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## Cigarette smoking and risk of alcohol use relapse among adults in recovery from alcohol use disorders

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### Abstract

**Background**—Individuals in recovery from alcohol use disorders (AUDs) frequently continue to smoke cigarettes. The purpose of this study was to examine the relationship between cigarette smoking status and risk of AUD relapse in adults with remitted AUDs among adults in the United States.

**Methods**—Data were drawn from Wave 1 (2001–2002) and Wave 2 (2004–2005) of the National Epidemiologic Survey on Alcohol and Related Conditions. Analyses included the subsample of respondents who completed both waves of data collection reported a history of alcohol abuse and/or dependence prior to Wave 1 (N=9,134). Relationships between Wave 1 cigarette smoking status (non-smoker, daily cigarette smoker, non-daily cigarette smoker) and Wave 2 alcohol use, abuse, and dependence were examined using logistic regression analyses. Analyses were adjusted for Wave 1 demographics; mood, anxiety, and substance use disorders; nicotine dependence; and AUD severity.

**Results**—Both daily and non-daily cigarette smoking at Wave 1 were significantly associated with a lower likelihood of alcohol use and a greater likelihood of alcohol abuse and dependence at Wave 2 compared to Wave 1 non-smoking. These relationships remained significant after adjusting for demographics, psychiatric disorders, substance use disorders, AUD severity, and nicotine dependence.

**Conclusions**—Among adults with remitted AUDs, daily and non-daily use of cigarettes was associated with significantly decreased likelihood of alcohol use and increased likelihood of alcohol abuse and alcohol dependence three years later. Concurrent treatment of cigarette smoking when treating AUDs may help improve long-term alcohol outcomes and reduce the negative consequences of both substances.

## Keywords

smoking; nicotine dependence; alcohol use disorders; relapse; epidemiology

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## 1. Introduction

Alcohol use and smoking, both major public health concerns associated with illness and mortality, are strongly correlated with each other. Smoking is associated with a greater likelihood of an alcohol use disorder (AUD) diagnosis (alcohol abuse or alcohol dependence), greater hazardous or binge drinking, more severe alcohol dependence, and greater alcohol-related problems (see McKee & Weinberger, 2013). Conversely, adults who consume alcohol or meet criteria for an AUD are more likely to report current and former smoking and to meet criteria for tobacco use disorders (Lasser et al., 2000; McKee et al., 2007). Further, while each substance has potentially serious health effects on its own, co-morbid smoking and alcohol use demonstrate multiplicative effects on disease (Kalman et al., 2010). Because of the strong and reciprocal relationship between alcohol use and smoking, it is important to understand how one behavior impacts changes in the other behavior, especially the ability to successfully abstain or avoid problematic use.

Epidemiologic data have shown that AUDs have a significant, and detrimental, impact on transitions in smoking behavior. Compared to those without AUDs, adult never smokers with AUDs are more likely to initiate smoking (Goodwin et al, 2013) and current smokers with AUDs are less likely to report successful smoking cessation (Breslau et al, 1996; Lasser et al., 2000; Weinberger et al., 2013). Further, former smokers with AUDs are more likely to report smoking relapse (Weinberger et al., 2013). Results from a clinical trial show that smoking after attempting to quit was more likely to occur on occasions of heavy drinking (Leeman et al., 2008).

While the epidemiologic data described above have shown a relationship between AUDs and smoking outcomes, less is known about the relationship between smoking and changes in alcohol behavior (e.g., relapse to AUDs) at a population level. One previous study used two waves of longitudinal data from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) to examine relapse to AUD symptoms or diagnosis over a three year period for adults who had met criteria for past alcohol dependence at Wave 1 (Dawson et al., 2007). In analyses of potential covariates of AUD relapse, being a past-year cigarette smoker at the time of the Wave 1 assessment was significantly associated with recurrence of both AUD symptoms and diagnosis at Wave 2. While the study was not designed to examine the association of smoking and relapse to AUDs as a primary aim, these preliminary findings suggest that a more detailed investigation of the association of smoking behavior and relapse to AUDs is warranted. Also, given that nicotine dependence, psychiatric disorders, and illicit drug use disorders are highly comorbid with AUDs and/or cigarette smoking (Goodwin et al., 2008; Grant et al., 2004a b; Lasser et al., 2000), an observed relationship between smoking and alcohol relapse may be confounded with these co-morbid disorders.

Against this background, the goal of the proposed study is to better understand the potential impact of cigarette smoking on risk of alcohol use relapse among those with remitted AUDs, compared with that of non-smokers. First, the study investigated the relationship between current daily and non-daily cigarette smoking and alcohol relapse three years later. Second, the study examined the potentially confounding role of mood, anxiety, and illicit drug use disorders; nicotine dependence; and AUD severity in the relationship between smoking and alcohol use and AUD relapse.

## 2. Methods

### 2.1. Data Source and Study Population

Study data were taken from Waves 1 and 2 of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) which assessed substance use, substance use disorders, and related physical and psychiatric disabilities in a representative sample of the adult U.S. population. Wave 1 interviews took place from 2001–2002 and included 43,093 U.S. civilian non-institutionalized adult respondents. Wave 2 interviews occurred three years later with 34,653 of the Wave 1 respondents, a follow-up rate of 80%. The study design and administration has been described in detail elsewhere (Grant et al., 2003a; Grant & Kaplan, 2005).

To accurately characterize relapse to alcohol, the sample for this study was restricted to individuals who (1) completed both the Wave 1 and Wave 2 assessments, (2) reported having alcohol abuse, alcohol dependence, or both more than one year prior to the Wave 1 assessment, and (3) reported being in remission from alcohol abuse or dependence for at least one year prior to Wave 1 data collection (N=9,134; 26.4% of the original Wave 1 sample). These criteria were developed to ensure that individuals were free of the outcome behavior at the beginning of data collection. Respondents were still considered in remission if they endorsed any criteria for alcohol abuse or dependence below Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994) diagnostic thresholds.

### 2.2. Measures

**2.2.1. Alcohol use, abuse, and dependence**—The primary study outcomes were defined as relapse to alcohol use, abuse, or dependence assessed during the Wave 2 follow-up interview. In the NESARC, alcohol use disorder status was determined by using the NIAAA Alcohol Use Disorder and Associated Disabilities Interview Schedule–DSM-IV Version (AUDADIS-IV), a fully structured diagnostic interview instrument designed for experienced lay interviewers (Grant et al., 2001). The reliability and validity of this measure are good-to-excellent (Grant et al., 1995).

Alcohol use at Wave 2 was defined as having consumed at least one drink at any time in the previous year. Additionally, to be given this label, a respondent must not have also met criteria for a diagnosis of alcohol abuse or dependence in the past year. A diagnosis of past-year alcohol abuse at Wave 2 was assessed by DSM-IV criteria and required the report of a pattern of alcohol use leading to clinically significant impairment or distress, as demonstrated by meeting at least one of the four abuse criteria (failure to complete major

responsibilities at work, school, or at home; use of alcohol in hazardous situations such as driving a car or operating machinery; alcohol-related legal problems; the continued use of alcohol despite social or interpersonal problems; American Psychiatric Association, 1994) in the previous 12 months. A DSM-IV diagnosis of past-year alcohol dependence at Wave 2 required that a respondent report at least three of the seven dependence criteria (tolerance, withdrawal, use of alcohol in larger amounts or over a longer period of time than planned, inability to cut down alcohol use, significant amount of time obtaining alcohol or recovering from alcohol use, reduction or cessation of important activities due to alcohol use, continued use despite recognition of alcohol-related problems; American Psychiatric Association, 1994) in the previous 12 months. A person who met criteria for both abuse and dependence was classified as dependent. Each of these outcomes (abuse, dependence) was considered as a dichotomous variable.

**2.2.2. Smoking behavior and nicotine dependence**—The NESARC assessment included measurements of use of a range of tobacco products (e.g., cigarettes, cigars, pipes, snuff, chewing tobacco). Smoking behavior at Wave 1 was defined as a three-category independent variable: (1) Non-Smokers: participants who reported no use of any cigarettes in the year prior to the Wave 1 assessment, (2) Daily Smokers: participants who reported cigarette use every day in the year prior to the Wave 1 assessment, and (3) Non-Daily Smokers: participants who reported smoking cigarettes 6 or fewer days per week in the year prior to the Wave 1 assessment. To isolate the association of cigarette use on alcohol relapse, participants who reported use of other forms of tobacco (e.g. cigars, pipes, snuff, chewing tobacco) were included in the sample only if respondents also reported cigarette use.

A diagnosis of past-year nicotine dependence at Wave 1 was assessed in the AUDADIS using DSM-IV criteria: experiencing withdrawal, giving up activities in favor of nicotine use, spending a great deal of time using nicotine, and using nicotine more than intended (Grant et al., 2004b). A previous test of reliability of the AUDADIS in the assessment of smoking behavior found excellent test-retest reliability for the diagnosis of past-year nicotine dependence (Intraclass Correlation=0.77, 95% Confidence Interval=0.70, 0.82; Grant et al, 2003b). Each participant who reported Wave 1 past-year smoking (daily or non-daily) was classified as either meeting criteria for past-year nicotine dependence or not meeting criteria for past-year nicotine dependence.

### 2.3. Statistical Analysis

**2.3.1. Sample frequencies**—The Rao Scott chi-squared test, which accounts for the complex survey design, was used to test if the proportion of individuals experiencing alcohol use relapse was statistically significantly different, first among the relevant socio-demographic covariates, as well as among Wave 1 daily and non-daily smokers vs. non-smokers more broadly. To measure potential changes in the smoking exposure between interviews, correlations between alcohol use status and smoking status at Wave 1 and Wave 2 were tested for significance using the Rao Scott chi-squared statistics. Sample attrition between waves was tested for significant differences in the frequency of loss to follow up among respondents with and without AUDs at Wave 1.

**2.3.2. Regression modeling**—Multiple regression modeling was used to examine the association between Wave 1 smoking status and the odds of alcohol use, abuse, or dependence at Wave 2. First, a model was run to determine the unadjusted odds ratio for smoking status and alcohol use relapse. Results from this model are presented using odds ratios (ORs) and 95% confidence intervals (CIs).

Then, five additional models were run to control for potential confounders and covariates. Results from these five adjusted models, described in more detail below, are presented using adjusted ORs (AORs) and 95% CIs. The first adjusted model examined the association between smoking status and alcohol use relapse controlling for key socio-demographic covariates: gender, race, age, education, marital status (married/living with someone as married, widowed, divorced/separated, single), and income. A second model was adjusted for a wide selection of mood and anxiety disorders reported at Wave 1 including history of major depression, manic depression, dysthymia, hypomania; history of anxiety disorders including panic disorder with/without agoraphobia, agoraphobia, social and specific phobia, generalized anxiety disorder, posttraumatic stress disorder, attention deficit-hyperactivity disorder, antisocial personality disorder, borderline personality disorder, and schizotypal or narcissistic personality disorder. One dichotomous variable was created for the occurrence of any mood/anxiety disorder (1=yes, 0=no). The third model adjusted for any other illicit substance use disorder reported at Wave 1, including sedatives, tranquilizers, opiates (other than heroin or methadone), stimulants, hallucinogens, cannabis, cocaine (including crack cocaine), inhalants/solvents, heroin, and other drugs. One dichotomous variable was created for any reported illicit drug use disorder (1=yes, 0=no). The model also adjusted for the potential interaction by lifetime history of nicotine dependence. A fourth model adjusted for non-disordered alcohol use (any alcohol use with no disorder) and eight separate measures of AUD severity using Wave 1 data and based on previous similar analyses (Dawson et al., 2007). Criteria included the initiation of drinking before age 15; the interval from first drink to onset of dependence; duration of dependence; duration of remission; the number of relapse episodes; number of lifetime symptoms prior to the year preceding Wave 1; the volume of alcohol consumed during the period of heaviest drinking; and ever having obtained either formal or informal help for alcohol problems. A fifth model was created to fully adjust for all of the above covariates simultaneously.

Adjusted models were restricted to complete cases only. Due to the interview skip patterns (e.g., only those who met criteria for alcohol dependence were asked certain questions), a large proportion of responses for four covariates were missing: interval from first drink to onset of dependence (n=3,652), number of relapse episodes (n=3,537), duration of dependence (n=3,588), duration of remission (n=1,719). Because inclusion of these covariates led to large sample size reductions in the regression models, we removed them as a variable in our final models in order to maintain a nearly complete analytic sample in adjusted models 4 and 5.

All tests were completed in STATA using weighted analysis (StataCorp, 2011) to account for residual differences between the sample and the population profile, according to the 2000 United States Population Census, as well as to account for nonresponse and sample

attrition. The weighted Wave 2 data represent the same baseline population as represented in Wave 1.

### 3. Results

#### 3.1. Sample Demographic Characteristics

Of the respondents in our sample with remitted AUDs, 18.6% were lost to follow-up at wave 2, while of the respondents without remitted AUDs, 19.5% were lost to follow-up at wave 2. Therefore, we restricted our analytical sample to only those who were not lost to follow up at wave 2, assuming minimal risk for selection bias from attrition.

See Table 1 for Wave 1 demographic frequencies of the full analytic sample and by smoking status. Among the full analytic sample ( $n=9,134$ ), 36.1% were daily smokers, 7.0% were non-daily smokers, and 56.9% were non-smokers. The daily smokers reported smoking an average of 19.6 cigarettes per day (95% CI=19.3–19.9) and the non-daily smokers reported smoking an average of 5.0 cigarettes on a days that they smoked (95% CI=4.7–5.3). The non-daily smokers reported smoking an average of 1–2 days per week. The highest rates of daily smoking were reported by respondents who were: men (37.5%), ages 18–29 (43.7%), Native American (46.6%), widowed, separated, or divorced (47.7%), those who reported earning \$0–19,999 (44.4%), and those with less than a high school degree (53.8%). Among non-daily smokers, the highest percentages of use of cigarettes was reported among men (7.2%), ages 18–29 (14.2%), Native American (9.6%), never married (10.3%), those with an income greater than \$70,000+ (8.2%), and more than a HS degree (8.0%). The most commonly reported non-cigarette tobacco products used by Wave 1 daily and non-daily cigarette smokers were cigars, snuff, and chewing tobacco. A majority of daily smokers met criteria for lifetime nicotine dependence while just under half of non-daily smokers met these criteria.

#### 3.2. Alcohol Use Frequencies

Across the Wave 1 study sample, 57.7% participants reported non-disordered, sub-threshold alcohol use at Wave 1. Forty-nine percent of respondents reported at least one abuse and/or dependence symptom. At the Wave 2 assessment, 61.2% of participants reported alcohol use in the previous year, while 12.1% of participants reported alcohol abuse, and 10.8% of participants reported alcohol dependence. Among both daily and non-daily smokers, rates of alcohol abuse and dependence were significantly higher than rates among non-smokers while the rate of non-problematic alcohol use was higher among non-smokers compared to smokers (see Table 2). Smoking status and alcohol use status variables were statistically correlated for all three outcomes. The changes in correlation coefficients between Wave 1 and 2 were minimal, suggesting that smoking prevalence paralleled changes in alcohol use behaviors, and lending support that smoking is a proximal risk factor for AUDs (see Table 2).

#### 3.3. Relapse to Alcohol Use and AUDs by Wave 1 Smoking Status

Compared with non-smokers, those who reported either daily or non-daily smoking at Wave 1 had statistically significantly higher odds of reporting recurrent alcohol abuse and



dependence at Wave 2 (Table 3). These relationships persisted after controlling in subsequent models for demographic variables, any mood or anxiety disorder, any illicit substance use disorder, non-disordered alcohol use, and AUD severity (Table 3). The interaction term for nicotine dependence was statistically significant for alcohol use ( $\beta=0.082$ ;  $p=0.023$ ) and dependence ( $\beta=0.398$ ;  $p<.0001$ ), but not alcohol abuse ( $\beta=0.014$ ;  $p=0.798$ ) and was included in the final models. Only one relationship was no longer significant after adjusting for covariates and that comparison was for daily smokers versus non-smokers for Wave 2 alcohol use when all covariates were included in the model (AOR<sup>5</sup> in Table 3).

In the fully adjusted model (Model 5), Wave 1 daily smokers had 17% greater odds of relapsing to alcohol abuse (95% CI: 1.02–1.34), and 54% greater odds of relapsing to alcohol dependence (95% CI: 1.38–1.71) compared to Wave 1 non-smokers. Non-daily smokers had 87% greater odds of relapsing to alcohol abuse (95% CI: 1.65–2.12), and 95% greater odds of relapsing to alcohol dependence (95% CI: 1.53–2.49) compared to Wave 1 non-smokers. Complete results are presented in Table 3.

Additionally, pairwise tests were completed to determine if the odds of alcohol use and AUDs were statistically significantly different between non-daily and daily smokers. Non-daily smokers were not significantly more likely to report alcohol use at Wave 2, compared with daily smokers (OR: 0.901; 95% CI: 0.74–1.10), nor did they report significantly greater alcohol dependence (OR: 1.19 95% CI: 0.89–1.58). However, non-daily smokers were significantly more likely to report alcohol abuse than daily smokers (OR: 1.46; 95% CI: 1.1–1.93) at Wave 2 (data not shown).

#### 4. Discussion

The purpose of this study was to examine the relationship between smoking status and risk of relapse three years later among adults with remitted AUDs using a representative sample of the adult U.S. population. Among adults with remitted AUDs, both daily and non-daily use of cigarettes at Wave 1 was associated with significantly increased likelihood of alcohol abuse and dependence three years later, compared with non-smoking. Wave 1 daily and non-daily smoking were both associated with a decreased likelihood of alcohol use at Wave 2 compared to Wave 1 non-smoking. These relationships remained significant after adjusting for demographics, psychiatric disorders, substance use disorders, non-disordered alcohol use, severity of AUDs, and nicotine dependence.

Smokers who smoke cigarettes every day compared to those who do not smoke every day differ with regard to smoking behavior. For example, non-daily smokers smoke fewer cigarettes on smoking days, are less likely to report dependence on nicotine, and are more likely to report motivation to quit smoking although non-daily smokers also appear to be similar to daily smokers with regard to having trouble quitting smoking (Rubinstein et al., 2014; Tindle & Shiffman, 2011). Little is known about the association of smoking and alcohol for smokers who consume cigarettes every day versus some days. One study of adolescents found that daily and non-daily smokers were equally likely to report smoking when they consumed alcohol (Rubinstein et al., 2014). Similarly, the current study found

that daily and non-daily smoking were similarly related to AUD relapse. Further, non-daily smokers were not less likely than daily smokers to report Wave 2 alcohol use and dependence and were actually more likely to report alcohol abuse.

The results of the current analyses are consistent with preclinical and clinical trial data. In preclinical studies, nicotine facilitates the acquisition of alcohol-self administration (Smith et al., 1999) and reinstates previously extinguished alcohol-seeking behavior (Lê et al., 2003). Adults reported increased urges to consume alcohol after smoking cigarettes (Cooney et al., 2007) and use of alcohol and nicotine together leads to greater cravings for both substances (Piasecki et al., 2011). In adults who completed treatment for both alcohol and tobacco use, there was an association between high urges to smoke cigarettes and relapse to alcohol consumption (Cooney et al., 2007). In a recent study of adults with alcohol dependence and smoking (Cooney et al., 2015), days when participants did not smoke, compared to days when participants did smoke, were associated with decreased alcohol consumption, lower urges to drink, and higher levels of self-efficacy and motivation to remain abstinent from alcohol. Secondary analysis from Project MATCH (Friend & Pagano, 2005), a clinical trial of behavioral treatments for AUDs, reported that participants who decreased their cigarette consumption during the course of treatment were less likely to relapse to alcohol consumption compared to participants who consumed the same or more than their baseline number of cigarettes. Together, there is evidence across multiple methodologies (i.e., preclinical, clinical, epidemiologic) that cigarette smoking is associated with relapse to alcohol.

Smoking may facilitate relapse to AUDs for a number of reasons. Adults who smoke cigarettes report greater reinforcement from alcohol (McKee et al., 2004) and there is preclinical and clinical evidence for cross-tolerance between nicotine and alcohol (e.g., Drobos, 2002; Kouri et al., 2004). Preclinical, clinical, and epidemiologic data have linked smoking to difficulty remaining abstinent from alcohol and smoking and alcohol show strong behavioral and neurochemical links to each other (McKee & Weinberger, 2013). Further, smoking has detrimental effects on neurocognition (e.g., executive function, memory, processing speed; Durazzo et al., 2012; Wagner et al., 2013) and is associated with greater impairments in cognition and altered brain structure in active and recently abstinent drinkers (Durazzo et al., 2007; Durazzo et al., 2013; Glass et al., 2006) and with decreased cognitive recovery in adults with AUDs in early recovery (Durazzo et al., 2006; Pennington et al., 2013). Together these data suggest that smoking cessation may provide benefits for continued abstinence from alcohol/remission from AUDs and may therefore be an important target for interventions in order to improve long-term alcohol outcomes.

Many adult smokers with AUDs report motivation to quit smoking (Ellingstad et al., 1999; Zullino et al., 2000) and the majority believe that quitting smoking will not make it difficult to resist urges to drink or harm their remission from AUDs (Kalman et al., 2010). While some studies have reported that current and past AUDs are associated with a decreased likelihood of quitting smoking, other data reports that smokers with past AUDs quit smoking at similar rates as adults without AUDs (Breslau et al., 1996; Hughes & Kalman, 2006; Weinberger et al., 2013). Concerns have been raised about the potential harmful effects of providing concurrent smoking and alcohol treatment on alcohol outcomes.



Overall, the balance of studies has found no detrimental impacts on alcohol outcomes when smoking cessation treatments are provided to adults in treatment for AUDs (e.g., Baca & Yahne, 2009; Cooney et al., 2009; Kalman et al., 2010; see Prochaska et al., 2004 and Kodl et al., 2006 for reviews). Of note, smoking treatments have been given at different points during alcohol treatment (Kodl et al., 2006) and a greater length of abstinence from alcohol at the start of treatment is associated with greater smoking cessation success (Prochaska et al., 2004). This suggests that, even with “concurrent” alcohol and smoking treatment, better outcomes may be found for patients who stop using alcohol prior to stopping the use of cigarettes. More research is needed to understand how timing of smoking treatment at different points during concurrent alcohol treatment (e.g., at a point during treatment that coincides with the start of sobriety versus at a point in treatment after sobriety has begun) relates to alcohol and smoking outcomes. Further, it should be noted that some patients prefer treatment for smoking after, rather than concurrently with, alcohol treatment (Kodl et al., 2006) and clinicians should consider patient preferences when developing treatment plans.

Long-term smoking cessation outcomes studies of adults in treatment for AUDs were low, regardless of whether smoking treatment was concurrent or delayed, similar to low rates of long-term successful cessation in the general smoking population (Centers for Disease Control and Prevention, 2011; Fiore et al., 2008). There is a need for continued research on improving cessation outcomes and reducing relapse rates. In order to facilitate the most favorable alcohol and smoking outcomes, additional research is also needed to identify optimal ways to motivate adults with AUDs to quit smoking, treatments that yield the best short and long term outcomes, and variables to target within treatments. For example, a study of lapses to alcohol consumption and smoking suggested the benefits of targeting mood, abstinence-related self-efficacy, and urges to smoke (Holt et al., 2012). Alcohol relapse behaviors were related to both daily and non-daily smoking, highlighting the need to target intermittent smoking as well as daily smoking in adults with AUDs.

It should be noted that a large number of Wave 1 participants with past AUDs, smokers and non-smokers, reported that they consume alcohol without any current problems. There are several possibilities for reasons for the large rate of non-problem alcohol use in this sample. First, participants with past AUDs may be underreporting problems related to current alcohol use. Second, participants may have learned to drink at a level or manner that no longer leads to problems. Third, participants may have resumed drinking but their behavior has not yet reached the point where it has begun to cause problems. While some suggest that former problematic drinkers can consume alcohol without problems (Hodgins, 2005), other research shows that relapse to AUDs in adults with former AUDs is associated with more frequent alcohol consumption (Moos & Moos, 2006) or alcohol consumption relative to abstinence (Dawson et al., 2007). Adults with past AUDs should be monitored by clinicians over time to assess whether drinking that is reported to be non-problematic remains that way in order to intervene as quickly as possible should problems begin to occur.

Nicotine dependence was a significant effect modifier of the association between cigarette use and alcohol use and dependence. This finding is consistent with other studies that have also demonstrated a strong co-morbidity or parallel risk between AUDs and nicotine

dependence. AUDs are associated with higher rates of nicotine dependence compared to the general U.S. population (12.8% versus 22.8%; Grant et al., 2004b) and incident nicotine dependence (Goodwin et al., 2013). One previous study found that adults with a diagnosis of nicotine dependence were greater than three times more likely to transition from alcohol use to alcohol dependence than adults without nicotine dependence (Hazard Ratio=3.29, 95% CI=2.9–3.7; Lopez-Quintero et al., 2011). Our results suggest that nicotine dependence is also associated with a greater likelihood of transition from past AUDs to recurrent AUDs. Just as clinicians should be aware the smoking is associated with AUD relapse, clinicians should also be aware that the endorsement of nicotine dependence may represent an even higher risk factor for their patients.

Limitations of this study must be noted. First, the NESARC sample included persons in the U.S. who were 18 year and older and noninstitutionalized. These results would have limited generalizability to other groups including adolescents and adults outside of the U.S. Second, data for the analyses were taken from two time points that were three years apart and were limited to the information assessed in the two interviews. Information that could not be examined includes the timing of or context related to relapse to alcohol use or AUDs. Future studies would benefit from examining the contexts of relapse to AUDs in cigarette smokers versus non-smokers. Third, the alcohol use outcomes were assessed three years after baseline and therefore relapse to AUDs could only be captured within this timeframe. It would be useful for future studies to examine the role of smoking in alcohol relapse over longer periods of time. Fourth, data from the NESARC relied on self-report and there was no biochemical verification of smoking or alcohol consumption. The reliance on self-report may have led to either the underreporting (e.g., problematic alcohol use, smoking) or overreporting (e.g., non-problematic alcohol use) of addiction-related behaviors.

Alcohol consumption and cigarette use are frequently co-occurring behaviors that can have negative impacts on the health of adults. The current data suggests that both daily and non-daily cigarette smoking are associated with a greater risk of relapse to AUDs among adults in the U.S., which is consistent with data from clinical treatment settings. Treatments for AUDs that include simultaneous treatment for smoking cessation and nicotine dependence may help improve long-term outcomes and reduce the negative consequences of both substances.

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TABLE 1

Demographic covariates by Wave 1 smoking status (n=9,134)

<i>Variable</i>	<b>Total</b>	<b>Wave 1 Non-Smokers</b>	<b>Wave 1 Non-Daily Smokers</b>	<b>Wave 1 Daily Smokers</b>	<b>p</b>
Total (%)		56.9	7.0	36.1	<0.0001
<i>Gender (%)</i>					
Male	64	62.2	65.9	66.5	<0.0001
Female	36	37.8	34.1	33.5	
<i>Age</i>					
18–29	13.1	9.7	26.6	15.9	
30–44	35.7	35.2	43.3	35	
45–64	40.3	41.2	26.4	41.7	<0.0001
65+	10.8	13.9	3.8	7.4	
<i>Race/ Ethnicity (%)</i>					
NH White	81	81	79.6	81.3	
NH Black	7.1	6.9	5.4	7.8	
NH Native American / AK Native	3	2.3	4	3.8	<0.0001
NH Asian/ Pacific Islander	1.5	1.4	1.8	1.6	
Hispanic	7.4	8.5	9.2	5.5	
<i>Marital status (%)</i>					
Current	65.7	71.6	59.8	57.5	
Widowed, separated, divorced	18.3	14.8	16.8	24.2	<0.0001
Never	16	13.6	23.4	18.3	
<i>Personal income (%)</i>					
\$0–19,999	32.8	28.5	28.9	40.4	
\$20–34,999	23.2	22.2	21.5	25.3	
\$35–69,999	29.8	31.5	33.1	26.5	<0.0001
\$70,000+	14.1	17.8	16.5	7.8	
<i>Education (%)</i>					



Variable	Total	Wave 1 Non-Smokers	Wave 1 Non-Daily Smokers	Wave 1 Daily Smokers	p
Less than HS degree	11.1	8.3	6.4	16.6	
High school degree	48.7	42.2	47.9	59.1	<0.0001
More than HS	40.2	49.5	45.7	24.3	
<i>Use of tobacco products<sup>1</sup> (%)</i>					
Cigarettes	67.8		100	100.0	
Cigars	13.2		22.5	19.8	
Pipe	10.2	n/a	11.2	12.8	<0.0001
Snuff	9.1		22.4	15.8	
Chewing tobacco	9.6		21.8	16.4	
Lifetime nicotine dependence	36.1		42.8	70.6	
<i>Non-disordered alcohol use at Wave 1 (%)</i>					
Sub-threshold use*	57.7	62.4	52.5	51.5	<.0001
At least one abuse/dependence symptom*	49.0	42.3	71.5	55.0	<.0001

NH, non-Hispanic; AK, Alaska; HS, high school

<sup>1</sup> includes those who report smoking cigarettes, with or without other tobacco use

\* Reported as column percents (i.e. among those who report daily cigarette use, XX% reports sub-threshold alcohol use

Prevalence and correlation of Wave 2 alcohol use status by Waves 1 and 2 smoking status

TABLE 2

	Wave 1 (% , se)					Wave 2 (% , se)						
	Non-Smoker	Non-Daily Smoker	Daily Smoker	p <sup>a</sup>	r <sup>2</sup>	p <sup>b</sup>	Non-Smoker	Non-Daily Smoker	Daily Smoker	p <sup>a</sup>	r <sup>2</sup>	p <sup>b</sup>
Wave 2 Alcohol: (% , se)												
None (18.2%; 0.26)	18.8 (0.32)	8.8 (0.77)	19.3 (0.47)	<0.0001	0.087	<0.0001	18.1 (0.56)	9.7 (1.08)	18.9 (0.29)	<0.0001	-0.027	0.0087
Use (61.2%; 0.30)	65.0 (0.38)	56.9 (1.14)	56.0 (0.52)	<0.0001	-0.076	<0.0001	64.8 (0.36)	48.3 (1.41)	55.1 (0.51)	<0.0001	-0.086	<0.0001
Abuse (12.1%; 0.18)	10.6 (0.19)	21.3 (1.17)	13.1 (0.34)	<0.0001	0.038	0.0006	10.5 (0.23)	28.0 (1.22)	13.9 (0.44)	<0.0001	0.054	<0.0001
Dependence (10.8%; 0.22)	7.1 (0.23)	20.2 (1.25)	15.1 (0.37)	<0.0001	0.139	<0.0001	7.2 (0.23)	25.2 (1.40)	17.0 (0.40)	<0.0001	0.159	<0.0001

se, standard error

<sup>a</sup> p-value represents the comparison of the prevalence of the Wave 2 alcohol use statuses among the three smoking statuses (Non-Smoker, Non-Daily Smoker, Daily Smoker)

<sup>b</sup> p-value represents the correlation of the smoking status and the alcohol use status

Odds of Wave 2 alcohol use disorder relapse by Wave 1 smoking status among individuals with a history of alcohol use disorders prior to Wave 1

**TABLE 3**

<i>Wave 2 alcohol use status:</i>		<b>OR (95% CI)</b>	<b>AOR<sup>1</sup></b>	<b>AOR<sup>2</sup></b>	<b>AOR<sup>3</sup></b>	<b>AOR<sup>4</sup></b>	<b>AOR<sup>5</sup></b>
<i>Non-daily smokers vs. non-smokers</i>							
None		<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
Use	0.71 (0.65–0.78)	0.74 (0.67–0.82)	0.72 (0.65–0.79)	0.78 (0.70–0.86)	0.84 (0.74–0.95)	0.81 (0.71–0.92)	
Abuse	2.30 (2.00–2.60)	1.67 (1.47–1.90)	2.32 (2.02–2.66)	2.27 (1.97–2.62)	2.45 (2.17–2.76)	1.87 (1.65–2.12)	
Dependence	3.30 (2.79–3.96)	2.19 (1.84–2.61)	3.19 (2.65–3.84)	2.89 (2.41–3.46)	2.88 (2.30–3.60)	1.95 (1.53–2.49)	
<i>Daily smokers vs. non-smokers</i>							
None		<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
Use	0.69 (0.65–0.72)	0.86 (0.82–0.91)	0.70 (0.66–0.74)	0.74 (0.68–0.81)	0.84 (0.78–0.91)	0.97 (0.91–1.04)	
Abuse	1.30 (1.19–1.37)	1.13 (1.05–1.22)	1.31 (1.22–1.4)	1.34 (1.21–1.47)	1.27 (1.16–1.40)	1.17 (1.06–1.29)	
Dependence	2.30 (2.17–2.53)	1.70 (1.55–1.86)	2.20 (2.04–2.39)	1.51 (1.29–1.77)	1.99 (1.81–2.19)	1.54 (1.38–1.71)	

OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval

AOR<sup>1</sup> - age, gender, income, race, education, marital status

AOR<sup>2</sup> - any mood or anxiety disorders at Wave 1

AOR<sup>3</sup> - any illicit substance use disorders at Wave 1, including interaction by nicotine dependence

AOR<sup>4</sup> - non-disordered alcohol use and alcohol use disorder severity

AOR<sup>5</sup> - fully adjusted for all covariates in models 1–4