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Drinking Level vs. Drinking Pattern and Cigarette Smoking Among Older Adults

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Abstract

Background: There is a lack of research on the role of alcohol consumption in cigarette smoking among older adults and the few studies on alcohol use and smoking with older adults have failed to distinguish between average level and pattern of drinking as predictors of smoking. The main purpose of this study was to examine the independent contributions of average level vs. pattern of drinking as predictors of cigarette smoking among older adults. A subsidiary purpose was to examine the link between continued smoking and mortality among older smokers.

Methods: We investigated average level and pattern of drinking as predictors of current smoking among 1151 older adults at baseline and of continued smoking and mortality among the subset of 276 baseline smokers tracked across 20 years. We used multiple linear and logistic regression analyses and, to test mediation, bias-corrected bootstrap confidence intervals.

Results: A high level of average drinking and a pattern of episodic heavy drinking were concurrently associated with smoking at baseline. However, only episodic heavy drinking was prospectively linked to continued smoking among baseline smokers. Continued smoking among baseline smokers increased the odds of 20-year mortality and provided an indirect pathway through which heavy episodic drinking related to mortality.

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Conclusions: Smokers who misuse alcohol are a challenging population for smoking cessation efforts. Older adults who concurrently misuse alcohol and smoke cigarettes provide a unique target for public health interventions.

Keywords

Alcohol consumption; drinking pattern; episodic heavy drinking; cigarette smoking; older adults

Introduction

The World Health Organization has called for models of health that address multiple health behaviors (WHO, 2013). In general adult samples, the association between alcohol misuse and cigarette smoking is the most commonly observed cluster of behaviors linked to morbidity and mortality (Noble et al., 2015; Meader et al., 2016). In fact, individuals who misuse alcohol are more likely to die from illnesses related to tobacco than from those related to alcohol (National Institute on Alcohol Abuse and Alcoholism (NIAAA), 2007a). However, much of the research on alcohol consumption and cigarette smoking in adults is limited by cross-sectional designs or relatively short time-spans. Moreover, there is a lack of research on the role of alcohol in smoking among older adults (Blazer & Wu, 2012). Further, the few studies on alcohol and smoking among older adults have failed to distinguish between average level and pattern of alcohol consumption.

The main purpose of this study was to examine the independent contributions of average level vs. pattern of drinking as predictors of cigarette smoking among older adults across a 20-year period. Increasing evidence points to the importance of examining both level and pattern of drinking among mixed-age samples of adults (Greenfield et al., 2014; Roerecke et al., 2011). In recent work (Holahan et al., 2014, 2015, 2017), we extended this line of inquiry to older adults, demonstrating the importance of pattern as well as level of consumption in both drinking problems and mortality among older drinkers. The present research broadens our previous work to encompass the role of level and pattern of drinking in cigarette smoking among older adults. A subsidiary purpose was to extend our earlier work on alcohol and mortality by examining the link between continued smoking and mortality among older smokers. Throughout, we use *episodic heavy* to describe a risky per occasion pattern of drinking. In reviewing previous research, we indicate where other investigators have used the alternative term *binge* to describe the same or a very similar pattern of drinking.

Among the few studies on alcohol consumption and smoking in community samples of middle-aged and older adults, we are unaware of any research that has examined the separate effects of average level and pattern of drinking. For example, several studies of large international samples addressed only average level of drinking. Utilizing cross-sectional data on 267,000 adults aged 45 years and older in New South Wales, Australia, Bonevski et al. (2014) found a positive association between alcohol consumption and cigarette smoking, but focused only on average weekly consumption. Similarly, Shankar et al. (2010) reported a positive association between the prevalence of alcohol use and cigarette smoking based on cross-sectional analyses of more than 11,000 adults aged 50 and older in the English

Longitudinal Study of Aging, but also focused only on average weekly consumption. In a study that used prospective data across a 12-year follow-up of approximately 4,000 adults age 65 and older in Dijon, France, Artaud et al. (2013) documented clustering of alcohol consumption and smoking, but again focused only on average weekly consumption.

Moreover, two studies of large U.S. samples either did not separate the effects of average level and pattern of drinking or addressed only drinking pattern. In a study of over 8,000 adults age 65 and older based on cross-sectional data from the National Epidemiologic Survey on Alcohol and Related Conditions, Lin et al. (2014) found that experiencing a lifetime alcohol use disorder, perhaps indicative of engaging in past patterns of episodic heavy drinking, was positively associated with both lifetime and past 12-month tobacco use disorders, though the separate effects of average level and pattern of drinking were not considered. Using cross-sectional data on more than 10,000 middle-aged (50–64 years) and older (65 years) adults from the National Surveys on Drug Use and Health, Blazer and Wu (2012) found a positive association between alcohol use and cigarette smoking, but focused only on episodic heavy (termed binge) drinking.

The few studies examining alcohol use in the context of smoking cessation programs highlight the role of alcohol in maintaining smoking among current smokers. However these studies have looked mostly at mixed-age samples and no studies have examined the separate effects of average level and pattern of drinking among older smokers. Following 139 alcohol dependent smokers age 18 and older for one year, Lisha et al. (2014) looked only at level of drinking and found that a higher average number of drinks post intervention predicted smoking relapse. Auguston et al. (2008) also focused only on level of drinking among 2,700 Finnish middle-aged and older male smokers and reported that a higher level of alcohol at baseline predicted three-year smoking relapse. In contrast, Cook et al. (2012) looked only at pattern of drinking in a mixed-age sample of 1,500 Wisconsin smokers followed for eight weeks and found that episodic heavy (termed binge) drinking predicted lower initial cessation and higher relapse. An exception is Kahler et al. (2009), who examined both pattern and level of smoking in a mixed-age sample of almost 5,000 smokers age 18 and older from the International Tobacco Control Four Country Survey. The investigators reported that only episodic heavy (termed heavy or binge) drinking predicted continued smoking across a 1-year period.

More research is needed on continued smoking among older smokers. Most research on smoking and mortality has involved broad age ranges with a focus on middle-aged adults (Gellert et al., 2012). Further, smoking status among older adults has primarily been assessed retrospectively rather than by tracking smoking change among baseline smokers across time (Gellert et al., 2012). A partial exception is a study by Nash et al. (2017), who followed 160,000 participants older than 70 in the National Institutes of Health-AARP (formerly American Association of Retired Persons) Diet and Health Study for a mean of 6 years, though smoking cessation information was retrospective. The investigators found that smoking cessation was associated with substantially decreased mortality risk, even among individuals who had not quit smoking until their 60s. However, we are unaware of any research that has investigated the role of alcohol use in continued cigarette smoking and mortality among older smokers.

The present study extends previous research on the role of alcohol consumption in smoking in community samples of middle-aged and older adults (Artaud et al., 2013; Blazer & Wu, 2012; Bonevski et al., 2014; Lin et al., 2014; Shankar et al., 2010). Here, we investigate the independent contributions of a high level of average drinking vs. an episodic heavy pattern of drinking as concomitants of current smoking among 1151 older adults who reported consuming alcohol in the last month at baseline and as predictors of continued smoking among the subset of 276 baseline smokers tracked across 20 years. In addition, the current study extends previous research on the mortality risk of continued smoking among older smokers (Nash et al., 2017). We examine: (a) the role of continued smoking in mortality among baseline smokers followed across 20-years and (b) whether average level and pattern of drinking contribute indirectly to elevated mortality risk through continued smoking.

Materials and Methods

Sample Selection and Characteristics

The present study is part of an overall longitudinal project that has examined late-life patterns of alcohol consumption and drinking problems (Brennan et al., 2010, 2011; Moos et al., 2004, 2009, 2010; Schutte et al., 2006) among late-middle-aged and older adults. A key goal of the overall project was to select individuals who had consumed alcohol during the last six months with a wide range of drinking behaviors, including some individuals with current or past drinking problems. We contacted individuals between the ages of 55 and 65 at baseline who had had outpatient contact in the prior three years with one of two medical centers in the western United States. The sample was comparable to similarly aged community samples with respect to health characteristics such as prevalence of arthritis, hypertension, and diabetes, and self-reported occurrence and length of hospitalization (Brennan & Moos, 1990; Moos et al., 1991).

Data were collected by individual surveys sent directly to participants at baseline, 1, 4, 10, and 20 years. The data collection period began in 1986–1988, when baseline data were collected, and ended in 2006–2008, when the 20-year follow-up was conducted. Of eligible respondents contacted at baseline, 92% agreed to participate, and 89% (1884) of these individuals provided complete data at baseline. Among participants who were still living (and for the 20-year follow-up not in very poor health), follow-up rates at these waves were 94%, 94%, 93%, and 86%, respectively (Moos et al., 2009). The study was approved by the Stanford University Medical School Panel on Human Subjects; after the project was fully explained, participants provided signed informed consent.

In the present study, baseline analyses included 1151 participants who had consumed alcohol in the last month. Following Holahan et al. (2014, 2015, 2017), very light drinkers (> 0 to < 1/2 drink on average per day) were excluded because in contrasting average level and pattern of drinking it was unlikely that they would be episodic heavy drinkers. The baseline sample included 414 (36%) women and 737 (64%) men. Participants were an average of 61 (SD = 3.12) years of age and 73% were married. Participants had an average of 14.5 (SD = 2.32) years of education, a median family income of $45,000, and were predominantly Caucasian (92%).

Prospective analyses focused on the subsample of 276 participants who were baseline cigarette smokers and participated in at least one follow-up, 82 (30%) women and 194 (70%) men. Baseline smokers were an average of 61 (SD = 3.08) years of age and 62% were married. Baseline smokers had an average of 13.80 (SD = 2.32) years of education, a median family income of $27,500, and were predominantly Caucasian (86%).

Measures

Alcohol consumption and the set of covariates were measured at baseline; current smoking was measured at baseline and at four follow-ups (1, 4, 10 and 20 years). Descriptive and psychometric information on the measures is available in the Health and Daily Living Form (Moos et al., 1992).

Alcohol Consumption Groups

Following Holahan et al. (2014, 2015, 2017), to enhance the public health and clinical applicability of our findings, we applied NIAAA guidelines of moderate vs. high level of average drinking and of regular vs. episodic heavy drinking (Gunzerath et al., 2004; NIAAA, 2007b) (see Table 1). Because participants were between the ages of 55 and 65 at baseline when alcohol consumption was assessed, we used NIAAA guidelines for adults up to age 65. Average level of drinking was measured by items in a quantity-frequency index of typical drinking and pattern of drinking was measured by items indexing the largest amount participants drank. The definitions of alcohol consumption groups are described below.

Average level of drinking (moderate vs. high).—Average level of drinking was assessed at baseline with a quantity-frequency index. Respondents were asked: "During the last month, how much of each of the following beverages did you usually drink in a typical day when you drank that beverage?". Quantity of alcohol consumption was assessed by items that measured the amounts of wine, beer, and liquor participants had consumed on the days they drank in the last month. Responses to these items were converted to reflect the ethanol content of the beverages consumed. Frequency of alcohol consumption was assessed by responses to questions asking how often per week (never, less than once, once or twice, three to four times, nearly every day) participants had consumed wine, beer, or liquor in the last month. From this information, quantity-frequency values were calculated to provide indices of participants' average daily ethanol consumption of each beverage type. Summing average daily ethanol consumption from the three beverage types provided a composite index of participants' average daily level of drinking.

Using the measure of average daily level of drinking, number of drinks per day was indexed based on the approximation that 5 oz of wine, 12 oz of beer, and 1 shot (1.5 oz) of liquor contain an average of 0.6 oz of ethanol (NIAAA, 2007b). Applying NIAAA guidelines (Gunzerath et al., 2004; NIAAA, 2007b), *moderate* drinking level (score = 0) was defined as an average daily level of drinking that was at least one-half drink per day but no more than 1 drink/day for women and 2 drinks/day for men. Correspondingly, *high* drinking level (score = 1) was defined as an average daily level of drinking that was greater than 1 drink per day for women and 2 drinks/day for men.

Pattern of drinking (regular vs. episodic heavy).—Next, we identified pattern of drinking at baseline by responses to a separate set of items that asked separately about wine, beer, and liquor: "During the last month what was the largest amount you drank of each of the following beverages?" Response options were indexed in number of glasses of wine, cans of beer, and shots of liquor. Episodic heavy drinking was defined consistent with NIAAA guidelines (Gunzerath et al., 2004; NIAAA, 2007b) and in a manner identical to that used in the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) and the U.S. Behavioral Risk Factor Surveillance System (Chavez et al., 2011). *Regular* drinking pattern (score = 0) was defined as consuming fewer than 4 (for women) and fewer than 5 (for men) drinks on the occasion of the largest amount of drinking. *Episodic heavy* drinking pattern (score = 1) was defined as consuming 4 or more (for women) and 5 or more (for men) drinks on the occasion of the largest amount of drinking.

Current cigarette smoking.—Current cigarette smoking was indexed at baseline and at each of the four follow-up waves. Current cigarette smoking was operationalized as responding yes to both smoking tobacco and to smoking one or more cigarettes per day (*non-cigarette smoker* = 0, *cigarette smoker* = 1). Among baseline cigarette smokers, we used two measures to index continued cigarette smoking. First, we indexed the percent of follow-up waves at which baseline smokers reported continued smoking. Specifically, across follow-ups we divided the number of waves the participant smoked by the total number of waves the participant provided data. To index a meaningful level of change, percent of follow-up smoking was operationalized in 10% units. In addition, we indexed current cigarette smoking at participants' last follow-up observation.

Total mortality.—Total mortality (*surviving* = 0, *death* = 1) was indexed during the 20-year follow-up. Fact of death was confirmed by death certificate for 92% of cases, by another official source (primarily the Social Security Death Index) for 7% of cases, and verbally by telephone by an individual at the participant's former residence (primarily the spouse) for 1% of cases (Holahan et al., 2014).

Covariates.—Based on Moos et al. (2004), in all prospective analyses we controlled for age, gender (*female* = 0, *male* = 1), socioeconomic status (SES), and marital status (*not married* = 0; *married* = 1) at baseline. Following Holahan et al. (2010, 2017), we indexed SES as the average of participant's family income and years of education, using standard scores for both measures to equate their scales. For 42 cases for whom family income was not available, we used years of education alone. In mortality analyses, we also controlled for number of medical conditions at baseline. Number of medical conditions was a count of 9 conditions diagnosed by a physician and experienced in the past 12 months (cancer, diabetes, heart problems, stroke, high blood pressure, anemia, bronchitis, kidney problems, and ulcers).

Analytic plan.—We used chi-square analyses to examine the concurrent associations at baseline between level and pattern of alcohol consumption and current smoking. Among baseline smokers, we used multiple linear and logistic regression analyses to examine the prospective associations of level and pattern of alcohol consumption with the percent of

follow-up waves at which participants reported continued smoking and smoking at participants' last observation, respectively. In addition, among baseline smokers, following Holahan et al. (2014, 2015), we used logistic regression analyses to examine the roles of both the percent of follow-up smoking and smoking at participants' last observation as predictors of 20-year total mortality. Finally, among baseline smokers, we examined whether continued smoking provided an indirect pathway through which level or pattern of alcohol consumption related to 20-year total mortality. We used Mplus (Mutheén & Mutheén, 1998–2017) to obtain bias-corrected bootstrap 95% confidence intervals of the indirect effect (see, Hayes & Rockwood, 2017). All prospective models controlled for age, gender, SES, and marital status at baseline. Models predicting mortality also controlled for number of medical conditions at baseline.

Results

Background Information at Baseline

In the sample of 1151 participants, 61% engaged in a high level of average drinking and 41% engaged in episodic heavy drinking at baseline. In the subsample of 276 baseline smokers, 70% engaged in a high level of average drinking and 60% engaged in episodic heavy drinking at baseline. The correlation between average level and pattern of drinking at baseline was .40 in both the full sample and the sample of baseline smokers.

In preliminary analyses, we examined the association of average level and pattern of drinking (separate analyses) with current smoking at baseline. There was a significant association between average level of drinking and current smoking ($\chi^2(1) = 15.16$, $n = 1151$, $p < .01$). Only 19% of moderate level drinkers were current smokers compared to 29% of high level drinkers. Similarly, there was a significant association between pattern of drinking and current smoking ($\chi^2(1) = 57.26$, $n = 1151$, $p < .01$). Only 17% of regular drinkers were current smokers compared to 37% of episodic heavy drinkers.

Alcohol and Continued Smoking Among Baseline Smokers

There was a substantial reduction in smoking during the follow-up period. Among baseline smokers who responded at the respective follow-up, the prevalence of current smoking was: 89% at 1 year, 68% at 4 years, 49% at 10 years, and 19% at 20 years.

Percent of follow-ups with continued smoking.—In a multiple linear regression analysis among baseline smokers, we examined the prospective association of average level and pattern of drinking at baseline with the percent of follow-up assessments at which participants reported current smoking (i.e., across waves 1, 4, 10, and 20 years). In predicting the percent of follow-ups with continued smoking, we used bootstrapped estimates of parameters and confidence intervals. Controlling for age, gender, SES, and marital status and with average level and pattern of drinking controlling for one another, only pattern of drinking was significantly associated with the percent of follow-ups with continued smoking (see Table 2). Independent of other variables in the model, episodic heavy compared to regular drinking among baseline smokers was associated with a 10% increase in continued smoking across the follow-up period.

Smoking at last observation.—In a logistic regression analysis among baseline smokers, we examined the prospective association of average level and pattern of drinking at baseline with current smoking at participants' last observation. Controlling for age, gender, SES, and marital status and with average level and pattern of drinking controlling for one another, only pattern of drinking was significantly associated with the odds of smoking at participants' last observation (see Table 3). Independent of other variables in the model, episodic heavy compared to regular drinking was associated with a 90% increase in the odds of smoking at participants' last observation.

Continued Smoking and Mortality Among Baseline Smokers

A total of 185 (67%) of the 276 baseline smokers died during the 20-year follow-up. In a logistic regression analysis, we examined the association between the percent of follow-up waves at which baseline smokers reported continued smoking and mortality. Controlling for age, gender, SES, marital status, and medical conditions, as well as for both level and pattern of drinking at baseline, the percent of follow-up waves at which baseline smokers reported continued smoking was significantly associated with the odds of mortality (see Table 4). Independent of other variables in the model, a 10% increase in the percent of follow-up waves at which baseline smokers reported continued smoking was associated with a 30% increase in the odds of mortality among baseline smokers.

In addition, in a logistic regression analysis, we examined the association between smoking at baseline smokers' last observation and mortality. Controlling for age, gender, SES, marital status, and medical conditions, as well as for both level and pattern of drinking at baseline, smoking at baseline smokers' last observation was significantly associated with the odds of mortality (see Table 5). Independent of other variables in the model, smoking at baseline smokers' last observation was associated with a more than a six-fold increase in the odds of mortality.

Finally, we examined whether continued smoking provided an indirect pathway through which alcohol consumption predicted 20-year total mortality in the models described above. A high compared to a moderate level of average drinking was not indirectly associated with mortality through either the percent of follow-up waves at which baseline smokers reported continued smoking (effect = −0.04, 95% CI = −.19, .11) or through smoking at baseline smokers' last observation (effect = −0.10, 95% CI = −.36, .14). However, an episodic heavy compared to a regular pattern of drinking was indirectly associated with mortality through both the percent of follow-up waves at which baseline smokers reported continued smoking (effect = 0.14, 95% CI = .01, .30) and through smoking at baseline smokers' last observation (effect = 0.24, 95% CI = .02, .49).

Inclusion of Very Light Drinkers

Following Holahan et al. (2014, 2015, 2017), we excluded very light drinkers (> 0 to < 1/2 drink on average per day) from the above analyses because it was unlikely that they would be episodic heavy drinkers. To assess the effect on the results if very light drinkers were included in the analyses, we conducted *post-hoc* sensitivity analyses (see Thabane et al., 2013). There were 368 very light drinkers at baseline; 67 of them were baseline smokers.

Including very light drinkers increased the baseline sample to 1,519 and increased the number of baseline smokers to 343. We included very light drinkers in repeating each of the prior sets of analyses: (a) alcohol and current smoking at baseline, (b) alcohol and continued smoking among baseline smokers, and (c) continued smoking and mortality among baseline smokers. The results were robust to the inclusion of very light drinkers. The significance levels (i.e., < .05, < .01) for average level and pattern of drinking and (in the mortality analyses) for continued smoking among baseline smokers remained the same in all analyses. The associated parameters and confidence intervals were similar to those reported above, and the indirect effect for pattern of drinking on mortality remained significant.

Discussion

The present findings extend previous research on the role of alcohol consumption in cigarette smoking in community samples of middle-aged and older adults (Artaud et al., 2013; Blazer & Wu, 2012; Bonevski et al., 2014; Lin et al., 2014; Shankar et al., 2010). We found that engaging in either a high level of average drinking or an episodic heavy pattern of drinking was associated concurrently with smoking among 1151 older adults at baseline. However, among the subset of 276 baseline smokers tracked across 20 years, only episodic heavy drinking was linked prospectively to the percent of follow-ups at which they reported smoking and to their continued smoking at their last observation. Further, extending previous research on the health consequences of smoking among older adults (Gellert et al., 2012; Nash et al., 2017), continued smoking among baseline smokers increased the odds of 20-year mortality and provided an indirect pathway through which heavy episodic drinking related to mortality.

Kahler et al. (2009) followed a mixed-age sample of smokers for one year and also found that, compared to average level of drinking, only episodic heavy drinking predicted continued smoking. As in the present study, Kahler and colleagues operationalized a risky per occasion pattern of drinking as 4 or more drinks for women and 5 or more drinks for men. They speculated that the unique predictive link of episodic heavy drinking to continued smoking may be due in part to intoxication triggering relapse. In that regard, Rossheim et al. (2013) found that, controlling for established smoking behavior, alcohol intoxication increased the odds of concomitant smoking among bar and nightclub patrons by more than three times. The authors speculated that alcohol attenuated the perceived risk of smoking. In addition, Cook et al. (2012) suggested that episodic heavy drinking may be linked to continued smoking because smoking cues are often associated with occasions of episodic heavy drinking. Consistent with this view, Kahler et al. (2010) found that alcohol-involved smoking lapses occur most often at restaurants, bars, and other occasions with friends—social contexts that often involve episodic heavy drinking. Further, Cook et al. (2012) found that episodic heavy drinkers report more smokers in their social network than do regular drinkers.

The present results on alcohol use and cigarette smoking contribute to emerging interest in the adverse health effects of episodic heavy drinking among older adults (Rao & Roche, 2017). These findings add to previous evidence (Holahan et al., 2014, 2015, 2017) that risky

drinking among older adults involves an episodic heavy pattern of drinking as well as a high level of average drinking.

These findings also contribute to the development of models of health that address multiple health behaviors (Geller et al., 2017). Alcohol and smoking share common mechanisms at both the contextual and biological levels. At a contextual level, many social occasions model and reinforce the co-use of alcohol and cigarettes (NIAAA, 2007a). At a biological level, alcohol and nicotine share pharmacological receptors in the mesocorticolimbic-dopamine system (Doyon et al., 2013; Rahman et al., 2016;). In controlled laboratory conditions, the effect of alcohol on cigarette self-administration is especially strong (Dermody & Hendershot, 2017).

Moreover, our results on continued smoking and mortality contribute to understanding the health significance of continued smoking among older smokers (Gellert et al., 2012). Our finding that continued smoking substantially increased the odds of 20-year mortality among smokers followed from on average 60 to 80 years of age reinforces arguments that quitting smoking has public health significance even among smokers at an advanced age (Müezzinler et al., 2015; Nash et al., 2017). Our finding that episodic heavy drinking related indirectly to mortality through continued smoking is a unique contribution. This result helps to link research on alcohol and smoking among older adults (Artaud et al., 2013; Blazer & Wu, 2012; Lin et al., 2014; Shankar et al., 2010) with research on smoking and mortality (Gellert et al., 2012; Nash et al., 2017) among older adults. Appreciating the linkages among episodic heavy drinking, smoking, and mortality may help to explain why the apparent longevity advantage associated with moderate drinking is eliminated by episodic heavy drinking among otherwise moderate drinking adults (Holahan et al., 2014; Mukamal et al., 2005; Roerecke et al., 2011).

Some cautions should be kept in mind in interpreting the present results. These are not experimental findings and do not provide evidence of causality. Also, although mortality was indexed objectively, our measures of alcohol consumption and cigarette smoking were based on self-report. Future research would be strengthened by including objective indices or collateral information on drinking and smoking. In addition, because the overall project selected respondents with a wide range of drinking behaviors and the present study focused on individuals who consumed an average of at least a half drink per day at baseline, the sample is not representative of the U.S. population of older adults. Further, the largely Caucasian sample precludes generalization to other racial and ethno-cultural groups. Another limitation is the relatively small sample of 276 baseline smokers. This may have resulted in the wide confidence intervals for drinking pattern in the prospective analyses. The present findings should be replicated with a larger sample.

Moreover, because alcohol use was the key focus of the overall study, it was measured in more detail than was smoking behavior. Future research is needed to examine the contribution of level vs. pattern of drinking to additional aspects of smoking (e.g., brief quit attempts and quitting-related motivation and self-efficacy). Finally, our finding that an episodic heavy pattern of drinking played a uniquely strong role in continued cigarette smoking should not be interpreted as evidence that a high level of average drinking is not

relevant to smoking maintenance. A high level of average drinking is associated with a higher likelihood of episodic heavy drinking. In the present sample of baseline smokers, as level of drinking went from moderate to high, the percentage of heavy episodic drinkers increased nearly two and a half times.

Research examining the health effects of alcohol consumption has focused mostly on average level of consumption (Gunzerath et al., 2004) and has obscured our understanding of the effect of drinking pattern independent of average level of consumption (Rehm et al., 2010). In fact, emerging evidence (Breslow et al., 2017; Han et al., 2017) indicates that episodic heavy (termed binge) drinking has been increasing among older adults in the U.S. since 2001 and is a significant public health concern. Among older smokers followed for up to two decades, we demonstrate that episodic heavy drinking plays a key role in maintaining smoking and indirectly increases mortality risk through continued smoking. Smokers who misuse alcohol are a challenging population for smoking cessation efforts (Roche et al., 2016). Older adults who concurrently misuse alcohol and smoke cigarettes provide a unique target for public health interventions (Kuerbis et al., 2014). A brief motivationally-focused alcohol intervention used in smoking cessation treatment with mixed-age heavy-drinking smokers (see Kaller et al., 2008) might be tailored to the needs of older smokers who misuse alcohol.

Acknowledgments

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Table 1.

Definitions of the alcohol consumption groups

Average Level of Drinking
Moderate: .5 and 1 drink/day (women); .5 and 2 drinks/day (men).
High: > 1 drink/day (women); > 2 drinks/day (men).
Pattern of Drinking
Regular: < 4 drinks/largest occasion (women); < 5 drinks/largest occasion (men).
Episodic Heavy: 4 drinks/largest occasion (women); 5 drinks/largest occasion (men).

Note. Alcohol consumption was indexed during the last month. We excluded non-drinkers. In addition, we excluded very light drinkers (> 0 to < 1/2 drink on average per day) because it was unlikely that they would be episodic heavy drinkers.

Table 2.

Results of regression analysis with drinking level and drinking pattern at baseline prospectively predicting percent of follow-up smoking among baseline smokers (n = 276)

Covariates	B[a]	95% CI
Age	0.06	−0.08, 0.20
Gender (Female = 0, Male = 1)	−0.27	−1.19, 0.67
SES[b]	−0.61[*]	−1.10, −0.09
Marital Status (No = 0, Yes = 1)	−0.91[*]	−1.73, −0.11
Drinking Level (Moderate = 0, High = 1)	−0.27	−1.36, 0.71
Drinking Pattern (Regular = 0, Episodic Heavy = 1)	1.04[*]	0.09, 2.02

Note. Percent of follow-up smoking is scaled in 10% units.

[a] Unstandardized.

[b] Standardized scale.

[*] $p < .05$

Table 3.

Results of logistic regression analysis with drinking level and drinking pattern at baseline prospectively predicting smoking at last observation among baseline smokers (n = 276)

Covariates	Odds Ratio	95% CI
Age	1.03	0.95, 1.12
Gender (Female = 0, Male = 1)	0.89	0.51, 1.56
SES[a]	0.62[**]	0.44, 0.87
Marital Status (No = 0, Yes = 1)	0.55[*]	0.32, 0.93
Drinking Level (Moderate = 0, High = 1)	0.76	0.41, 1.39
Drinking Pattern (Regular = 0, Episodic Heavy = 1)	1.90[*]	1.06, 3.39

[a] Standardized scale.

[*] $p < .05$

[**] $p < .01$

Table 4.

Results of logistic regression analysis with percent of follow-up smoking predicting mortality among baseline smokers (n = 276)

Covariates	Odds Ratio	95% CI
Age	1.10	0.997, 1.21
Gender (Female = 0, Male = 1)	2.48[**]	1.32, 4.69
SES[a]	0.85	0.57, 1.26
Marital Status (No = 0, Yes = 1)	0.94	0.50, 1.76
Medical Conditions	1.36[*]	1.01, 1.84
Drinking Level (Moderate = 0, High = 1)	1.61	0.80, 3.26
Drinking Pattern (Regular = 0, Episodic Heavy = 1)	1.08	0.55, 2.11
Percent of Follow-Up Smoking[b]	1.30[**]	1.19, 1.42

[a] Standardized scale.

[b] Scaled in 10% units.

[*] $p < .05$

[**] $p < .01$

Table 5.

Results of logistic regression analyses with smoking at last observation predicting mortality among baseline smokers (n = 276)

Covariates	Odds Ratio	95% CI
Age	1.10[*]	1.001, 1.21
Gender (Female = 0, Male = 1)	2.49[**]	1.30, 4.76
SES[a]	0.90	0.61, 1.35
Marital Status (No = 0, Yes = 1)	0.93	0.49, 1.76
Medical Conditions	1.35[*]	1.01, 1.81
Drinking Level (Moderate = 0, High = 1)	1.73	0.86, 3.49
Drinking Pattern (Regular = 0, Episodic Heavy = 1)	1.08	0.55, 2.11
Smoking at Last Observation	6.78[**]	3.65, 12.59

[a.]Standardized scale.

[*]$p < .05$

[**]$p < .01$