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Concurrent Drinking and Smoking among College Students: An Event-Level Analysis

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Abstract

Cigarette smoking and drinking commonly co-occur among college students, a population that is at high risk for developing alcohol and nicotine use disorders. Several studies have been conducted that have examined predictors of drinking or smoking to gain a better understanding of the antecedents of engaging in these behaviors. Yet, few studies have examined specific factors that influence concurrent smoking and drinking in this population. The current study used data from a 21-day electronic diary-based study of college students ($n = 86$) who engaged in concurrent drinking and smoking to examine event-level associations between alcohol use and cigarette smoking in the student's natural environment. We specifically focused on within-person analyses of contexts in which students reported smoking and drinking simultaneously in comparison to contexts in which students reporting drinking without smoking. Situational contexts included environmental setting, whether s/he was alone or with others, and changes in stress and urges to smoke before initiating drinking. Results indicated that students drank more while smoking and smoked three times as many cigarettes, on average, during drinking episodes. Being with others at a party or a bar was associated with increased odds of smoking while drinking. Likewise, increased stress since the prior assessment predicted a greater likelihood of smoking while drinking. Based on the findings from the present study, it is important for future prevention and intervention efforts to consider social settings and heightened stress among students as potential risk factors for engaging in concurrent drinking and smoking.

Keywords

alcohol; drinking; smoking; college students; ecological momentary assessment

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Cigarette smoking is strongly associated with alcohol use in young adults, particularly those attending college who are beginning to experiment with smoking (Harrison, Hinson, & McKee, 2009; Reed, Wang, Shillington, Clapp, & Lang, 2007). A large body of work has examined predictors of drinking and of smoking to gain a better understanding of the antecedents of engaging in drinking or smoking. However, few studies have examined the specific factors that influence concurrent smoking and drinking among college students. The current study was designed to examine contextual correlates of concurrent drinking and smoking among college students using ecological momentary assessment (EMA; Stone & Shiffman, 1994), a method that can capture fine-grained information about behavior in the student's natural environment.

The co-occurrence of smoking and drinking among college students has been shown in many studies (e.g., Dierker et al., 2006; Jackson, Colby, & Sher, 2010; Reed et al., 2007; Weitzman & Chen, 2005). Using a nationally representative sample, Weitzman and Chen (2005) found 98% of student smokers drank alcohol. College student smokers drink significantly more per occasion, drink more frequently, and have significantly more alcohol-related problems than non-smoking student drinkers (Reed et al., 2007; Wetter et al., 2004). Jackson and colleagues (2010) used a daily web survey and found that drinking and smoking tended to co-occur and that students drank significantly more drinks per day when smoking and smoked significantly more cigarettes when drinking. Unfortunately, the daily surveys did not provide information about the contexts in which concurrent drinking and smoking occurred in their sample.

Contextual risk factors are defined as those environmental characteristics (e.g., a party) and/or individual experiences (e.g., stress) that facilitate drinking and/or smoking. Parties, drinking/smoking with others (versus alone), and sporting events are all associated with higher rates of drinking and smoking (Colder et al., 2006; Etcheverry & Agnew, 2008; Grossbard, et al., 2007; Piasecki, McCarthy, Fiore, & Baker, 2008; Stromberg et al., 2007). Recent EMA studies of smoking or drinking in college students have found that being outside, being in the presence of other smokers, and being in a location where smoking was permitted were the strongest predictors of smoking (Cronk & Piasecki, 2010). Thus, several EMA studies have provided information about the contextual influences on smoking (e.g., Cronk & Piasecki, 2010) and drinking (e.g., Mohr et al. 2005) in the daily lives of college students. However, few studies have evaluated the contextual influences on concurrent drinking and smoking episodes.

Understanding the factors that predict concurrent heavy drinking and smoking may provide valuable information for efforts to reduce smoking-related and drinking-related morbidity and mortality. For example, among nicotine-dependent drinkers, it has been shown that drinking is a predictor of smoking relapse (e.g., Borland, 1990). Drinking has been associated with increases in cigarette craving and subsequent increased risk of smoking (Piasecki et al., 2008), perhaps due to cueing, given the evidence that alcohol may act as a cue for tobacco use in both laboratory (Gulliver et al., 1995) and field settings (Shiffman et al., 1994). It has been proposed that nicotine and ethanol may stimulate the same dopaminergic pathways and might result in cravings for one another (Wise, 1988). Cigarette craving has been shown to increase during drinking among social smokers (King & Epstein, 2005). In general, individuals may develop a learned association between smoking and drinking (e.g., smoking while at a bar).

Importantly, programs that target concurrent smoking and drinking may have the net effect of reducing population-level smoking and drinking. Further, decoupling smoking and drinking is an important goal due to findings that concurrent smoking and drinking has been associated with a heightened risk for cancer and neurocognitive deficits, as well as an

attenuation of the cardiovascular benefits of drinking alcohol (e.g., Pelucchi, Gallus, Garavello, Bosetti, & La Vecchia, 2006), with an estimated 50% increase in health risk when the behaviors are combined, in comparison to the sum of their independent risks (Bien & Burge, 1991).

Using data from a 21-day prospective electronic diary-based study, we examined the event-level associations between alcohol use and cigarette smoking in a college population. We specifically focused on within-person and between-person analyses of contexts in which the individual was smoking and drinking simultaneously in comparison to contexts in which the student drank and did not smoke. Situational contexts included environmental setting, whether s/he was alone or with others, and changes in stress and urges to smoke before initiating drinking. The current study focused on two primary research questions. First, we were interested in replicating the finding that individuals tend to smoke more cigarettes during drinking versus non-drinking episodes and drink more alcohol when smoking (e.g., Jackson et al., 2010). The second question was whether contextual factors predicted smoking cigarettes during drinking episodes, as compared to episodes of drinking without smoking. Finally, the effects of contextual factors on both drinking and smoking might vary across gender and level of smoking (daily vs. non-daily smoker; e.g., Cronk & Piasecki, 2010; Todd, 2004). Thus, we were interested in whether the effects of contextual factors were moderated by gender or daily smoking status.

Methods

Participants in the current study were college students enrolled at a large public university in the northwest of the United States. Eligibility criteria for study participants included drinking more than 5/4 drinks per drinking occasion (men/women), at least once in the past month, and drinking alcohol and smoking concurrently at least once per week. Participants were recruited through flyers, advertisements, and email invitations (to students who had been screened as concurrent drinkers/smokers from another ongoing study) and asked to complete an online screening survey. Students who completed the survey were entered into a drawing for a \$50 gift certificate. Participants who met inclusion criteria (69%, $n=111$ of 160 screened) were routed to an online baseline assessment for which they received \$20 to complete. Of those, 108 completed the baseline assessment, and 86 enrolled in the daily monitoring study. Reasons for not enrolling included: not coming into our offices for a training session ($n = 20$), lack of time for monitoring ($n = 1$), and quitting smoking between baseline and the training session ($n = 1$).

After baseline, participants attended in-person training on how to complete daily diaries via a web-enabled phone. Beginning the next day, participants were prompted randomly via email or text message to complete a survey three times per day for 21 consecutive days. Participants had two hours to complete each random survey and were sent one reminder within one hour of the initial prompt. Over 75% of reports were completed within 5 minutes after the initial prompt. They were also instructed to complete a survey during each drinking or smoking episode. For both random prompts and participant-initiated reports, drinking and smoking within an episode were defined as the number of drinks and/or cigarettes since the prior report (either via random prompt or self-initiated survey). Students received \$3 for each random report, plus a \$21 bonus for every week they completed at least two of three random surveys per day. In total, participants could earn \$252 for the monitoring period (see response rates below).

Measures of gender and daily smoking status (assessed by the question “Do you smoke every day?”) were collected in the baseline survey. The other measures were derived from the random and event reports. At each report, the students were asked the number of

drinking occasions since the prior report (time and day of prior report was shown to the student), how many drinks they consumed per occasion, how many cigarettes they smoked since the prior report, and whether they smoked cigarettes while drinking. From these items we created the outcome measures used in the current study: any drinking/smoking, number of drinks/cigarettes, and concurrent smoking while drinking (yes/no).

Contextual variables assessed at each report included where they were drinking during each occasion (if drinking was reported), including at home, at a party, at a bar¹, at a restaurant, at a sporting event, outside, or other, and whether they were drinking alone or with others. In addition, single item measures of stress (“Since the last report have you dealt with anything stressful?” rated on a 5 point scale from “not at all” to “very much”) and urges to smoke (“I have a strong urge for a cigarette right now” rated on a 5 point scale from “strongly disagree” to “strongly agree”), adapted from a prior EMA study (Muraven, Collins, Shiffman, & Paty, 2005) and the Questionnaire of Smoking Urges (Cox, Tiffany, & Christen, 2001), were used as predictors of drinking and smoking episodes. Specifically, we calculated the within-person difference in stress and urge ratings between reports to assess whether changes in stress and urges over time impacted subsequent drinking and smoking episodes.

Results

The mean age of the sample was 20.1 (SD=1.7) and 42.1% were female. The sample was 77.4% White, 13.4% Asian, 2.3% American Indian/Alaskan Native, 1.9% African American, 1.1% Native Hawaiian/Pacific Islander, 3.8% “unknown,” and 3.5% of the sample identified as Hispanic or Latino. Consistent with the screening criteria, 4.2% drank alcohol and smoked cigarettes concurrently every day, 51.4% drank alcohol and smoked at the same time a few times per week, and 44.4% drank and smoked at the same time at least once per week. Average number of drinks per drinking day was 5.74 (SD = 2.20), average number of cigarettes per smoking day was 3.08 (SD = 2.77), and 28.1% of the sample were daily smokers.

Over the 21 days of monitoring for 86 participants, 86.2% of random reports (4670/5418) were obtained and 51 participants (59.4% of the sample) also completed 217 participant-initiated reports at times of drinking (68 reports), smoking (96 reports), or drinking and smoking (53 reports). Preliminary analyses revealed no significant differences in drinking/smoking rates or any other variables of interest across random and event reports, nor between those participants who did and did not provide event reports. Given these findings, data from random and event reports were combined for all analyses. The total number of reports was 4887, including 864 occasions of drinking (17.7% of reports), 1706 occasions of smoking (34.9% of reports), and 383 occasions of concurrent drinking and smoking (7.8% of reports). Smoking occurred on 44.3% of all drinking occasions. Daily smokers and females were more likely to smoke cigarettes during drinking episodes than non-daily smokers ($\chi^2(1, N = 86) = 44.18, p < 0.001$) and males ($\chi^2(1, N = 86) = 5.99, p = 0.02$), respectively. Daily smokers reported smoking while drinking across 60% of drinking occasions versus 47% of non-drinking occasions. Non-daily smokers reported smoking while drinking across 37% of drinking occasions versus 15% of non-drinking occasions.

The average number of drinks consumed while smoking was 5.16 (SD = 3.68), as compared to an average of 4.05 (SD = 3.57) drinks consumed while not smoking. The average number of cigarettes smoked during periods in which drinking occurred was 3.35 (SD = 3.12), as

¹Local ordinance prohibited smoking in bars and restaurants, thus it was assumed that reports of smoking at a bar or restaurant occurred in designated smoking areas, not within the bar or restaurant.

compared to an average of 0.85 (SD = 1.78) while not drinking. Participants who reported concurrent drinking and smoking ($n = 70$, 81.4%) were asked at what point during the drinking episode they started to smoke. Participants responded that they started smoking after starting to drink on 54.9% of occasions, started smoking before starting to drink on 23.9% of occasions, and started smoking and drinking at the same time on 21.2% of occasions.

Bivariate associations between drinking and smoking are provided in Table 1. The between-subjects correlations (above the diagonal), which were estimated by taking the mean of all occasions averaged across people, indicated strong direct associations between all measures of drinking and smoking. The magnitude of the correlations at the within-subjects level (below the diagonal), which takes into account occasions nested within people, were consistent with the between-subjects associations. The intraclass correlations (ICCs) indicated that 7% of the variability in drinking and 34% of the variability in any smoking was within-person variability.

Given that occasions of drinking and smoking were nested within students we used multilevel modeling (Raudenbush & Bryk, 2002) to account for the dependence of observations. Specifically, multilevel models provide estimates of the variability within each person (Level 1) and between individuals (Level 2) across occasions. All models were estimated in Mplus version 5.21 (Muthén & Muthén, 2009) using maximum likelihood estimation, which allowed for missing observations and varying numbers of occasions within and between individuals. A logit link function was used for models with binary outcomes (e.g., any drinking) and a log link function was used for models with count outcomes (e.g., number of drinks). Level 1 variables were centered within person and Level 2 variables were grandmean centered.

A series of four models were estimated in an attempt to replicate the analyses conducted by Jackson and colleagues (2010): (1) drinking predicting any smoking; (2) drinking predicting number of cigarettes; (3) smoking predicting any drinking; and (4) smoking predicting number of drinks. For all models we included the effect of weekend occasions (defined as Friday, Saturday or Sunday)² on Level 1 and we included gender as a Level 2 effect. The results, presented in Table 2, indicated that any smoking, number of cigarettes, and the weekend were significant predictors of any drinking and number of drinks per occasion. Any drinking and number of drinks, but not weekend, were significant predictors of any smoking and number of cigarettes smoked when smoking. Level 2 estimates were also consistent with prior findings (Jackson et al, 2010) with males drinking significantly more drinks per occasion than females.

The second goal of the current study was to examine the contexts in which drinking and smoking tended to co-occur, in comparison to contexts when students only engaged in drinking without smoking³. We were specifically interested in four different contextual variables: who the student was with while drinking (alone or with others); where the student was drinking (at home, at a party, or at a bar versus all other locations)⁴; and whether the student reported an increase in stress or urges to smoke since the report prior to the occasion

²Time of day was included in initial analyses, but was not predictive of concurrent drinking/smoking in the current sample. Interestingly the drinking occasions and concurrent drinking and smoking occasions were rather evenly distributed across different times of the day.

³The contextual questions asked during the random and event prompts limited our analyses to comparing the drinking plus smoking occasions versus the drinking-only occasions, because the questions inquired about whom a person was with and where they were "when they were drinking." Thus, we do not have data on contextual influences on occasions of smoking, unless the participants reported drinking while smoking.

in which drinking was reported. Number of drinks, weekend, smoking level, and gender were also included as predictors.

Results, shown in Table 3, indicated that concurrent drinking and smoking occasions can be differentiated from occasions in which individuals drank without smoking. First, being at a party or at a bar was associated with significantly greater odds of smoking while drinking, such that individuals who were at a party were 3.57 times more likely to smoke while drinking and individuals who were at a bar were 2.17 times more likely to smoke while drinking. Increased stress from the prior assessment and number of drinks consumed were both associated with concurrent drinking and smoking occasions, such that individuals who experienced an increase in stress and individuals who consumed more drinks were more likely to smoke while drinking.

The final goal in the current study was to examine whether results from the models of concurrent smoking and drinking were consistent across gender and levels of smoking (non-daily vs. daily smoker at baseline). Estimates of cross-level interactions using random slopes revealed two significant effects by smoking status and no significant moderation effects by gender (all $p > 0.10$). A significant interaction between urges to smoke and smoking status in the prediction of concurrent smoking and drinking ($B (SE) = 0.38 (0.13), p = 0.005$), indicated that daily smokers reported a greater decrease in urges to smoke prior to drinking without smoking, whereas non-daily smokers reported an increase in urges to smoke prior to drinking without smoking. Follow-up analyses indicated that daily smokers reported significantly greater urges to smoke than non-daily smokers ($\beta = 0.44, p < 0.001$), regardless of the context. Finally, daily smokers were 6.2 times more likely to smoke while drinking at bars versus other locations, as compared to non-daily smokers who were not significantly more likely to smoke while drinking at bars.

Discussion

The results from the current study add to prior research on the strong association between drinking and smoking among college students (Dierker et al., 2006; Jackson et al., 2010; Reed et al., 2007). In the current study, students were significantly more likely to smoke more cigarettes when they were drinking, and drink more alcohol per occasion when they were smoking. We also extended recent research by identifying contexts in which students were more likely to smoke while they were drinking. Students who drank at a party were over three times more likely to smoke while drinking. Being at a bar was associated with increased odds of smoking while drinking, particularly among daily smokers. Students were significantly more likely to smoke while drinking if they experienced an increase in stress since the prior report.

The results from the current study are consistent with interviews of college students who indicated that smoking while drinking at parties was socially acceptable (Nichter, Nichter, Carkogle, Richardson, & TERN, 2010) and that smoking played an important role during times of stress (Nichter, Nichter, Carkoglu, & TERN, 2007). Thus, interventions that target smoking might be particularly important in social settings and at times of heightened stress among students. Implementing such interventions in real-time via cell phones in response to fluctuations in stress or changes in environmental contexts may be beneficial. Non-daily smokers reported increased urges to smoke if they did not smoke while drinking, while daily

⁴Other drinking locations were assessed, however, being at home, at a party, or at a bar represented 82.2% of all drinking occasions and thus we focused on these contexts in the current analyses. Other locations included being at a restaurant (4.9% of drinking occasions), at a sporting event (1.2% of drinking occasions), outside (4.5% of drinking occasions), and “other” (7.2% of drinking occasions).

smokers had higher levels of urge to smoke, regardless of the context. Importantly, daily smokers only drank without smoking if they reported a very large decrease in urges to smoke since the prior report and, in general, the daily smokers reported more cigarettes smoked between reports. Meditation-based urge surfing exercises have shown efficacy among college student smokers (Bowen & Marlatt, 2009), and may be beneficial for both daily smokers and non-daily smokers.

The current study had several strengths, including multiple daily assessments and the opportunity to capture the contexts in which smoking and drinking occurred in near real-time. The present study also had limitations. To minimize assessment burden, only a few contextual influences were examined in the current study. Because the design was correlational, it is impossible to disentangle whether being in a context (e.g., at a bar) leads to concurrent drinking and smoking or whether individuals selected environments that permitted drinking and smoking. Finally the current study did not evaluate whether characteristics of the students (e.g., motives, sensation seeking) predicted concurrent drinking and smoking. It may be important to determine whether these factors play a role in order to better tailor prevention and intervention efforts.

Decoupling drinking and smoking is an important target for several reasons. Among many individuals who are trying to quit smoking they find drinking to be a high-risk situation for relapse. Furthermore, for individuals who only smoke when they drink, it is important to determine the situations in which they are most likely to smoke while drinking. Individuals who smoke while drinking are still at greater risk for morbidity and mortality related to smoking (than those who drink without smoking), thus understanding how, why, and when these two health risk behaviors co-occur is an important public health goal.

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Table 1
 Between-Subjects (Above Diagonal; N=86), Within-Subjects (Below Diagonal; N=4,887), and Intraclass Correlations among Measures of Drinking and Smoking

	Any drinking	# of drinks	Any smoking	# of cigarettes	Smoking while drinking
Any drinking	0.75***	0.21**	0.22**	0.50**	0.44**
# of drinks	0.24**	0.26**	0.67**	0.39**	0.46**
Any smoking	0.24**	0.26**	0.38**	0.46**	0.08
# of cigarettes	0.50**	0.46**	0.07	0.34	0.42
Smoking while drinking	0.07	0.07	0.34	0.42	0.08
Intraclass correlations	0.07	0.07	0.34	0.42	0.08

Note.

* $p < 0.05$;

** $p < 0.01$.

Table 2
 Unstandardized Estimates (Standard Errors) from Multilevel Models Predicting Smoking and Drinking Behavior

	Any drinking	# of drinks	Any smoking	# of cigarettes
Level 1 predictors				
Any drinking	--	--	1.03 (0.21)**	0.52 (0.09)**
# of drinks	--	--	0.20 (0.04)**	0.08 (0.02)**
Any smoking	1.46 (0.16)**	1.47 (0.14)**	--	--
# of cigarettes	0.23 (0.04)**	0.17 (0.03)**	--	--
Weekday/weekend	0.68 (0.10)**	0.72 (0.08)**	-0.16 (0.09)	0.001 (0.05)
Level 2 predictor				
Gender (1=female)	-0.10 (0.24)	-0.58 (0.19)**	0.05 (0.47)	0.17 (0.27)
Random intercept variance				
	1.04 (0.26)**	0.29 (0.07)**	4.01 (0.86)**	1.81 (0.50)*

Note.

* $p < 0.05$;

** $p < 0.01$.

Table 3
 Multilevel Models Predicting Concurrent Smoking and Drinking Occasions versus non-Smoking Drinking Occasions

	Est. (SE)	OR
Level 1 predictors		
# of drinks	0.16 (0.03)**	1.18
Alone vs. With others	-0.32 (0.39)	0.73
At home (1=at home versus other locations)	-0.03 (0.24)	0.97
At a party (1=at a party versus other locations)	1.28 (0.30)**	3.57
At a bar (1=at a bar versus other locations)	0.78 (0.36)*	2.17
Change in urge to smoke	-0.11 (0.07)	0.90
Change in stress	0.20 (0.06)**	1.22
Weekday/weekend	0.03 (0.21)	1.04
Level 2 predictor		
Gender (1=female)	0.29 (0.44)	
Daily smoker (1=yes)	1.45 (0.43)**	

Note.

* $p < 0.05$;

** $p < 0.01$;

Est. = unstandardized estimate; SE = standard error; OR = odds ratio.