



The relationship between alcohol use and cigarette smoking in a sample of undergraduate college students

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Abstract

During the decade of the 1990s, smoking prevalence increased nearly 30% in the college student population. Although most college students initiate smoking before the age of 18, recent evidence suggests a sizable minority of undergraduates report starting smoking while in college. This study examined the concurrent use of alcohol and tobacco as well as the relationship between alcohol use and smoking initiation among a sample of undergraduate students attending a large public university in the southwestern United States. We defined three categories of smoking status for this study: never smokers ($n=777$), experimenters ($n=158$), and smokers ($n=178$). Both experimenters and smokers reported consuming significantly more drinks per occasion in the past 28 days and more drinks on one occasion in the past 2 weeks compared to never smokers; however, there was no significant difference between experimenters and smokers on either of these measures of consumption. The results of two multinomial logistic regression models showed that measures of alcohol consumption and drinking frequency were significantly associated with being an experimenter or smoker after controlling for demographic and other drug use covariates. Results of a logistic regression analysis revealed a significant relationship between past year drinking frequency and smoking initiation among respondents who reported that they were not smoking at all 12 months prior to their survey participation. The influence of alcohol consumption on smoking initiation among college students is discussed.

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1. Introduction

1.1. Prevalence of college student smoking

Despite decreases in smoking prevalence among most adults in the U.S. over the past several decades (CDC, 1999; National Cancer Institute, 2000) smoking among young adults ages 18–24 rose dramatically during the 1990s (CDC, 1997; Johnston, O'Malley, & Bachman, 1999; Rigotti, Lee, & Wechsler, 2000). Similar increases have also been observed within this age range among college students, a group that has previously been more resistant to tobacco use than other young adults (Emmons, Wechsler, Dowdall, & Abraham, 1998; Johnston et al., 1999; Wechsler, Rigotti, Gledhill-Hoyt, & Lee, 1998). The prevalence of smoking among college students increased by 28% during the mid-1990s and has remained stable over the last few years (Emmons et al., 1998; Patterson, Lerman, Kaufmann, Neuner, & Audrain-McGovern, 2004; Rigotti et al., 2000; Wechsler et al., 1998; Wetter et al., 2004). Although this increase could be attributed to a cohort effect produced from the dramatic rise in smoking among middle and high school students observed in the 1990s (Johnston et al., 1999) or from the increased advertising and marketing of cigarettes by the tobacco industry to young adults (Ling & Glantz, 2002; Sepe & Glantz, 2002), determinants of smoking among college students remain unclear. Furthermore, the rising smoking rates among young adults may ultimately impact the progress made since 1965 to reduce smoking prevalence among adults in the U.S. (Wechsler et al., 1998).

1.2. Correlates of smoking in college student populations

Several factors have been shown to be associated with college student smoking. Some demographic correlates of smoking in this population include: gender (females), white race, age (first year students), and college educated parents (Emmons et al., 1998; Patterson et al., 2004; Wechsler et al., 1998; Wetter et al., 2004). Living in a co-ed dorm predicts smoking (Emmons et al., 1998), whereas, residing in a substance-free dorm is associated with lower smoking prevalence (Wechsler, Lee, & Rigotti, 2001). Psychological variables such as negative mood (Patterson et al., 2004), stress (Naquin & Gilbert, 1996; West & Lennox, 1992), positive attitudes toward smoking (Hines, 1995), affect regulation, smoking outcome expectancies (Wetter et al., 2004), and rebelliousness (Choi, Harris, Okuyemi, & Ahluwalia, 2003) have all been shown to predict smoking.

The association between the use of alcohol and tobacco has also been widely observed in college student populations (Hines, Fretz, & Nollen, 1998; McKee, Hinson, Rounsaville, & Petrelli, 2004; Saules et al., 2004; Sher, Gotham, Erickson, & Wood, 1996). In one recent study conducted at a Canadian university, nearly 3 of 4 (74%) of the undergraduate participants reported smoking while drinking (McKee et al., 2004). Among first year college students, individuals who initiate smoking before coming to college have higher rates of heavy episodic drinking (i.e., consuming five or more drinks on any one occasion) than late-onset students (i.e., college initiators); however, heavy episodic drinking rates among late-onset smokers approximate those of early-onset smokers when these individuals reach their senior year (Saules et al., 2004). Several studies have also found heavy episodic drinking and marijuana use in college predict cigarette smoking (Emmons et al., 1998; Jones, Oeltmann, Wilson, Brener, & Hill, 2001; Schorling et al., 1994).

1.3. Theoretical explanations linking alcohol consumption and cigarette smoking

There are several theoretical mechanisms that have been used to explain the observed relationship between the concurrent use of alcohol and cigarettes. According to alcohol myopia theory (Steele & Josephs, 1990), heavy drinking restricts an individual's attentional capacity and only the most salient aspects of one's environment will be attended to by a person who is intoxicated. In this case, impelling environmental cues that promote smoking such as other people smoking, cigarette vending machines, etc. may be more salient to the intoxicated individual than inhibiting cues that discourage smoking (i.e., personal attitudes about smoking, beliefs about the health risks of smoking, etc.).

Classical conditioning explanations of the concurrent relationship between drinking and smoking argue that over time the frequent pairing of alcohol with cigarettes results in alcohol serving as a stimulus which causes the conditioned response of cigarette craving (for a review, see Tiffany, 1995). Models of young adult peer influence also offer possible explanations for the concurrent use of alcohol and cigarettes. For instance, in a recent study of young adults ages 19 to 25, both a concurrent and prospective relationship between peer use and participant use was observed for cigarette smoking and heavy drinking (Andrews, Tidesley, Hops, & Li, 2002). Additionally, an alternative conceptualization of the 'gateway' theory of substance use (Kandel & Yamaguchi, 1993) might predict that alcohol use (or the use of other drugs) may influence smoking behavior through specific developmental stages of substance use progression in some college students.

1.4. Smoking initiation and college students

Generally, smoking initiation occurs before the age of 18 (U.S. Department of Health and Human Services, 1994), but recent evidence suggests that a sizable number of smokers initiate after the age of 18 (Mowery, Brick, & Farrelly, 2000). Among college students, nearly 1 in 8 report initiating smoking while in college (Wechsler et al., 1998; Wetter et al., 2004) and almost 20% of college student daily smokers reported initiating smoking *after* the age of 19 (Everett et al., 1999). This pattern of early-adulthood initiation presents an interesting question: Why are some smokers initiating at this later age when they arrive at college?

This delayed initiation could simply be an extension of the typical patterns of initiation observed among adolescents, or perhaps, there is something unique about the college culture and environment that supports initiation among individuals who lived through adolescence without taking up smoking (Keeling, 1999). Because alcohol and the use of other drugs has been shown to be associated with smoking in college students (Emmons et al., 1998; Jones et al., 2001; Schorling et al., 1994), it is possible that the high prevalence of alcohol consumption and heavy episodic drinking in college student populations (O'Malley & Johnston, 2002) influences initiation of smoking among individuals who entered college as non-smokers.

To date, most studies examining the association between alcohol consumption and cigarette smoking have focused upon the concurrent use of these substances rather than linking alcohol use with smoking initiation. However, one recent study examined the prospective relationship between baseline alcohol consumption and smoking (Wetter et al., 2004). The authors found a cross-sectional association between baseline alcohol consumption and smoking but the use of alcohol did not predict smoking prospectively. In an earlier study, Sher and colleagues (1996) demonstrated the reciprocal effects of alcohol use disorders and tobacco dependence among college students over a 6-year period, but because this study focused on

alcohol and tobacco dependence, it cannot directly be taken as evidence linking alcohol consumption to smoking initiation.

The purpose of the present paper is two-fold: (1) to examine the concurrent use of alcohol and cigarettes among undergraduate college students, and (2) to examine the relationship between alcohol consumption and smoking initiation among a population of undergraduate college students. Using data collected from a cross-sectional survey at a large, urban university in the southwestern United States, we explored the relationship between alcohol consumption and smoking status as well as the relationship between alcohol consumption and smoking initiation. Based upon the results of previous studies (McKee et al., 2004; Mello, Mendelson, & Palmieri, 1987; Sher et al., 1996; Shiffman & Balabanis, 1995), we hypothesized that smokers (daily and occasional use) would drink more than individuals experimenting with cigarettes (ever-smokers who have smoked fewer than 100 lifetime cigarettes) and more than never smokers. We also predicted that heavier drinking and greater frequency of alcohol consumption would be associated with the increased likelihood of being a smoker or experimenter relative to never smoking. Additionally, we hypothesized that greater drinking frequency and heavier alcohol consumption would be associated with becoming a smoker among students reporting that they were not smoking at all 12 months before completing the survey.

2. Methods

2.1. Survey participants

A random sample of 6150 undergraduates (approximately 26% of the 26,000 undergraduate student population) were invited to participate in an internet survey concerning college student achievement, lifestyles, alcohol, and other drug behavior during the spring 2005. Of those invited, approximately 31% completed the survey (1920 respondents). The population of students examined in these analyses was limited to students between the ages of 18 and 24. We utilized these selection criteria to include younger students who are more likely to be experimenting with smoking or in the early stages of smoking uptake (National Cancer Institute, 2000). Of the 1920 respondents, 1730 undergraduate respondents met the inclusion criteria; however, because we also limited our sample of smokers to individuals with a past 30-day prevalence of smoking to ensure recent smoking behavior, the final sample included 1113 respondents.

As observed in Table 1, the sample included almost three-quarters (73.5%) female respondents. Whites comprised 58.5% of the sample followed by Hispanics/Latinos (21.1%), Asian/Pacific Islanders (13.6%), African Americans (2.6%), and multiracial/other (4.1%). The mean age of the sample was slightly older than 20 ($M=20.2$ years, $S.D.=1.5$). Compared to the demographics of the study university, females were over-represented by 15%. The proportions of Hispanic, Asian, and African American respondents in our sample were fairly representative of the undergraduate student population of the study university (20%, 15.8%, and 4.1%, respectively).

2.2. Procedure

Participants were invited via email to participate in the internet survey. The email invitation included a brief description of the survey, instructions on how to complete the survey, and a direct internet link to the

Table 1
Sample demographics, alcohol use, and drug use by smoking status

Characteristics	Sample (<i>n</i>)	Total	Smoking status		
			Never smoker	Experimenter	Smoker
Gender**					
Male	294	26.5%	61.6%	19.0%	19.4%
Female	817	73.5%	72.7%	12.5%	14.8%
Race***					
White	651	58.5%	65.4%	15.4%	19.2%
Hispanic	235	21.1%	75.3%	16.2%	8.5%
Asian	151	13.6%	76.8%	8.6%	14.6%
African American	29	2.6%	93.1%	3.4%	3.4%
Other	46	4.1%	65.2%	13.0%	21.7%
Age***					
Mean (S.D.)	1113	20.2 (1.5)	20.1 (1.5)	20.0 (1.4)	20.7 (1.6)
Greek membership***					
No	973	87.9%	72.5%	13.2%	14.4%
Yes	134	12.1%	52.2%	21.6%	26.1%
Past year drinking frequency***					
Never	172	15.9%	98.3%	1.2%	0.6%
1–2 occasions	129	11.9%	94.6%	2.3%	3.1%
3–5 occasions	112	10.4%	89.3%	6.3%	4.5%
6–9 occasions	106	9.8%	81.1%	12.3%	6.6%
10–19 occasions	143	13.2%	75.5%	13.3%	11.2%
20–39 occasions	141	13.0%	59.6%	22.7%	17.7%
40 or more occasions	278	25.7%	32.0%	27.0%	41.0%
Drinks per occasion***					
Mean (S.D.)	1064	3.0 (3.1)	2.1 (2.6)	4.8 (2.8)	5.3 (3.3)
Maximum reported drinks (past 2 weeks)***					
Mean (S.D.)	1039	3.6 (4.9)	2.1 (3.4)	6.6 (5.6)	7.9 (6.0)
Marijuana use (past year)***					
No	722	65.6%	87.8%	6.9%	5.3%
Yes	379	34.4%	36.7%	27.4%	35.9%
Other illegal drug use (past year)***					
No	1008	91.0%	76.1%	13.3%	10.6%
Yes	100	9.0%	9.0%	21.0%	70.0%
Prescription drug use w/o prescription (past year)***					
No	936	84.4%	78.4%	12.0%	9.6%
Yes	173	15.6%	24.3%	24.9%	50.9%

S.D. = standard deviation.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

survey. To ensure that each respondent could only complete the survey on a single occasion, participants used their student ID number to access the survey. In lieu of providing an incentive to each respondent for completing the survey, all participants were entered into a sweepstakes lottery with the chance of winning one of several cash prizes ranging in value from \$25 to \$250. A survey reminder email was sent out 4 days following the initial email invitation to all non-responders and participants who partially completed the survey. Second and third reminders were sent to non-responders and partial completers four days

following the first reminder email. In order to comply with laws and regulations regarding non-solicited email contacts, each email contact contained language informing potential respondents that they could request to be removed from all future email contacts by responding to an email address provided in the communication.

Participants who logged on to the survey site were asked to read a brief introduction to the survey and then were presented with an online consent form to review. Consent was obtained by having participants select the “I consent” radio button at the bottom of the online consent form. The survey consisted of a set of demographic items and questions about cigarette, alcohol, and drug use.

2.3. Survey measures

Participants first completed a set of demographic items that included questions about the respondent's gender, age, race/ethnicity (white, Hispanic, African American, Asian, and other), and Greek-letter (fraternity/sorority) membership. Smoking status was determined using two items from the set of smoking-related questions: (1) “Have you ever smoked a cigarette?” and (2) “Have you ever smoked at least 100 cigarettes in your entire life?” Participants who indicated cigarette use were also asked to indicate the number of days they smoked cigarettes during the past 30 days as well as the number of cigarettes they usually smoked on those days. We classified participants who reported never smoking a cigarette as never smokers. Respondents who reported smoking more than 100 cigarettes and reported smoking during the past 30 days were classified as smokers. Experimenters were defined as having smoked fewer than 100 cigarettes in his or her lifetime but reported having smoked a cigarette during the past 30 days. We only included smokers who reported smoking during the past 30 days because the measures of alcohol consumption we included in this study are based upon drinking behavior in the past 28 days. Thus, by using this criterion, we could better examine the concurrent use of these substances in the past month for each survey respondent.

All experimenters and smokers were asked about their concurrent use of cigarettes and alcohol. Specifically, we asked these participants the frequency with which they smoked cigarettes while drinking alcoholic beverages (1=never, 4=always) and whether they smoked more while consuming alcoholic beverages (1=less than usual, 5=more than usual). We also asked smokers and experimenters about their usual method of obtaining cigarettes (“get them free”, “have others buy them”, or “buy them myself”) and their smoking history 12 months ago (“were you smoking at all this time 12 months ago”).

In addition to the cigarette specific questions, the survey included several measures of alcohol consumption and drinking frequency. One question asked participants to recall the number of occasions they consumed alcohol in the past 12 months (1=never, 2=1–2, 3=3–5, 4=6–9, 5=10–19, 6=20–39, 7=40 or more). The number of drinks a respondent reported consuming per occasion was calculated using a modification of the Consumption Model Analysis Program developed by Gruenewald and Nephew (1994) (see Clapp et al., 2003). To determine drinks per occasion (DPO), respondents were asked to report alcohol consumption during the past 28 days using a combination of alcohol quantity and frequency items. The alcohol consumption items also included a question concerning the highest number of drinks consumed by participants in the past 2 weeks.

Participants were queried about their illegal drug use (marijuana, cocaine, and ecstasy) and their use of prescription drugs without a prescription (Ritalin/Adderall, Soma, and OxyContin) during the past 12 months (1=never, 2=1–2 occasions, 3=3–5 occasions, 4=6–9 occasions, 5=10–19 occasions, 6=20–39 occasions, and 7=40 or more occasions).

For the analyses reported in this paper, we collapsed the race/ethnicity variable into two categories: white and non-white (including Hispanic). Additionally, we combined the two items measuring the past year use of cocaine and ecstasy and the three items measuring the past year use of Ritalin/Adderall, Soma, and OxyContin without a prescription into two separate measures: (1) illegal drug use (excluding marijuana) and (2) the use of prescription drugs without a prescription. The marijuana measure was kept separate from the measure of other illegal drugs because a large proportion (41%) of our sample reported using marijuana one or more times in the past year. Additionally, the response options for the drug use questions were collapsed into two categories (yes/no) because the infrequent use of most of these substances.

2.4. Data analysis

We examined the relationship between drinking and smoking status (i.e., never smoker, experimenter, smoker) using multinomial logistic regression modeling. For this analysis, two logit models were developed to test this relationship: the first model tested the relationship between alcohol consumption (drinks per occasion) and smoking status (model 1), while the second model tested the relationship between past year drinking frequency and smoking status (model 2). Because of the strong correlation between drinking frequency and alcohol consumption ($r=0.610$, $p<0.001$), we modeled both of these drinking measures in separate multinomial models. For both models, we modeled the likelihood of being an experimenter (logit 1) or smoker (logit 2) versus being a never smoker. The main covariates of interest in these models were alcohol consumption and drinking frequency; however, because many studies have demonstrated that participant gender, age, race/ethnicity, Greek-letter membership, and other drug use significantly predicts alcohol consumption and other substance use (Clapp, Reed, Holmes, Lange, & Voas, 2006; Duhig, Cavallo, McKee, George, & Krishnan-Sarin, 2005; Wechsler, Dowdall, Davenport, & Castillo, 1995; Wechsler, Lee, Kuo, & Lee, 2000; Wechsler et al., 2002), we included these covariates in our models as well. We first examined the bivariate associations between these covariates and smoking status (Table 1) and included only those variables with a significant bivariate association in the multinomial models. All model covariates were entered into the models simultaneously.

The second analysis examined the relationship between the frequency of alcohol consumption and the odds of becoming a smoker (versus being a never smoker) using logistic regression modeling. For this analysis, we defined all respondents who reported that they were not smoking at all 12 months ago and reported smoking during the past 30 days as smoking initiators. In this case, because the survey did not ask smokers or experimenters the age at which they *initiated* smoking, we could not determine whether initiators began smoking during the past year or had relapsed back to smoking after having been quit for a period of time 12 months before the survey. Typically, individuals under the age of 25 are experimenting with smoking and will cycle through stages of smoking and quitting (National Cancer Institute, 2000). Thus, it is possible that some of the “initiators” examined in this analysis had smoked previously at an earlier time in their lives and had recently relapsed to smoking again.

The main independent variable of interest for these analyses was drinking frequency, but our model also included the following covariates: respondent gender, race, age, Greek-letter membership, and past year marijuana, prescription, and illegal drug use. Covariates with significant bivariate relationships to our

dependent variable of smoking initiation were included in the final logistic regression model (Table 3). Variables were entered into the model simultaneously.

Because nearly three-quarters of our sample were women, we stratified both the multinomial logistic and logistic regression analyses by gender to determine whether the relationship between drinking (quantity and frequency) and smoking differed for men and women. The patterns of results obtained for men and women were nearly identical; thus, we report the non-stratified results of our models. Additionally, responses to the alcohol consumption measures (drinks per occasion and maximum number of drinks in the past 2 weeks) that fell more than three standard deviations above the mean were considered statistical outliers and were excluded from all analyses ($n=18$ participants). Cases with missing data were deleted list-wise for each analysis.

3. Results

3.1. Participant demographics and drinking variables by smoking status

Overall, more than two-thirds (69.8%) of the sample were never smokers, followed by smokers (16%) and experimenters (14.2%). On average, respondents reported consuming three drinks per drinking occasion during the past 28 days and 3.6 drinks on the heaviest drinking occasion in the past 2 weeks.

Smoking status by sample demographics, alcohol consumption, and past year drug use is shown in Table 1. Both gender ($X^2=13.22$, $p<0.01$) and race ($X^2=29.64$, $p<0.001$) were significantly related to smoking status. The results of a one-way ANOVA showed that age was also significantly related to smoking status with smokers being significantly older than either experimenters ($p<0.001$) or never smokers ($p<0.001$). Results also indicated a significant relationship between Greek-letter membership and smoking status, $X^2=23.11$, $p<0.001$.

Significant relationships were also observed between the three measures of drinking included in this study and respondent smoking status (Table 1). Heavier past year drinking was associated with being a smoker or experimenter ($X^2=343.69$, $p<0.001$). We used ANCOVA to examine drinks per occasion and maximum number of drinks in the past 2 weeks as a function of smoking status while controlling for age, gender, race, Greek-letter membership, the past year use of marijuana, illegal, and prescription drugs. Results showed smokers and experimenters reported significantly higher drinks per occasion compared to never smokers (both p -values <0.001). There was no difference in drinks per occasion between experimenters or smokers. Smokers and experimenters also reported significantly more maximum drinks per occasion in the past 2 weeks than never smokers after controlling for model covariates (both p -values <0.001). As with drinks per occasion, smokers and experimenters did not significantly differ from each other on the measure of maximum number of drinks during the past 2 weeks.

Among participants who reported smoking a cigarette during the past 30 days, a significantly higher proportion of smokers reported buying their own cigarettes (83.8%) compared to experimenters (16.2%) $X^2=40.75$, $p<0.001$. Not surprisingly, experimenters reported smoking significantly fewer cigarettes per day compared to smokers, $t(1,322)=-7.93$, $p<0.001$. Experimenters also reported smoking less often while drinking than smokers, $t(1,211)=-8.13$, $p<0.001$. Interestingly, both experimenters and smokers reported increasing the number of cigarettes they smoked while they were drinking.

3.2. Multinomial logistic regression models predicting smoking status

The results of the multinomial logistic regression analyses are shown in Table 2. The first model (model 1) estimated the odds of being either an experimenter (logit 1) or smoker (logit 2) as a function of drinks per occasion while controlling for the influence of gender, race/ethnicity, age, Greek-letter membership,

Table 2
Results of two multinomial logistic regression models

	Model 1 ^a				Model 2 ^a			
	Logit 1		Logit 2		Logit 1		Logit 2	
	Experimenter vs. never smoker		Smoker vs. never smoker		Experimenter vs. never smoker		Smoker vs. never smoker	
	AOR ^b	95% CI	AOR ^b	95% CI	AOR ^b	95% CI	AOR ^b	95% CI
<i>Gender</i>								
Female	1.00		1.00		1.00		1.00	
Male	1.25	0.80–1.96	0.81	0.49–1.37	1.61	1.04–2.49*	1.03	0.63–1.71
<i>Race</i>								
White	1.00		1.00		1.00		1.00	
Non-white (including Hispanic)	1.19	0.78–1.83	0.93	0.57–1.52	1.33	0.87–2.05	1.07	0.65–1.74
<i>Age</i>	1.04	0.91–1.19	1.45	1.26–1.66***	0.93	0.81–1.07	1.30	1.12–1.49***
<i>Greek membership</i>								
No	1.00		1.00		1.00		1.00	
Yes	1.30	0.71–2.38	1.30	0.68–2.48	1.04	0.58–1.88	1.10	0.58–2.07
<i>Marijuana use (past year)</i>								
No	1.00		1.00		1.00		1.00	
Yes	4.53	2.85–7.20***	6.06	3.51–10.48***	2.84	1.78–4.53***	4.69	2.67–8.23***
<i>Prescription drug use (past year)</i>								
No	1.00		1.00		1.00		1.00	
Yes	1.72	0.96–3.06	3.32	1.87–5.88***	1.59	0.89–2.84	2.57	1.44–4.60**
<i>Other illegal drug use (past year)</i>								
No	1.00		1.00		1.00		1.00	
Yes	3.27	1.36–7.90**	10.90	4.85–24.54***	3.61	1.51–8.63**	11.92	5.29–26.87***
<i>Drinking frequency (past year)</i>								
Never					1.00		1.00	
1–2 occasions					4.10	0.42–39.97	3.22	0.33–31.83
3–5 occasions					10.87	1.31–90.41*	5.07	0.57–45.12
6–9 occasions					20.31	2.57–160.17**	4.83	0.55–42.65
10–19 occasions					20.20	2.62–156.02**	6.73	0.83–54.46
20–39 occasions					34.04	4.43–261.51**	10.72	1.34–85.45*
40 or more occasions					60.12	7.88–458.60***	25.19	3.23–196.04**
<i>Drinks per occasion</i>	1.23	1.14–1.34***	1.25	1.14–1.37***				

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^a Model 1 ($N = 1037$), model 2 ($N = 1059$).

^b AOR = adjusted odds ratio.

and other drug use. The first two columns of Table 2 report the adjusted odds ratios and 95% confidence intervals for both logit models. For the logit 1 model, past year marijuana use and past year use of illegal drugs (cocaine and ecstasy) significantly increased the odds of being an experimenter. Specifically, marijuana users and illegal drug users were more than four times and three times as likely, respectively, to be experimenters than never smokers. Furthermore, the number of drinks per occasion was associated with the increased odds of being an experimenter by 23%. Respondent gender, race, age, Greek-letter membership, and prescription drug use were not significant predictors in the logit 1 model.

A similar pattern of results was observed for the logit 2 model for most covariates as well as the drinks per occasion variable. Unlike the logit 1 model, respondent age and the past year use of a prescription drug without a prescription were significantly associated with the odds of being a smoker. Specifically, age increased the odds of being a smoker by 45% while reported past year use of a prescription medication was associated with a 3-fold increase in the likelihood of being a smoker relative to a never smoker.

The right side of Table 2 reports the results of a multinomial logistic regression that estimated the odds of being a smoker or experimenter as a function of past year drinking frequency and the same covariates included in model 1. The results for most covariates of both logit models were similar to the results of model 1 with one exception: being male was associated with a 61% increase in being an experimenter relative to females; however, gender was not predictive of smoking status in the logit 2 model. Having three or more drinking occasions in the past year (relative to past year drinking abstinence) was associated with the increased odds of being an experimenter. Remarkably, participants reporting 40 or more past year drinking occasions were 60 times more likely to be experimenters compared to drinking abstainers. For the logit 2 model, reporting 20 or more past year drinking occasions was associated with the increased odds of being a smoker and those respondents with 40 or more drinking occasions were 25 times more likely to be a smoker relative to individuals who reported no past year drinking.

The results of a third multinomial logistic regression analysis (not shown in Table 2) that included maximum number of drinks in the past 2 weeks as well as the same model covariates were similar to the results obtained for both models shown in Table 2.

3.3. Logistic regression models predicting smoking initiation

In our sample, a total of 142 respondents (8.4%) reported becoming smokers during the past 12 months. Table 3 shows the results of a multiple logistic regression analysis examining the relationship between becoming a smoker as a function of past year drinking frequency after controlling for the covariates of gender, race/ethnicity, Greek-letter membership, and past year drug use (i.e., marijuana use, illegal drug use, and prescription drug use without a prescription). As observed in Table 3, males were nearly 80% more likely to report becoming a smoker compared to females. Additionally, respondents who reported past year use of marijuana, illegal drugs or prescription drugs without a prescription were all more likely to become a smoker relative to respondents who reported never using these drugs. Respondent race and membership in a Greek-letter organization were not significant predictors of initiating smoking during the past year. Past year drinking frequency was significantly associated with the odds of becoming a smoker. Specifically, respondents who reported drinking on three or more drinking occasions were significantly more likely to report becoming a smoker compared to past year abstainers. Participants who reported the most past year drinking occasions (40 or more occasions) were nearly 16 times more likely to report becoming a smoker relative to alcohol abstainers.

Table 3
Logistic regression modeling the odds of becoming a smoker in the past year^a

Variable	Percent	X^2	AOR ^b	95% CI
<i>Gender</i>				
Female	12.3		1.00	
Male	24.6	20.56***	1.79	1.12–2.86*
<i>Race</i>				
Non-white (including Hispanic)	12.1		1.00	
White	18.1	6.24*	1.04	0.65–1.68
<i>Greek</i>				
No	14.2		1.00	
Yes	24.7	7.10**	0.75	0.38–1.48
<i>Marijuana use (past year)</i>				
No	5.9		1.00	
Yes	41.1	169.04***	3.59	2.14–6.03***
<i>Illegal drug use (past year)</i>				
No	13.1		1.00	
Yes	73.5	91.77***	3.48	1.45–8.73**
<i>Prescription drug use (past year)</i>				
No	10.9		1.00	
Yes	54.8	12.95***	2.30	1.26–4.22**
<i>Drinking frequency (past year)</i>				
Never had alcohol	1.7		1.00	
1–2 occasions	2.4		2.12	0.35–12.95
3–5 occasions	7.4		5.99	1.23–29.12*
6–9 occasions	10.4		6.62	1.37–32.07*
10–19 occasions	12.9		6.20	1.33–28.77*
20–39 occasions	25.7		12.50	2.76–56.60**
40 or more occasions	42.9	150.04***	15.75	3.50–70.79***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^a $N = 879$.

^b AOR = adjusted odds ratio.

The results of two separate logistic regression models that included the measures of alcohol consumption (drinks per occasion and maximum number of drinks in the past 2 weeks) yielded similar results (i.e., greater alcohol consumption was associated with the increased odds of reporting becoming a smoker).

4. Discussion

The results of the present study demonstrate a relationship between smoking and alcohol consumption after controlling for confounding variables such as age, gender, race, Greek-letter

organization membership, and other drug use. Specifically, both smokers and experimenters reported drinking significantly more drinks per occasion as well as significantly more maximum number of drinks in the past 2 weeks than never smokers. These findings are similar to other studies that have found associations between alcohol consumption and cigarette smoking in samples of college students (Hines et al., 1998; McKee et al., 2004; Saules et al., 2004; Soeken & Bausell, 1989). Additionally, our results suggest that any amount of smoking is associated with greater alcohol consumption relative to individuals who have never smoked a cigarette. Because there was no difference between smokers and experimenters on the alcohol consumption measures our original hypothesis concerning differences in consumption for the three categories of smokers was only partially supported.

We also found respondents who were classified as smokers reported smoking significantly more frequently when drinking than participants classified as experimenters. However, there was no difference between smokers and experimenters in terms of smoking more cigarettes when drinking. Thus, regular smokers smoke cigarettes more frequently when drinking alcohol, but both smokers and experimenters increase their consumption of cigarettes when they drink. The fact that both smokers and experimenters reported increased smoking in drinking situations is consistent with several recent studies that have linked alcohol consumption to increased attention to smoking-related cues (Field, Mogg, & Bradley, 2005) as well as to smoking urges (King & Epstein, 2005; Sayette, Martin, Wertz, Perrott, & Peters, 2005) among both light and heavy smokers.

Consistent with one of our predictions, the results of the multinomial regression analysis indicated that both alcohol consumption and past year drinking frequency were significantly associated with being an experimenter or smoker after controlling for demographic covariates and other drug use. Interestingly, our results also suggest the use of illegal drugs (including marijuana) and prescription drugs without a physician's prescription are important predictors of smoking status as well. In each model, the use of any of these substances significantly increased the likelihood of being a smoker or an experimenter, replicating the results of studies using samples of adolescents and young adults (Flay, Hu, & Richardson, 1998; Perdersen & Skrondal, 1999; White, Pandina, & Chen, 2002). Despite the significant relationship obtained between the drinks per occasion and smoking status variable (model 1), the odds-ratio estimates for both logit models were small relative to the estimates obtained for drug use or for the past year drinking frequency measure included in model 2, suggesting the amount one drinks on any one occasion may be a less important factor associated with smoking behavior compared to drinking frequency or the use of other drugs.

Although most smoking initiation occurs before the age of 18, there is a population of college students who start smoking while attending college (Everett et al., 1999; Wechsler et al., 1998; Wetter et al., 2004). Thus, beyond high school and adolescence, some individuals may still be at risk for developing a nicotine addiction. For the present study, we examined the link between alcohol consumption and smoking initiation. The results showed a strong relationship between past year alcohol use and the initiation of smoking within the past year among past year non-smokers, supporting our hypothesis concerning the relationship between frequency of alcohol use and becoming a smoker. This finding differs somewhat from Wetter and colleagues (2004) who found a positive prospective relationship between alcohol consumption and smoking behavior change among baseline occasional smokers but not among baseline *never* smokers. It is important to note, however, the results of the present study are based on a cross-sectional sample and not a longitudinal sample which could account for the disparate findings between our respective studies.

The majority of respondents who reported initiating smoking during the past year were classified as experimenters (70%) rather than smokers (i.e., occasional or daily smokers), indicating most of the respondents who began smoking during the past year were still in the early stages of smoking experimentation. It is likely many of these experimenters will not become regular smokers; however, a sizable minority of initiators (30%) reported occasional or daily smoking during the past month. Thus, the frequent use of alcohol among college students who do not smoke appears to be a significant risk factor correlated with experimenting with smoking or becoming a regular smoker.

Among adolescents, cigarettes and alcohol have been termed “gateway substances” (Sher et al., 1996; Torabi, Bailey, & Majd-Jabbari, 1993) as the use of one or both substances has been linked to the use of other drugs in both cross-sectional and longitudinal studies of non-college adolescents (Bailey, 1992; Duhig et al., 2005; Fleming, Leventhal, Glynn, & Ershler, 1989; Kandel & Yamaguchi, 1993). The results of this study suggest alcohol may possibly be a “gateway substance” for cigarette use among college students who resisted smoking during adolescence. Because the use of marijuana, prescription, and other illegal drugs was also associated with an increased likelihood of becoming a new smoker, our results suggest that, for some students, the college years represent a period of time of experimentation with and use of alcohol, tobacco, and other drugs (Chen & Kandel, 1995; Johnston, O’Malley, Bachman, & Schulenberg, 2004), so the influence of these other substances on smoking initiation must be considered. The importance of this point is underscored by the results of several recent studies that suggest marijuana may be a “gateway drug” for smoking among adolescents and college students (Amos, Wiltshire, Bostock, Haw, & McNeil, 2004; Hight, 2004; Tullis, Dupont, Frost-Pineda, & Gold, 2003). Additionally, peer group influences, the college environment itself (i.e., dormitory living, little or no adult supervision, etc.) as well as psychological factors such as isolation or group identity may also play important roles influencing smoking initiation during this period of life.

By demonstrating a positive association between the concurrent use of alcohol and cigarettes, we provide some support for a link between alcohol consumption and the initiation of smoking among a sample of undergraduate college students. Despite these findings, several limitations should be acknowledged when interpreting the results of this study. First, the cross-sectional design of our survey precludes making any definitive causal claims about the direction of the relationship we observed between drinking and smoking status and drinking and smoking initiation. Although respondents in the smoking initiation analysis reported that they were not smoking 12 months prior to the survey, we did not ask them whether they were drinking 1 year ago. Thus, it is possible that smoking initiation may have occurred *before* the initiation of drinking. However, this possibility is not likely given the high prevalence of alcohol consumption among U.S. college students (O’Malley & Johnston, 2002). A second limitation concerns the possibility that participants who reported they were not smoking 12 months before the survey may have been smokers at an earlier age that quit but then relapsed back to smoking within the last year. Because we did not ask participants the age at which they smoked their first cigarette, it was not possible to determine if smoking initiation definitively occurred during the past 12 months.

A third study limitation concerns our low survey response rate of 31% which hinders our ability to generalize these results to the undergraduate student population where we conducted the study or to other college student populations. Although our response rate was low, the response rates of web-based surveys examining alcohol or other substance use can vary widely depending upon the population sampled. For example, in a recent study, comparing estimates of adult alcohol use using web-based, telephone, and U.S. mail survey modes, the authors found a 15.4% response rate to the web-based survey which was significantly lower than the other survey modes (Link & Mokdad, 2005). In contrast, McCabe and

colleagues found a much higher response rate for a web-based survey of alcohol and drug use in a college student population compared to a paper-and-pencil survey sent through the U.S. mail (McCabe, Boyd, Couper, Crawford, & D'Arcy, 2002).

Despite these limitations, the results of this study provide additional evidence linking the role of alcohol consumption to smoking behavior among college students. Future research concerning alcohol and smoking initiation among college students (or more generally, young adults over the age of 18) should examine both the group and individual level factors that may mediate the relationship between alcohol consumption and smoking behavior as well as the contexts (i.e., bars and parties) of the concurrent use of these substances. Additionally, the mechanisms underlying the concurrent use of these substances in college student populations should be examined so that appropriate interventions can be designed to prevent and reduce smoking and heavy drinking in this young adult population.

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