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Marijuana Use Among Young Adult Non-Daily Cigarette Smokers Over Time

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Abstract

Recent data regarding growth in concurrent use of nicotine and marijuana have raised concern that reductions in legal restrictions on marijuana use may increase risk for tobacco-related harms. Previous studies have shown cross-sectional links between use of both substances, but less is known about associations over time. The goal of the present study was to test the hypothesis that there is a bidirectional relationship between use of marijuana and use of tobacco products over time, such that increasing use of either substance would predict increasing use of the other. Participants (n = 391, 52% male) were 18-24 year-old Californians who were non-daily cigarette smokers at enrollment and had never been daily smokers. They reported nicotine/tobacco and marijuana use quarterly over 2 years. Longitudinal negative binomial and logistic regression models indicated that each additional timepoint at which participants reported recent marijuana use predicted 9-11% increases in tobacco quantity and frequency. Additionally, each additional timepoint at which cigarette or tobacco use was reported predicted 19-22% greater marijuana frequency.

Data suggest that young adults who use marijuana more frequently are likely at risk for greater tobacco exposure, and vice versa. These findings suggest a need for preventive measures that focus on concurrent use of both substances rather than either individually.

Keywords

tobacco; marijuana; young adult

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1. Introduction

Young adulthood (ages 18-24) is a critical developmental period that commonly includes multiple important life changes (e.g., living independently, college and/or full-time employment, marriage/cohabitation). This period is also marked by increased access and susceptibility to risky behaviors, including tobacco and other drug use. Recent national data on 18-24 year old young adults indicate past-month prevalence of 22-25% for marijuana (Schulenberg et al., 2018) and 29.1% for cigarettes (Cohn et al., 2018) . In both cases rates were higher than those of older adults.

While increasing use of marijuana and tobacco each raise public health concerns, recent escalation of concurrent use of both is evident in the literature. This trend has ignited interest in exploring whether marijuana use may potentiate exposure to tobacco-related harms. Recent analyses of national data suggest rates of co-use of tobacco and marijuana increased by 18.2% from 2003 to 2012, and 40.6 % of adults aged 18-25 reported past-month use of both products in 2012 (Schauer, Berg, Kegler, Donovan, & Windle, 2015). Our own analyses of Population Assessment of Tobacco and Health data suggest users of combustible tobacco products, e-cigarettes, and multiple tobacco products were 4-8 times more likely to report current marijuana use, and concurrent users of tobacco and marijuana were less likely to attempt tobacco cessation (Strong et al., 2018). National data indicate that co-use is particularly common among daily marijuana users and non-daily tobacco smokers (Pacek et al., 2018; Weinberger et al., 2018). Experimentation with marijuana among tobacco smokers (Leatherdale, Ahmed, & Kaiserman, 2006) and experimentation with tobacco among marijuana users (Schauer, Berg, Kegler, Donovan, & Windle, 2016) may in part be facilitated by product modifications that allow for consumption of both products simultaneously (Agrawal, Budney, & Lynskey, 2012). Relatedly, advertisements for tobacco products may be designed to indicate that the products can be used to consume marijuana (Crawford, 2007; Sowles, Krauss, Connolly, & Cavazos-Rehg 2016). Some initial findings suggest using tobacco products to deliver marijuana (e.g. cigar/blunt wrappers; pipes; vape pens) may both increase and normalize young adults' use of tobacco products (McDonald, Popova, & Ling 2016).

Use of both products may potentiate smoking-related disease by not only increasing exposures to two sources of harmful constituents but by potentiating persistent use. Frequency of marijuana use has been linked consistently to greater nicotine dependence and more persistent tobacco use (Degenhardt et al., 2010; Ford, Vu, & Anthony, 2002; Patton, Coffey, Carlin, Sawyer, & Lynskey, 2005; Ramo, Liu, & Prochaska, 2012; Timberlake et al., 2007). Users of both products perceive marijuana as safer (Berg et al., 2015), report low interest in quitting both marijuana (Amos, Wiltshire, Bostock, Haw, & McNeill, 2004; Ramo, Delucchi, Liu, Hall, & Prochaska, 2014) and tobacco (Ford et al., 2002; Metrik, Spillane, Leventhal, & Kahler, 2011), and are less likely to successfully quit using tobacco (Schauer, King & McAfee, 2017). Thus, young adults who use both products may be disproportionately vulnerable to doing so chronically. Evidence for overlapping negative health consequences (e.g., respiratory, immunologic, and cardiovascular dysfunction) of tobacco and marijuana smoking (International Agency for Research on Cancer, 2014; Moir

et al., 2008; Moore, Augustson, Moser, & Budney, 2005; Volkow, Baler, Compton, & Weiss, 2014; World Health Organization, 2009) suggest high priority for understanding and preventing use in young adulthood.

The context of both tobacco and marijuana use have changed dramatically in the past decade as a result of increasing availability, perceived safety and acceptability of non-cigarette tobacco products, and growing legalized access to marijuana (Gorukanti, Delucchi, Ling Fisher-Travis, & Halpern-Felsher, 2017; Huang et al., in press; Huerta, Walker, Mullen, Johnson, & Ford, 2017; Wang, Heard, & Roosevelt, 2017; Willett et al., 2019). While a number of studies have demonstrated cross-sectional links between use of both products, less is known about the interplay between use of both over time among young adults. This potential bidirectional relationship may be especially important in the context of non-daily tobacco smoking. Pooled data from multiple national surveys show that adults aged 18-24 are more likely to be non-daily smokers than older adults (Reyes-Guzman et al., 2017). Further, preliminary evidence suggests a link between non-daily cigarette smoking and recent increases in daily cannabis use from 2.8% to 8.0% between 2002-2014 (Goodwin et al., 2018). However, the extent to which trajectories of marijuana and tobacco use may interact is unknown, and examination of young adult non-daily cigarette smokers provides an opportunity to identify risk factors for tobacco progression. Thus, the first goal of this study was to test the hypothesis that, among 18-24 year old non-daily cigarette smokers, greater frequency of marijuana use over two years would be positively associated with cigarette quantity and frequency, frequency of non-cigarette tobacco product use, and likelihood of polytobacco use over time. Second, we tested for the existence of a bidirectional relationship, hypothesizing that more frequent use of tobacco would predict heavier marijuana use.

2. Material and Methods

2.1 Participants.

A community sample of 391 18-24 year old California residents was recruited during 2015-17 for a parent study of non-daily cigarette smoking in young adults. Eligibility requirements included non-daily cigarette smoking for the past 6 months or more and owning a smartphone or having regular internet access. Individuals who had previously been daily smokers for one month or more or were not residents of California were excluded.

2.2. Procedure.

Participants were recruited primarily via paid Facebook posts that were targeted by age and location. Clicking on these posts led to the study website, where eligibility was determined. Interested and eligible individuals provided informed consent and completed the baseline assessment on the website. They completed additional quarterly electronic assessments 3, 6, 9, 12, 15, 18, 21 and 24 months later via SurveyMonkey (San Mateo, CA). At the baseline, 12, and 24 month timepoints, assessments consisted of a single survey that was typically completed in 15-20 minutes and for which participants received $25 compensation. At the 3, 6, 9, 15, 18, and 21 month timepoints, participants completed brief daily assessments for 9 consecutive days, and were compensated with $4 per day completed plus an additional $4 if

all 9 days were completed (i.e., up to $40). Because evidence suggests young adults smoke more cigarettes on weekend days (Colder et al., 2006; Cronk et al., 2011), each 9-day period began on a Friday to standardize the number of weekend days included. Links to surveys were sent to participants' email addresses and smartphones. Staff reminded participants to complete assessments via text message, telephone, and email. All procedures were approved by the University of California, San Diego Institutional Review Board.

2.3 Measures.

Demographic characteristics including age, sex, race, ethnic background, and student status were measured at baseline by self-report. Student status was collapsed into a dichotomous variable comparing full-time students (59% of the sample) to all other participants.

Cigarette and other tobacco use were assessed at each of the 9 timepoints. At baseline (BL) and 12 and 24 months later, the Timeline Follow Back (TLFB) (L. C. Sobell & Sobell, 1992; M. B. Sobell, Sobell, Klajner, Pavan, & Basian, 1986) was used to evaluate number of cigarettes smoked, as well as whether participants had used each of marijuana, alcohol, e-cigarettes, hookah tobacco, and any other tobacco product (OTP; smokeless or chewing tobacco, snus, cigars, cigarillos), on each of the 14 days preceding the day of assessment receipt. At the 3, 6, 9, 15, 18 and 21 month assessments, participants reported whether they had used marijuana, alcohol, e-cigarettes, hookah tobacco, and OTPs in the past 24 hours on each of 9 consecutive days. Raw data for each of the days assessed were aggregated to create variables reflecting quantity of cigarettes smoked over 9 or 14 days of each assessment period (*total cigarettes*), and frequency or number of days on which marijuana (*marijuana days*), cigarettes (*cigarette days*), e-cigarettes (*e-cigarette days*), hookah tobacco (*hookah days*), and OTPs (*OTP days*) were used during each assessment period. We created a count variable that reflected the number of days at each timepoint on which participants reported using any tobacco product (*tobacco days*), and a binary variable that assessed whether or not they reported use of multiple tobacco products at each timepoint (*polytobacco use*).

The *marijuana days* variable was used to calculate a time-varying variable (*marijuana frequency*) that measured cumulative number of timepoints, up to and including the one being assessed, at which *marijuana days* was greater than 0. For example, if a participant reported 1 marijuana day at baseline, 0 at 3 months, and 4 at 6 months, his or her values for *marijuana frequency* at those timepoints would be 1 (> 0 days at baseline), 1 (> 0 days at baseline + 0 days at 3 months), and 2 (> 0 days at baseline + 0 days at 3 months + > 0 days at 6 months), respectively. The purpose of this variable was to capture cumulative marijuana use aggregated over the full two years, rather than within each assessment period. We assumed that if marijuana use is a predictor of heavier tobacco use, individuals who use marijuana more frequently over the entire study period would be most vulnerable to this association. Thus, we believed that this variable would better capture marijuana use over time relative to a variable that evaluated marijuana frequency at each assessment but did not account for previous use. Consequently, analyses included cumulative *marijuana frequency* as a predictor of tobacco outcomes over 2 years. Similar variables were calculated to reflect cumulative frequencies of cigarette use, overall tobacco use, polytobacco use, and alcohol use. Because timepoints varied in the number of days on which use was assessed, we also

created a time-varying variable (*assessment days*) that measured number of days on which use was assessed at each timepoint.

2.4 Statistical Analyses.

All analyses were conducted using Stata 15.0 (StataCorp, College Station, TX), with α=.05. We used bivariate tests to evaluate relationships between demographic, predictor, and outcome variables. Tests of associations between cumulative marijuana frequency and tobacco use over time were conducted by testing separate models of the association of the predictor (*marijuana frequency*) with each time-varying outcome (*total cigarettes, cigarette days, tobacco days*, and *polytobacco use*). Each model included cumulative *alcohol frequency* and *assessment days* as covariates, as well as terms for both linear (*time*) and quadratic ($time^2$) time and their interactions with *marijuana frequency*. Nonsignificant interaction terms that were removed and the model refit. Count outcomes (*total cigarettes, cigarette days*, and *tobacco days*) were evaluated via longitudinal negative binomial regression, using Stata's *xtnbreg* module, because that was a better fit to the data than linear or Poisson models. *Polytobacco use*, as a time-varying binary outcome, was analyzed using a longitudinal logistic regression model via the generalized estimating equations (GEE) approach using *xtgee* in Stata. Tests of whether tobacco frequency was associated with marijuana use over time were conducted by fitting separate models of the associations of each predictor (cumulative *cigarette frequency, tobacco frequency*, and *polytobacco frequency*) with *marijuana days* over time, again utilizing negative binomial models.

3. Results

3.1 Preliminary analyses.

The proportion of the sample completing each post-baseline assessment generally decreased over time: 94% at 3 months, 88% 6 months, 85% at 9 months, 89% at 12 months, 84% at 15 months, 82% at 18 months, 78% at 21 months and 81% at 24 months. Having missing data at a specific timepoint was not significantly associated with predictor or outcome variables at the previous assessment. Quantity and frequency of cigarette and marijuana use over time are shown in Table 2. Bivariate assessments indicated that women, full-time students, and Asian Americans smoked fewer cigarettes than others (ps<.05), and therefore sex, student status, and race/ethnicity were included as covariates in subsequent hypothesis tests.

3.2 Cumulative marijuana frequency and cigarette quantity.

The final model is shown in Table 3. All interactions were non-significant, indicating the association between marijuana frequency and total cigarettes was consistent over time; these terms were excluded from the final model. There was a significant main effect of marijuana frequency [Incidence Rate Ratio (IRR)=1.11 (95% CI 1.07, 1.1614), p<.001]. The effect size indicates that each additional timepoint at which recent marijuana use was reported was associated with an 11% increase in number of cigarettes. Put another way, if Participant A reported never using marijuana through the first 5 assessments, and Participant B reported recent marijuana use at each of these assessments, Participant B would be expected to report 55% more cigarettes at the 5^{th} assessment (i.e, Y1) than Participant A.

3.3 Cumulative marijuana frequency as a predictor of tobacco frequency over time.

The models of cigarette and tobacco frequency are shown in Table 3. Both yielded similar results as the first analysis. Cumulative marijuana frequency was a significant predictor of cigarette [IRR=1.09 (1.06, 1.12), $p<.001$] and overall tobacco [IRR=1.09 (1.06, 1.12), $p<.001$] frequencies. In both cases, the association was stable over time. These analyses suggest that each additional assessment period with recently marijuana use predicted a 9% increase in both the number of cigarette days and in the number of days on which any tobacco product was used.

3.4 Cumulative marijuana frequency and likelihood of polytobacco use.

The GEE model indicated polytobacco use was more common among men but did not vary by race/ethnicity or student status. There were significant interactions between marijuana use and time, suggesting the impact of marijuana frequency on polytobacco use changed over time. More specifically, the interaction between cumulative marijuana use and time^2 was a significant predictor of likelihood of concurrent use of multiple tobacco products over time ($z = 3.94$, $p < .001$). To better understand this interaction, we calculated odds ratios indicating the association between cumulative marijuana frequency and odds of polytobacco use at each individual timepoint, accounting for all covariates in the original model. A plot of these odds ratios (see Figure 1) indicates the association between cumulative marijuana use and polytobacco use was highest at baseline, when the possible values for the former were 0 (did not use marijuana in the past 14 days) and 1 (used marijuana on > 0 of the past 14 days). At baseline, participants who used marijuana recently were 65% more likely to report use of multiple tobacco products than those who reported no recent marijuana use. This association decreased over time as a function of the increasing range of possible values of cumulative marijuana frequency. More specifically, at each timepoint, the odds ratio reflects change in odds of recent multiple product use with a one-point change in the cumulative marijuana predictor. As the range of cumulative marijuana frequency increased over time, a one-point change became relatively smaller. Over the second year of observation, each additional timepoint of marijuana use was associated with a 10-21% increase in the odds of polytobacco use.

3.5 Cumulative tobacco frequencies as predictors of marijuana frequency over time.

The model examining cumulative frequency of cigarette smoking on marijuana frequency over time yielded a significant main effect [IRR=1.20 (1.12, 1.27), $p < .001$; Table 4] that did not vary over time. When we modeled the association between cumulative all tobacco use and marijuana frequency, we found a significant main effect [IRR=1.22 (1.13, 1.32), $p<.001$] that did not vary with time. Similarly, analyses showed a significant main effect of cumulative frequency of polytobacco use on marijuana frequency [IRR=1.19 (1.11, 1.29), $p<.001$] but no interaction with time. These results indicate that each additional timepoint at which participants reported any tobacco use or polytobacco use predicted 22% and 19% more days of marijuana use, respectively.

4. Discussion

The aim of this study was to examine whether cumulative frequency of recent marijuana use at quarterly assessments over 2 years would be associated with quantity and frequency of tobacco use among young adults who were non-daily cigarette smokers at baseline. Additionally, we sought to examine whether cumulative tobacco use over time predicted frequency of marijuana use. As expected, we found a dose-response relationship, such that participants with greater marijuana use reported greater quantity and frequency of cigarette use, and greater frequency of use of any tobacco product. Cumulative marijuana use also predicted likelihood of use of multiple tobacco products at single timepoints over time. Each additional timepoint of recent marijuana use was generally associated with a 10-20% increase in tobacco quantity/frequency. Similarly, non-daily cigarette smokers who used multiple tobacco products more frequently also reported more frequent use of marijuana. Each additional timepoint at which participants used cigarettes, all tobacco, or multiple tobacco products was associated with approximately 20% greater marijuana frequency.

These findings are consistent with cross-sectional studies suggesting substantial overlap between marijuana and tobacco use (Cohn et al., 2015; Strong et al., 2018). However, our data also meaningfully extend previous work by demonstrating that longer-term use of marijuana is associated with greater tobacco consumption and vice versa. These associations (e.g., of cumulative marijuana with tobacco over time and of cumulative tobacco with marijuana over time) were comparable in magnitude, suggesting a bidirectional relationship in which either may be the initial substance of interest. Given decreasing legal barriers to marijuana use, the fact that cumulative marijuana use was associated with increasing tobacco frequency in a sample of non-daily cigarette smokers is concerning, as it indicates that marijuana use may promote tobacco progression, increasing risk of poor health outcomes.

Various mechanisms may underlie the observed relationships between use of tobacco and marijuana over time. For example, more frequent simultaneous use of marijuana and tobacco (e.g., used at the same time or mixed together and smoked) would lead one substance to serve as a behavioral cue for the other, and possibly to increased use of both. Additionally, learned cognitions may play a role, as demonstrated in a study examining expectancies of interactions between marijuana and tobacco effects (Ramo, Liu, & Prochaska, 2013). Higher expectations that marijuana use increases tobacco use and urges have been positively associated with tobacco and marijuana frequency, severity of marijuana use, and proportion of days of marijuana and tobacco co-use (Ramo et al., 2014). Thus, individuals who hold these expectancies and use marijuana may experience more tobacco urges, leading to increased tobacco use over time.

Further mechanisms are suggested by a recent review of neurobiological mechanisms underlying co-use (Rabin & George, 2015). One proposed mechanism centers on synergistic effects or functional interactions, whereby use of one substance enhances the reinforcing effects of the other. Currently, the few studies that directly addressed this question have yielded conflicting findings. Some have supported the notion that nicotine enhances the effects of marijuana, while others have failed to support this relationship (Haney et al., 2013; Penetar et al., 2005). As such, further study of this relationship is warranted.

Another mechanism centers on compensatory effects, whereby use of one substance alleviates negative effects of the other. This hypothesis derives from evidence that marijuana withdrawal effects may be ameliorated by nicotine and vice versa (Levin et al., 2010; Vandrey, Budney, Hughes, & Liguori, 2008). In support of this mechanism, a study of expectancies for the interactive effects of nicotine and marijuana found that higher expectations of smoking as a means to cope with marijuana urges were associated with greater marijuana cravings (Ramo et al., 2013). Whether this influences the progression of marijuana and tobacco co-use is currently unknown and merits exploration. In all, multiple active mechanisms are likely contributing to this overlap, consistent with our finding of a bidirectional relationship.

Exploration of such mechanisms and trajectories of co-use have clear clinical implications, especially in the context of smoking cessation. Evaluations of the influence of cannabis use on cessation outcomes have primarily comprised secondary analyses of cessation trials (e.g., (Vogel, Rubinstein, Prochaska, & Ramo, 2018)). Similarly, knowledge about the impact of tobacco on cannabis cessation is based on secondary analyses (e.g., (McClure et al., 2018)). There is preliminary evidence that pharmacotherapy (Adams, Arnsten, Ning, & Nahvi, 2018) and behavioral therapy (Beckham et al., 2018) may be effective treatments for cooccurring marijuana and tobacco use. Our findings converge with this evidence to encourage further systematic exploration into how marijuana-tobacco relationships impact clinical outcomes and into what may be effective at treating concurrent use. Clinically, these findings also reinforce the importance of evaluating use of both products even for intermittent users, and of incorporating evaluation outcomes into efforts to quit using one or both products.

This study has some limitations. A primary limitation is that the parent study was designed to focus on tobacco rather than marijuana use, and thus assessment of the latter was less detailed. However, it is important to note that robust relationships emerged despite this limited assessment. Relatedly, the items assessing use of specific tobacco products did not allow us to separate use of traditional cigars and cigarillos, and so these were grouped into the “OTP” category. Because these products are commonly used as “blunts” to smoke marijuana, being able to differentiate their use may provide additional important information. Moreover, our assessment of marijuana use was limited to frequency and did not capture quantity of use nor the extent to which use of marijuana and tobacco products was simultaneous. Another limitation is that the sample was composed of 18-24 year-old California residents who were non-daily cigarette smokers at baseline, and may not generalize to other populations with differing levels of social and legal acceptance of tobacco and/or marijuana use. Previous research has indicated that young adults who are intermittent cigarette smokers are the most likely to engage in co-use, the issues are particularly relevant for this group (Pacek et al., 2018; Weinberger et al., 2018). However, future research examining whether these associations differ in other settings would make a valuable contribution. A final limitation is that this study did not examine mechanisms that might explain the association between tobacco and marijuana use.

5. Conclusions

In sum, these findings suggest that there is reason for concern about potential increases in tobacco use resulting from ongoing changes in the social and legal environments in the US. Restrictions on use of marijuana have been loosened or abolished, which may send young adults the message that use is safe, and thereby promote increases in marijuana use. Similarly, young adults are likely to perceive nicotine products other than cigarettes as safer and more acceptable than cigarettes (Choi & Forster, 2013, 2014). The use of tobacco to deliver marijuana (e.g., blunts) and the fact that both products can be consumed using the same vaporizing devices may heighten these perceptions. Thus, there is a potential risk that increasing permissiveness around marijuana use may increase tobacco use and thus vulnerability to the maladaptive effects of tobacco. Concurrently, tobacco use predicts increased marijuana use, suggesting that tobacco users are a particularly high-risk group for engaging in marijuana use. Additional longitudinal research with varying populations is needed to confirm these relationships, but the extant evidence seems sufficient to recommend prevention programs that aim to reduce the use of marijuana and tobacco together.

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Highlights

- Co-occurring use of marijuana and tobacco is an emerging public health issue.
- Little is known about trajectories of co-use, especially among young adults.
- A bidirectional relationship over time between marijuana and tobacco use emerged.
- Increases in marijuana use predicted increases in tobacco use over time, and vice versa.
- Systematic research into mechanisms of co-use is warranted.

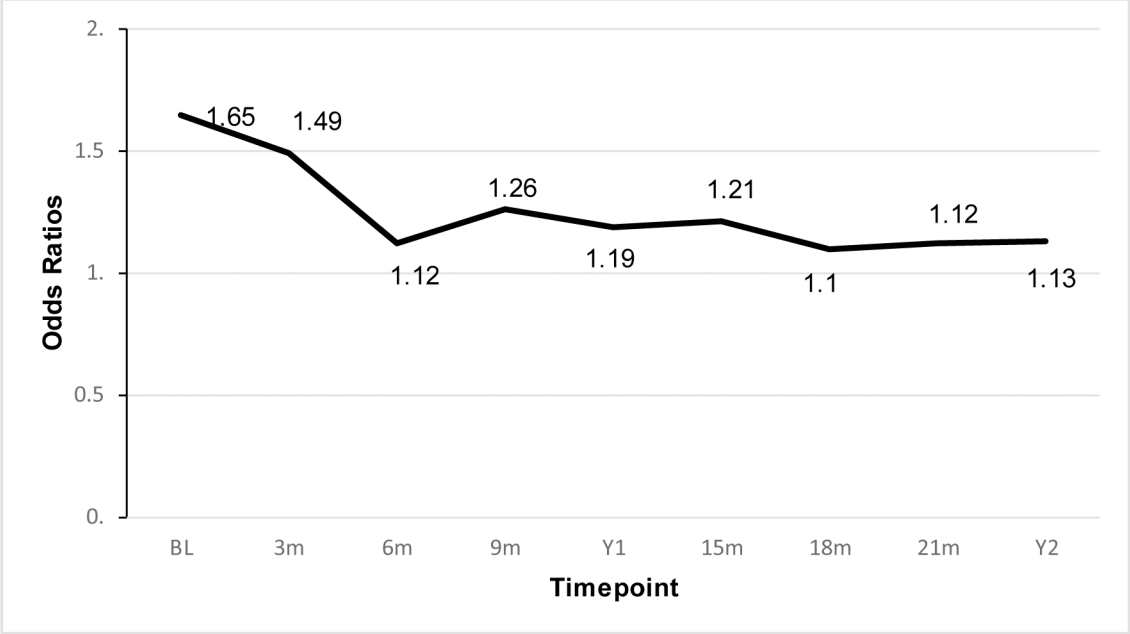

Figure 1.

Odds ratios indicating the timepoint-specific association between cumulative marijuana use and likelihood of polytobacco use, adjusted for sex, race/ethnicity, student status, alcohol frequency, and days of assessment.

Table 1.

Demographic and descriptive statistics.

Variable	% (N) or *M* (SD)
Gender (% Male)	52% (203)
Age	20.5 (1.8)
Race/Ethnicity	
Non-Hispanic Caucasian	45% (176)
Hispanic/Latino	26% (102)
Asian American	20% (78)
Multiple Ethnicities	9% (35)
Baseline marijuana days[a]	3.9 (5.1)
Baseline cigarette days[a]	5.7 (4.0)
Baseline tobacco days[a]	7.1 (4.3)

[a]reflects days of use in the 14 days immediately preceding the baseline assessment.

Table 2.

Quantity and frequency of cigarette and marijuana use over time.

Timepoint	Mean cigarettes per day	% days using cigarettes	% with ≥ 1 cigarette day	% days using marijuana	% with ≥ 1 marijuana day
Baseline	1.09	40.5%	94.0%	27.8%	57.2%
3 months	1.31	47.4%	87.4%	37.9%	60.7%
6 months	0.97	37.1%	75.9%	37.7%	57.1%
9 months	0.93	34.9%	69.3%	36.8%	54.3%
1 year	0.70	30.0%	74..6%	38.6%	55.0%
15 months	0.79	27.7%	59.1%	36.7%	53.3%
18 months	0.74	25.5%	38.0%	35.5%	55.2%
21 months	0.74	25.8%	30.6%	36.0%	53.6%
2 years	0.58	22.2%	36.8%	36.4%	58.8%

Note: calculations refer to use during the 9 or 14 days immediately preceding each assessment only.

Table 3.

Longitudinal negative binomial regression models testing associations between cumulative marijuana frequency and cigarette quantity, cigarette frequency, and overall tobacco frequency over time.

	Cigarette Quantity				Cigarette Frequency				Overall Tobacco Frequency			
Predictor	**IRR (95 % CI)**	**SE**	***z***	***p***	**IRR (95 % CI)**	**SE**	***z***	***p***	**IRR (95 % CI)**	**SE**	***z***	***p***
Assessment days	1.04 (1.03, 1.05)	0.01	5.74	<.001	1.06 (1.05, 1.07)	0.01	10.92	<.001	1.02 (1.01, 1.03)	0.01	8.173.27	<.001
Student status	0.85 (0.74, 0.97)	0.06	−2.35	.019	0.86 (0.75, 0.99)	0.06	−2.05	.040	0.91 (0.81, 1.02)	0.05	−1.60	.030.110
Cumulative alcohol frequency	1.06 (1.05, 1.08)	0.01	7.78	<.001	1.05 (1.03, 1.06)	0.01	7.18	<.001	1.06 (1.04, 1.07)	0.01	7.71	<.001
Sex	0.90 (0.79, 1.03)	0.06	−147	.140	0.89 (0.78, 1.03)	0.06	−1.58	.115	0.77 (0.69, 0.87)	0.05	−4.32	<.001
Race/ethnicity	1.07 (1.01, 1.13)	0.03	2.22	.026	1.05 (0.99, 1.11)	0.03	1.68	.094	1.01 (0.97, 1.07)	0.03	0.58	.561
Time	0.83 (0.81, 0.85)	0.01	−14.74	<.001	0.86 (0.85, 0.88)	0.01	−13.22	<.001	0.84 (0.82, 0.86)	0.01	−14.51	<.001
Cumulative marijuana frequency	1.11 (1.07, 1.14)	0.02	6.30	<.001	1.09 (1.06, 1.12)	0.02	5.73	<.001	1.09 (1.06, 1.12)	0.02	5.47	<.001

Note: IRR = incidence rate ratio; CI = confidence interval; Std. Err = Standard Error. Student status was coded as 0 = non-full-time student, 1= full-time student. Sex was coded as 0 = male, 1 = female. Race/ethnicity was coded as 0 = non-Hispanic Caucasian, 1 = Asian American, 2 = Hispanic/Latino, 3 = other or multiple.

Table 4.

Longitudinal negative binomial regression model testing the association between cumulative cigarette frequency and marijuana frequency over time.

Variable	IRR (95% CI)	Std. Err.	z-score	p-value
Assessment days	1.05 (1.03, 1.06)	0.01	5.55	<.001
Student status	1.41 (1.05, 1.88)	0.21	2.31	.021
Cumulative alcohol frequency	1.06 (1.04, 1.08)	0.01	5.95	<.001
Sex	1.70 (1.27, 2.27)	0.25	3.56	<.001
Race/ethnicity	1.01 (0.89, 1.15)	0.06	0.16	.874
Time	1.00 (0.98, 1.01)	0.01	−0.23	.819
Cumulative cigarette frequency	1.20 (1.12, 1.27)	0.04	5.62	<.001

Note: IRR = incidence rate ratio; CI = confidence interval; Std. Err = Standard Error. Student status was coded as 0 = non-full-time student, 1= full-time student. Sex was coded as 0 = male, 1 = female. Race/ethnicity was coded as 0 = non-Hispanic Caucasian, 1 = Asian American, 2 = Hispanic/Latino, 3 = other or multiple.