Fiore et al., 2008).

Participants were emailed follow-up surveys at 3, 6, and 12 months after the study began. This research was approved by the University of California, San Francisco Institutional Review Board.

## **2.2 Measures**

**2.2.1 Baseline demographics.** Age, sex (male or female), race/ethnicity (recoded into White or non-White), employment status (recoded into any employment or unemployed), education (recoded into high school degree or less, some college, or college degree or higher), and household income (recoded into less than \$20,000, \$21,000 to \$60,000, \$61,000 to \$100,000, or over \$100,000) were measured at baseline.

**2.2.2 Baseline smoking characteristics and alcohol use.** Nicotine dependence was assessed using the 6-item Fagerström Test of Cigarette Dependence (FTCD)(Fagerström, 2012), scored on a scale of 0 to 10, from low to heavy dependence. Daily smoking at baseline was measured with the item, “On average, how many days in a week do you smoke cigarettes (0-7)?”. Responses were recoded into daily smoking (7 days) or non-daily smoking (0-6 days). The Smoking History Questionnaire (Hall et al., 2006) assessed early smoking (i.e., age of initiation, age began smoking regularly, number of prior quit attempts) as well as usual number of cigarettes smoked per day. The Stages of Change Questionnaire (Prochaska & DiClemente, 1983) was used to categorize participants into one of three stages of change (precontemplation, contemplation, preparation) based on their readiness to quit smoking at baseline. Alcohol is another substance commonly used by young adults, and use of alcohol can co-occur with tobacco and/or marijuana (Cohn, Johnson, Rath, & Villanti, 2016; Gubner, Thrul, Kelly, & Ramo, 2018). Hence, we measured alcohol use for possible inclusion as a covariate in the models, using the item, “Have you consumed alcohol in the past 30 days?” (yes/no).

**2.2.3 Marijuana use.** Current marijuana use was measured at each time point using the Staging Health Risk Assessment (S-HRA, developed by Pro-Change Behavior Systems; South Kingstown, RI), based on the Transtheoretical Model stages of change (DiClemente et al., 1991) and the Healthy People 2020 goals for the United States (The Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020, 2008). The item read: “Marijuana is also called pot, weed, and grass. Are you planning to stop using marijuana?” (I have never used marijuana, I stopped using it more than 6 months ago, I stopped using it less than 6 months ago, Yes, I am planning to stop using it in the next 30 days, Yes, I am planning to stop using it in the next 6 months, or No, I am not planning to stop using it in the next 6 months). Participants were categorized as marijuana users if they indicated recent use on the staging item. All others were categorized as non-marijuana users.

**2.2.4 Smoking outcomes.** The following outcomes were assessed at 3, 6, and 12 months: 1) seven-day point prevalence abstinence, 2) smoking reduction, 3) presence of a quit attempt since the last assessment, and 4) stage of change for quitting smoking. Self-reported point prevalence abstinence and reduction were assessed with the item, “How many cigarettes have you smoked in the past 7 days?”. To measure point prevalence abstinence, responses were coded into abstinent in the past seven days (zero cigarettes) or smoking (at least one cigarette). Reduction was calculated using baseline cigarettes per day, and coded into reduced or not reduced by at least 50% since baseline. Quit attempts were measured with, “Have you tried to quit smoking for at least 24 hours since your last Tobacco Status Project survey?” (no, yes, I have not smoked even 1 cigarette since my last TSP survey, recoded into yes/no). Stage of change was measured using the Stages of Change Questionnaire (Prochaska & DiClemente, 1983), recoded into precontemplation, contemplation, preparation, or action/maintenance. Those

in action/maintenance indicated that they had quit smoking. All outcomes were measured at each time point.

**2.2.5 Treatment engagement and perceptions.** Participants in the intervention group reported their perceptions of the intervention at treatment end (3 months) by rating their agreement (1 = strongly disagree, 4 = strongly agree) with 7 items. Items addressed whether the intervention was easy to understand, gave sound advice, gave participants something to think about, and helped them to be healthier, as well as whether they used the information, thought about the information, and would recommend the intervention (Ramo, Thrul, Chavez, Delucchi, & Prochaska, 2015). Responses were coded as disagreement (1-2) or agreement (3-4). Engagement was measured by the number of Facebook comments an individual posted during the 90-day intervention, including comments on posts and during live counseling sessions (range: 0-168).

### **2.3 Analyses**

First, marijuana users and non-users at baseline were compared on baseline demographic and smoking characteristics. Second, differences in reported smoking outcomes between users and non-users during the follow-up period were analyzed using a series of generalized estimated equations (GEEs) with binary distributions and logit link functions for dichotomous variables (seven-day point prevalence abstinence, reduction, quit attempts) and a multinomial distribution with a logit link function for the ordinal variable (stage of change). Longitudinal analyses controlled for intervention group (treatment or control) and adjusted for baseline stage of change (precontemplation, contemplation, or preparation), baseline average cigarettes per day, sex, alcohol use, and age participants began smoking regularly. The first two covariates were determined *a priori* and the latter were selected based on the observed baseline differences



between marijuana users and non-marijuana users. Because all participants were smokers at baseline, longitudinal analyses only included data from the three follow-up points (3, 6, and 12 months). Largely due to attrition, there were 493 missing data points (32.9%) across all three time points on the abstinence variable, 498 (33.2%) on the reduction variable, 489 (32.6%) on the quit attempts variable, and 502 (33.5%) on the readiness to quit variable. GEE analyses are relatively robust to missingness, and a participant's data could still be included in the analyses if they were missing one or more time points. Third, chi-square tests for independence were used to compare marijuana users' and non-marijuana users' perceptions of the intervention. An independent-samples t-test was used to compare treatment engagement (i.e., number of comments posted) between marijuana users and non-marijuana users in the treatment group.

### 3. Results

Baseline participant characteristics are displayed in Table 1. Marijuana users were more likely to be male, more likely to drink alcohol, smoked fewer cigarettes per day, and began smoking cigarettes regularly at an older age than non-users. Associations between smoking variables and marijuana use at each follow-up time point are displayed in Table 2. Use of marijuana by young adult smokers was associated with a lower likelihood of reduced smoking ( $OR=.71$ , 95% CI [.51, .98],  $p=.036$ ) and a lower likelihood of abstaining from smoking ( $OR=.56$ , 95% CI [.35, .90],  $p=.017$ ) in the past seven days, as assessed over 12 months of follow-up. Marijuana users and non-marijuana users did not significantly differ in likelihood of having made a quit attempt ( $OR=.74$ , 95% CI [.52, 1.04],  $p=.087$ ) or readiness to quit smoking ( $OR=.96$ , 95% CI [.75, 1.24],  $p=.750$ ; Table 3). Moreover, users and non-users did not significantly differ in their perceptions of the intervention ( $p's >.18$ ) or treatment engagement ( $t[249]=1.67$ ,  $p=.097$ ;

*M* Facebook comments for marijuana users = 31.00, *SD* = 39.84; *M* for non-marijuana users = 39.95, *SD* = 44.73).

#### **4. Discussion**

This study showed longitudinal patterns of marijuana use, point-prevalence abstinence from smoking, and reduction in smoking among young adults participating in a digital smoking cessation intervention trial. Most importantly, results showed that young adult smokers who co-used marijuana were less likely to reduce their cigarette smoking or to have been abstinent from smoking than were those who did not use marijuana; however, they did not differ in readiness to quit smoking or likelihood of having made a quit attempt.

Although smoking marijuana in addition to cigarettes increases young adults' likelihood of negative physical effects (e.g., coughing, decreased lung capacity; (Taylor et al., 2002), smoking marijuana may make quitting cigarettes more difficult in part by perpetuating the habit of smoking. Quitting smoking requires breaking associations or cues between the behavior of smoking and other contextual factors (e.g., people, places; Conklin, 2006). Young adults commonly use marijuana in conjunction with cigarettes (Ramo, Liu, & Prochaska, 2012b). Thus, continuing to use marijuana may hamper cigarette smokers' efforts to change their behavior. Indeed, results showed that marijuana users were less likely to have recently abstained from smoking or reduced their smoking over a 12-month period. On the other hand, marijuana use status was consistently unrelated to readiness to quit smoking at baseline and during the follow-up period. Moreover, users and non-users did not significantly differ in the likelihood of making a quit attempt over 12 months. Results are consistent with research showing that young adult marijuana users do generally view quitting smoking as important (Ramo, Delucchi, et al., 2014), but have less ability to follow through with a complete abstinence goal despite a desire to quit

smoking (Ramo & Prochaska, 2012). Overall, our finding that marijuana users are less likely to report recent abstinence or reduction in smoking is consistent with extant literature suggesting that marijuana users are less likely to be successful at quitting smoking (Ford et al., 2002; Gourlay et al., 1994).

Encouragingly, marijuana users and non-marijuana users participating in the digital smoking cessation arm of the intervention did not differ in their perceptions of the intervention or their engagement in it. This suggests that young adults who use marijuana were receptive to the content and digital platform of the smoking cessation intervention. The intervention content included minimal information on the potential harmful effects of marijuana use. Future intervention content could highlight the negative effects continued marijuana use may have on quitting smoking, and could serve as a resource for young adults who want to quit using one or both substances. The variables most strongly and consistently associated with smoking outcomes over time were baseline stage of change for quitting smoking and marijuana use. Both should be assessed to inform treatment efforts with young adult smokers.

Strengths of this study include multiple smoking-related outcomes, a 12-month longitudinal design, and a focus on young adults (a high-risk group for marijuana use). This study had a few notable limitations. First, outcomes were self-reported. Our group has previously demonstrated the reliability and validity of young adults' online self-reported tobacco and marijuana use (Ramo, Hall, & Prochaska, 2011; Ramo, Liu, & Prochaska, 2012a), as well as the accuracy and limited bias of self-reported point prevalence abstinence in the present sample (Thrul, Meacham, & Ramo, 2018). Therefore, we opted to use self-reported abstinence, which had a much higher response rate. Second, current marijuana use was categorized into use versus non-use. It is possible that the relationship between marijuana use and smoking outcomes differs

by heaviness of marijuana use, which our survey item did not assess. Although past research has shown that readiness to avoid marijuana use is significantly correlated with past 30 day marijuana use (Naar-King, Kolmodin, Parsons, Murphy et al., 2010; Naar-King, Wright, Parsons, Frey, Templin, & Ondersma, 2006; Ramo, Liu, & Prochaska, 2012), future research should include a more detailed measure of marijuana use. The measure of alcohol use was similarly nonspecific, and a more detailed measure may yield different results. Moreover, up to twice as many of the participants indicated being abstinent for 7 days at each follow-up than identified as being in action/maintenance for having quit smoking. This was especially true of participants who were not using marijuana concurrently, as reflected in the significant difference in point prevalence abstinence and reduction between marijuana users and non-marijuana users. This finding may be due to the sample including non-daily smokers, and/or the young adult age of the participants. Based on self-report, 5-10% of the sample refrained from smoking for at least one week, yet were not committing to quitting. Future research could include more nuanced measure of marijuana use and measures of smoking specific to non-daily cigarette smokers.

## **5. Conclusions**

Compared to older adult smokers surveyed in previous decades, today's young adult tobacco and marijuana co-users may have more difficulty in quitting smoking cigarettes. Study findings indicate that while marijuana use is unrelated to motivation to quit tobacco and engage in cessation interventions, marijuana use is associated with less success in reducing and abstaining from tobacco. Additional support and targeted tobacco cessation strategies to address challenges associated with marijuana use may be needed.

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Table 1. *Baseline characteristics of marijuana users versus non-users.*

	<b>Marijuana Users</b> ( <i>N</i> = 254)	<b>Non-Marijuana Users</b> ( <i>N</i> = 246)	<b>Overall</b> ( <i>N</i> = 500)
Age (M/SD)	20.8 (2.0)	20.9 (2.0)	20.8 (2.0)
Sex (%/N male)*	52.8% (134)	36.6% (90)	44.8% (224)
Race (% non-Hispanic White)	70.5% (179)	76.0% (187)	73.2% (366)
Employment status (%/N)			
Employed	64.5% (164)	61.8% (152)	63.2% (316)
Unemployed	35.4% (90)	38.2% (94)	36.8% (184)
Current student status (%/N)			
Not currently in school	70.1% (178)	69.1% (170)	69.6% (348)
In school part-time	8.7% (22)	8.9% (22)	8.8% (44)
In school full-time	21.3% (54)	22.0% (54)	21.6% (108)
Education (%/N)			
High school degree or less	51.2% (130)	44.7% (110)	48.0% (240)
Some college	42.9% (109)	49.6% (122)	46.2% (231)
College degree or higher	5.9% (15)	5.7% (14)	5.8% (29)
Household income (%/N)			
Less than \$20,000	25.2% (64)	32.5% (80)	28.8% (144)
\$21,000 - \$60,000	50.4% (128)	47.6% (117)	49.0% (245)
\$61,000 - \$100,000	17.7% (45)	13.0% (32)	15.4% (77)
Over \$100,000	6.7% (17)	6.9% (17)	6.8% (34)
Drank alcohol in the past 30 days (%/N)*	78.7% (200)	64.6% (159)	71.8% (359)
FTCD (M/SD) <sup>†</sup>	3.0 (2.1)	3.4 (2.1)	3.2 (2.1)
Usual number of cigs/day (M/SD)*	10.4 (5.9)	11.9 (7.5)	11.1 (6.8)
Daily cigarette smoking (%/N daily smokers)	85.4% (217)	87.8% (216)	86.6% (433)
Age of first cigarette	14.0 (7.0)	14.2 (6.9)	14.1 (7.0)
Age began smoking cigarettes regularly*	17.4 (10.8)	15.7 (2.5)	16.6 (7.9)
Years of smoking cigarettes	4.8 (3.1)	5.3 (3.2)	5.1 (3.2)
Lifetime quit attempts (cigarettes; median/IQR)	3.0 (5.0)	3.0 (4.0)	3.0 (5.0)
Past-year cigarette quit attempts (median/IQR)	1.0 (2.0)	1.0 (2.0)	1.0 (2.0)
Stage of change for quitting cigarettes			
Precontemplation	31.1% (79)	28.9% (71)	30.0% (150)
Contemplation	49.2% (125)	48.0% (118)	48.6% (243)
Preparation	19.7% (50)	23.2% (57)	21.4% (107)

\*Marijuana users and non-marijuana users significantly differ ( $p < .05$ )

<sup>†</sup>Fagerstrom Test for Cigarette Dependence



Table 2. Descriptive statistics for smoking cessation outcomes of marijuana users and non-users at follow-up time points.

Smoking cessation outcome	3 months		6 months		12 months	
	MJ Users (N=171)	Non-MJ Users (N=183)	MJ Users (N=144)	Non-MJ Users (N=175)	MJ Users (N=168)	Non-MJ Users (N=174)
Seven-day point prevalence abstinence (%/N)	6.4% (11)	14.2% (26)	14.5% (21)	18.5% (33)	14.9% (25)	28.2% (49)
Reduced smoking* (%/N)	40.4% (69)	49.7% (91)	47.6% (69)	57.9% (103)	48.2% (81)	59.2% (103)
Made a quit attempt since last survey (%/N)	63.7% (109)	71% (130)	62.8% (91)	69.7% (124)	60.1% (101)	70.1% (122)
Readiness to quit smoking (%/N)						
Precontemplation	29.2% (50)	20.8% (38)	22.8% (33)	20.2% (36)	31.5% (53)	20.1% (35)
Contemplation	35.1% (60)	31.1% (57)	33.1% (48)	27.5% (49)	24.4% (41)	23.6% (41)
Preparation	33.9% (58)	40.4% (74)	35.2% (51)	38.8% (69)	35.7% (60)	37.4% (65)
Action/maintenance	1.8% (3)	6.6% (12)	6.9% (10)	9.6% (17)	8.3% (14)	18.4% (32)

\* Reduced number of cigarettes per day by at least 50% since baseline

Table 3. Generalized estimating equations models testing the differences between marijuana users and non-marijuana users on smoking cessation outcomes over time.

	Seven-day point prevalence abstinence (% yes)			Reduction in smoking by 50% or more (% yes)			Quit attempt (% yes)			Readiness to quit (Stage of Change)		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Marijuana use (Ref: no use)	.56	.35, .90	.017	.71	.51, .98	.036	.74	.52, 1.04	.087	.96	.75, 1.24	.750
Time	1.89	1.40, 2.55	< .001	1.34	1.12, 1.60	.001	.95	.76, 1.20	.675	1.11	.94, 1.30	.221
Condition (Ref: control)	2.68	.98, 7.32	.055	2.09	1.13, 3.85	.012	1.09	.54, 2.17	.813	1.14	.67, 1.95	.624
Time X Condition	.72	.48, 1.08	.109	.82	.63, 1.06	.130	.97	.72, 1.31	.839	.92	.72, 1.18	.529
Baseline cigarettes/day	.97	.93, 1.00	.080	1.00	.98, 1.03	.813	.99	.96, 1.01	.237	1.00	.98, 1.02	.769
Baseline smoking stage of change (Ref: preparation)												
Contemplation	.46	.28, .75	.002	.52	.34, .82	.005	.42	.24, .73	.002	1.80	1.21, 2.68	.004
Precontemplation	.14	.07, .29	< .001	.29	.18, .47	< .001	.11	.06, .20	< .001	1.80	1.23, 2.63	.002
Sex (Ref: male)	1.44	.91, 2.28	.117	1.08	.76, 1.54	.671	1.05	.73, 1.50	.787	1.23	.95, 1.60	.117
Age began smoking regularly	1.02	1.00, 1.04	.045	1.01	.98, 1.04	.503	1.00	.99, 1.01	.946	1.01	1.00, 1.01	.124
Recent alcohol use (Ref: yes)	1.02	.60, 1.75	.931	.88	.61, 1.28	.514	.69	.47, 1.00	.052	1.13	.84, 1.53	.410

Note: Outcomes were binary except readiness to quit, which was multinomial.