

Original Investigation

The role of comorbidity in explaining the associations between anxiety disorders and smoking

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Abstract

Introduction: Research has generally found strong associations between smoking and anxiety disorders. The present study sought to examine the role of comorbidity in explaining these relationships.

Methods: Participants from the National Comorbidity Survey-Replication ($N = 5,692$) were included in the present study. Axis I disorders were assessed using the World Mental Health Survey Initiative version of the World Health Organization Composite International Diagnostic Interview. In addition, smoking and mental health treatment history were assessed.

Results: Multivariate analyses covarying for demographic variables and psychiatric and substance use comorbidity found that posttraumatic stress disorder was uniquely associated with every smoking outcome of interest, including 12-month and lifetime daily and heavy smoking, nicotine dependence, and cessation failure. Generalized anxiety disorder and social anxiety disorder were associated with fewer smoking-related outcomes, and contrary to predictions, panic disorder was only independently associated with 12-month daily smoking. Panic attack history, however, was uniquely associated with 12-month daily and heavy smoking, nicotine dependence, and lifetime cessation failure. In addition, analyses indicated that greater number of anxiety disorders was associated with greater prevalence of each smoking outcome, and the presence of even one anxiety disorder was associated with elevated smoking prevalence.

Discussion: Several specific anxiety disorders were found to be uniquely associated with smoking behavior. Findings suggest that comorbidity may only explain the associations with smoking difficulties for some anxiety disorders.

Introduction

There are strong associations between psychiatric disorders and smoking (Lasser et al., 2000). These associations are clinically

important from a public health perspective, as certain disorders are associated with lower quit rates (Lasser et al.) and increase risk of relapse during a quit attempt (Zvolensky et al., 2008).

Much of the research examining the role of psychiatric disorders in preventing smoking cessation has focused on depression (Anda et al., 1990). Although history of major depressive disorder is not a significant risk factor for poor cessation outcome in the majority of available studies (Hitsman, Borrelli, McChargue, Spring, & Niaura, 2003), depressive symptoms prior to smoking cessation treatment, as well as increases in such symptoms during treatment, have been reliable predictors of relapse (Burgess et al., 2002; Covey, Glassman, & Stetner, 1990; Kahler et al., 2002; Zelman, Brandon, Jorenby, & Baker, 1992).

A more recent and increasingly robust body of literature has begun to examine the linkages between smoking and anxiety-related disorders (Feldner, Babson, & Zvolensky, 2007; Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007; Patton et al., 1998; Zvolensky, Feldner, Leen-Feldner, & McLeish, 2005). Several empirical studies have demonstrated that smoking at higher rates may be concurrently and prospectively associated with an increased risk of more severe anxious arousal symptoms and greater life impairment related to such symptoms (Breslau & Klein, 1999; Breslau, Novak, & Kessler, 2004; Goodwin, Lewinsohn, & Seeley, 2005; Isensee, Wittchen, Stein, Hofler, & Lieb, 2003; Johnson et al., 2000; McLeish, Zvolensky, & Bucossi, 2007; Zvolensky, Schmidt, & McCreary, 2003). Anxiety disorders are also thought to directly contribute to smoking frequency and cessation failure. Smokers frequently endorse smoking to reduce anxiety, and negative affect is a strong predictor of relapse (Kassel, Stroud, & Paronis, 2003). Furthermore, it has been proposed that the cues for smoking and anxiety may become cross-conditioned so that they are mutually reinforcing (Morissette et al., 2007). That is, cues for anxiety may come to elicit smoking cravings and vice versa.

Posttraumatic stress disorder (PTSD) is one anxiety disorder associated with high rates of smoking (45% with PTSD vs. 23% in general population; Lasser et al., 2000). In addition,

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smokers with PTSD, compared with those without the disorder, smoke more cigarettes per day and are more dependent on nicotine (Babson, Feldner, Sachs-Ericsson, Schmidt, & Zvolensky, 2008; Beckham et al., 1997), and people who develop PTSD after exposure to a traumatic event report increased smoking behavior compared with those who do not develop such symptoms (Breslau, Davis, & Schultz, 2003). The relationship between PTSD and smoking might be explained directly by the use of smoking to reduce PTSD symptoms (Beckham et al., 2005). Smokers with PTSD, compared with those without the disorder, are, in fact, more likely to report smoking in order to reduce negative affect (Beckham et al., 1995, 2005) and to endorse greater affective dysregulation and increased smoking behavior following exposure to traumatic stimuli (McClernon et al., 2005). In addition, the presence of PTSD was recently found to predict early relapse following a quit attempt (Zvolensky et al., 2008).

Another anxiety disorder related to smoking is panic disorder (PD). Some have suggested the physical sensations from withdrawal, and alternative coping strategies, physical impairment, and poorer perceived health associated with smoking may lead to panic attacks (Zvolensky, Schmidt, & Stewart, 2003). In addition, poor distress tolerance and high emotional reactivity and anxiety sensitivity found in PD may contribute to relapse following cessation attempts due to the inability to withstand physical and emotional symptoms of withdrawal (Zvolensky, Schmidt, & Stewart). In line with this type of perspective, Lasser et al. (2000) found prevalence estimates of current smoking that were higher among individuals with PD than among the general population (35.9% vs. 22.5%). Similar estimates were found among those reporting panic attack history (38.1%). McCabe et al. (2004) also found rates of current and heavy smoking to be elevated among a treatment-seeking sample of individuals with PD compared with those with social anxiety disorder (SAD) and obsessive-compulsive disorder, thus providing support for the unique relationship between PD and smoking.

Although less work is available, elevated smoking rates also have been found in other anxiety disorders, including generalized anxiety disorder (GAD), SAD, and specific phobia (Breslau, 1995; Lasser et al., 2000). Lower estimates have been found for individuals with obsessive-compulsive disorder (Baker-Morrisette, Gulliver, Wiegel, & Barlow, 2004; Bejerot & Humble, 1999; McCabe et al., 2004). These findings suggest that smoking may be due, in part, to emotion regulation difficulties and intense negative affect associated with GAD and SAD (Mennin, McLaughlin, & Flanagan, 2009). Indeed, the higher rates of psychological distress found in smokers may be related to difficulties in smoking cessation. The “selection hypothesis” of smoking posits that smokers who are burdened by psychiatric difficulties, such as anxiety, may have a harder time quitting than those with lower levels of distress (Coombs, Kozlowski, & Ferrence, 1989; Hughes & Brandon, 2003). Indeed, those who are successful in quitting smoking have lower rates of psychological distress than those who do not quit (Coombs et al.; Hughes & Brandon). Based on this hypothesis, we would expect to see higher prevalence rates of anxiety disorders among smokers.

Although promising, research demonstrating elevated rates of smoking among individuals with anxiety disorders has at least three key limitations. First, many of these studies rely on treatment-seeking populations, which may be characterized by more severe symptoms or narrow demographics. Second, many

of the epidemiological studies examining the anxiety disorders/smoking relationship used *DSM-III-R* criteria for anxiety disorder diagnosis (Breslau et al., 2003; Lasser et al., 2000). Since significant changes in diagnostic criteria of disorders such as PTSD have been made in the *DSM-IV* (American Psychiatric Association, 1994), it is important to update these analyses using current criteria. Third, most research in this area is based on analyses using univariate models. Anxiety disorders rarely occur alone, however, and are often comorbid with substance use problems (Grant et al., 2004) and depression (Brown, Campbell, Lehman, Grisham, & Mancill, 2001). Indeed, one population study examining various mood, anxiety, and substance use disorders found that after controlling for their comorbidity, only alcohol and drug abuse/dependence remained independently associated with smoking (Black, Zimmerman, & Coryell, 1999). The associations between anxiety disorders and smoking found in many other studies may likewise be explained by comorbid diagnoses.

In the present study, we sought to address some of the limitations in previous research by using the National Comorbidity Survey-Replication (NCS-R). The NCS-R is a large recent nationally representative survey that includes extensive data on *DSM-IV* psychiatric diagnoses and smoking behavior. Its size is one of its most important features, given the multivariate analyses we planned to conduct and the sample size required for sufficient power for these analyses. Our main objective of this study was to examine the role of comorbidity in accounting for the increased risk of smoking among individuals with PTSD, PD, GAD, and SAD. Given the heterogeneous nature of specific phobia and the low prevalence of agoraphobia without a history of panic, we decided to exclude these disorders from our analyses. Based on previous research, we hypothesized that smoking difficulties, including daily and heavy smoking, nicotine dependence, and cessation failures, would be higher among all four disorders but would be especially pronounced among individuals with PD and PTSD. We also expected that these relationships would remain elevated after controlling for other anxiety disorders, substance abuse/dependence, and depression comorbidity. In addition, since Zvolensky, Schmidt, and Stewart (2003) argued for relationships between smoking and both PD and panic attacks, we conducted additional analyses to examine the role of panic attacks in increasing risk for smoking difficulties. Lastly, given the use of treatment-seeking samples in previous studies (e.g., McCabe et al., 2004) and the availability of data on treatment utilization among NCS-R respondents, we conducted exploratory analyses to examine whether smoking behaviors differed between treatment users and nonusers.

Method

Sample

The NCS-R is composed of a representative sample of English-speaking adults from the contiguous United States. Participants were interviewed in person at their place of residence between February 2001 and April 2003. A detailed description of the methodology, weighting, and sampling procedures used in the NCS-R has been provided by Kessler et al. (2004).

All respondents completed Part I of the interview ($N = 9,282$), which contained a section covering each of the mental disorders of primary concern to the NCS-R researchers, including depression, PD, and SAD. Part II included sections on

additional disorders (e.g., PTSD) as well as risk factors, consequences (e.g., tobacco use), services, and other correlates of mental health disorders. In an effort to reduce respondent burden, Part II was completed only by a subsample of the original Part I respondents, oversampling those with clinically significant psychopathology. The data were weighted to reflect the population distribution for a range of sociodemographic characteristics. The current investigation was based on data from both Part I and Part II from which we obtained a subsample of individuals ($n = 5,692$) who reported psychiatric and smoking history. The sample was 53% woman with an average age of 45.01 years ($SD = 17.9$). The racial and ethnic representation of the study participants was 72.8% Caucasian, 11.7% Black, 11.1% Hispanic, and 4.4% from other ethnicities.

Procedure

Based on the 2000 U.S. Census, a stratified multistage probability sample was created. Respondents received a letter describing the survey, and their potential participation several days before in-person contact was made. Interviews were conducted by professional interviewers who had obtained extensive training and were closely supervised by the Institute for Social Research. The administration of the interview was completed face-to-face with the assistance of a laptop computer. The interviewers obtained verbal informed consent from each respondent. The consent procedures were approved by the Human Subject Research Committees at Harvard Medical School and the University of Michigan. Respondents received \$50 as a token of appreciation for completing the interview. The overall response rate was 70.9%. Part I was weighted to adjust for discrepancies between the sample and the U.S. Census in terms of geographic and sociodemographic variables. Additional weighting of Part II was conducted to adjust for differential probability of selection from Part I (Kessler et al., 2004).

Measures

Demographics

The interview included an extensive demographic section that assessed sex, age, education, marital status, and current household income.

Diagnostic assessment

Lifetime and 12-month PD with or without agoraphobia, SAD, GAD, PTSD, major depressive episode, and alcohol and drug use disorders were assessed using the World Mental Health Survey Initiative version of the World Health Organization Composite International Diagnostic Interview (WMH-CIDI; Kessler & Ustun, 2004). This is a structured diagnostic interview from which *DSM-IV* Axis I (American Psychiatric Association, 1994) diagnoses are derived. The Composite International Diagnostic Interview has been found to have good validity and reliability for anxiety, mood, and substance use disorders (First, Spitzer, Gibbon, & Williams, 2002).

Smoking history assessment

Respondents completed an extensive assessment related to past and current smoking behavior. The variables of interest were lifetime and 12-month history of daily smoking, lifetime/12-month nicotine dependence, lifetime/12-month heavy smoking, and lifetime history of failed quit attempt. Lifetime history of daily smoking was determined according to whether respon-

dents indicated that they ever “smoked tobacco every day or nearly every day for a period of at least 2 months.” Twelve-month daily smoking status was determined according to whether respondents reported smoking on at least 300 days during the past 12 months (0 = *no*, 1 = *yes*). Heavy smoking status was determined according to whether respondents reported smoking 20 or more cigarettes on a typical day during the past 12 months (0 = *no*, 1 = *yes*) or during the year(s) in their lives in which they smoked most (0 = *no*, 1 = *yes*, for lifetime status). Lifetime and 12-month *DSM-IV* nicotine dependence (0 = *no*, 1 = *yes*) was assessed using the WMH-CIDI (see above). In addition, lifetime history of failed quit attempts was coded according to whether respondents (a) reported making two or more “serious attempt(s) to quit smoking” (for those who do not currently smoke) or (b) reported a past attempt but currently smoke (0 = *no*, 1 = *yes*).

Mental health treatment history

Mental health service utilization also was assessed in the NCS-R. Twelve-month history of mental health treatment was determined based on whether respondents indicated seeing a psychiatrist, psychologist, social worker, counselor, or “any other mental health professional, such as a psychotherapist or mental health nurse,” during the past 12 months for “problems with your emotions or nerves or your use of alcohol or drugs.”

Data analytic approach

All analyses were conducted using SAS v. 9.1 and employed the appropriate NCS-R statistical weights to ensure that the sample was representative of the general U.S. population. Dichotomous smoking variables (see above) were used as dependent variables in each analysis. Cross-tabulations were calculated to determine the prevalence of lifetime and current smoking outcomes among individuals with current or lifetime anxiety disorders or panic attack history. Bivariate logistic regression analyses were carried out to examine associations between smoking variables and anxiety disorders. Subsequently, multiple logistic regressions were performed with smoking outcome variables using anxiety disorder variables as predictors after adjusting for sociodemographic variables of age, sex (0 = *male*, 1 = *female*), race (0 = *non-Caucasian*, 1 = *Caucasian*), education (number of years of formal schooling), income, and marital status. Additional multiple logistic regression analyses were conducted that also covaried for depression and alcohol and drug abuse or dependence. Similar analyses were conducted to examine the unique associations between panic attacks and smoking variables, though PD diagnosis was not included in these analyses.

Results

Lifetime smoking behavior and anxiety disorders

Table 1 presents the results of the bivariate associations between lifetime smoking behavior and anxiety disorders. As expected, lifetime history of daily smoking, heavy smoking, nicotine dependence, and difficulty quitting was significantly associated with each anxiety disorder. To further assess the unique risk conveyed by lifetime anxiety disorders by covarying demographics and anxiety disorder diagnoses, both demographics and each of the four anxiety disorders were entered simultaneously into multivariate logistic regression analyses.

Table 1. Prevalence of lifetime daily smoking, heavy smoking, nicotine dependence, and difficulty quitting across the anxiety disorders with bivariate and multivariate analyses predicting smoking variables

	N (%)	OR (95% CI)	AOR-1 ^a (95% CI)	AOR-2 ^b (95% CI)
Ever smoked daily				
SAD	395/694 (56.9)	1.43 (1.22–1.67)**	1.23 (1.06–1.43)*	1.01 (0.87–1.18)
PD ± agoraphobia	214/347 (61.7)	1.72 (1.35–2.19)**	1.43 (1.07–1.91)*	1.24 (0.95–1.61)
GAD	273/444 (61.6)	1.73 (1.45–2.07)**	1.50 (1.24–1.82)**	1.30 (1.05–1.61)*
PTSD	251/389 (64.5)	1.96 (1.53–2.50)**	2.96 (1.49–2.58)**	1.58 (1.21–2.06)**
Total sample	2,798/5,692 (49.2)			
Likelihood ratio test	—	—	422.72**	756.18**
Ever smoked heavily				
SAD	190/694 (27.4)	1.57 (1.37–1.80)**	1.45 (1.24–1.70)**	1.19 (1.01–1.39)*
PD ± agoraphobia	99/347 (28.5)	1.62 (1.20–2.18)**	1.34 (0.97–1.87)	1.19 (0.87–1.63)
GAD	130/444 (29.3)	1.70 (1.42–2.03)**	1.41 (1.18–1.68)**	1.21 (0.98–1.45)
PTSD	117/389 (30.1)	1.76 (1.32–2.33)**	1.83 (1.30–2.58)**	1.45 (1.03–2.03)*
Total sample	1,159/5,692 (20.4)			
Likelihood ratio test	—	—	369.62**	547.85**
Nicotine dependent				
SAD	115/694 (16.6)	2.59 (2.05–3.28)**	1.82 (1.39–2.38)**	1.31 (1.01–1.71)*
PD ± agoraphobia	55/348 (17.2)	2.50 (1.89–3.31)**	1.38 (0.98–1.94)	1.14 (0.82–1.58)
GAD	87/444 (19.6)	3.12 (2.61–3.72)**	2.12 (1.70–2.65)**	1.59 (1.28–1.98)**
PTSD	75/389 (19.3)	2.95 (2.15–4.05)**	2.11 (1.42–3.14)**	1.47 (1.01–2.16)*
Total sample	470/5,692 (8.3)			
Likelihood ratio test	—	—	158.82**	359.50**
History of unsuccessful quit attempt				
SAD	253/396 (63.9)	2.02 (1.66–2.44)**	1.50 (1.21–1.85)**	1.36 (1.10–1.66)**
PD ± agoraphobia	138/214 (64.5)	1.99 (1.58–2.52)**	1.37 (1.04–1.80)*	1.29 (0.99–1.68)
GAD	182/273 (66.7)	2.23 (1.86–2.68)**	1.73 (1.38–2.16)**	1.58 (1.24–2.03)**
PTSD	163/251 (64.9)	2.03 (1.53–2.68)**	1.61 (1.16–2.24)**	1.46 (1.05–2.01)*
Total sample	1,377/2,799 (49.2)			
Likelihood ratio test	—	—	190.08**	215.91**

Note. ORs represent bivariate associations between individual anxiety disorders and specified smoking variable. AOR = adjusted odds ratio; GAD = generalized anxiety disorder; OR = odds ratio; PD = panic disorder; PTSD = posttraumatic stress disorder; SAD = social anxiety disorder.

^aAORs-1 were adjusted for each variable listed above plus age, ethnicity, education, marital status, and income.

^bAORs-2 included the variables used with AOR-1 plus alcohol abuse/dependence, drug abuse/dependence, and depression.

* $p < .05$; ** $p < .01$.

Each anxiety disorder remained significantly associated with the smoking behavior outcomes of interest, though PD was only uniquely associated with history of daily smoking and unsuccessful quit attempt. In order to further account for the roles of depression and alcohol and drug abuse/dependence in contributing to the relationship between anxiety disorders and smoking, additional regression analyses were conducted with major depressive episode, alcohol abuse/dependence, and drug abuse/dependence entered into the model. The findings differed somewhat: SAD and PD were no longer associated with history of daily smoking, GAD was no longer associated with heavy smoking, and PD was no longer associated with unsuccessful quit attempt.

We also examined whether anxiety disorder onset preceded or followed regular smoking initiation. A majority of those with a lifetime history of regular smoking and anxiety disorder diagnosis indicated that they first started smoking regularly prior to the age at which they developed their disorder (PTSD: 56.9%, GAD: 67.8%, and PD: 53.5%), though most smokers with SAD (81.3%) reported the onset of their disorder prior to the age at which they first smoked. These differences are likely attributed

to the very early age of onset reported for people with SAD ($M = 11.66$, $SD = 7.2$).

Twelve-month smoking behavior and anxiety disorders

Next, similar analyses were conducted with the exception that 12-month diagnoses and smoking history were considered. Bivariate analyses indicated significant associations between each anxiety disorder and daily smoking, heavy smoking, and nicotine dependence status. Multivariate analyses in which demographic variables and anxiety disorder diagnoses were entered simultaneously revealed persistent and unique associations between each anxiety disorder and increased risk for daily smoking, though only PTSD and GAD were associated with increased risk for heavy smoking and PTSD, GAD, and SAD were associated with increased risk for nicotine dependence. Furthermore, when also controlling for depression and alcohol and drug abuse/dependence, the findings remained the same with the exception that SAD and GAD were no longer associated with higher prevalence rates of daily smoking. Table 2 presents findings from these analyses.

Table 2. Prevalence of 12-month daily smoking, heavy smoking, and nicotine dependence across the anxiety disorders with bivariate and multivariate analyses predicting smoking variables

	N (%)	OR (95% CI)	AOR-1 ^a (95% CI)	AOR-2 ^b (95% CI)
Smoke daily				
SAD	132/389 (33.9)	1.84 (1.47–2.30)**	1.28 (1.02–1.60)*	1.12 (0.90–1.39)
PD ± agoraphobia	81/205 (39.5)	2.32 (1.76–3.04)**	1.59 (1.14–2.22)**	1.42 (1.04–1.94)*
GAD	84/230 (36.5)	2.04 (1.58–2.64)**	1.55 (1.15–2.08)**	1.27 (0.92–1.76)
PTSD	77/203 (37.9)	2.16 (1.70–2.74)**	1.70 (1.29–2.24)**	1.46 (1.08–1.97)*
Total sample	1,288/5,692 (22.6)			
Likelihood ratio test	—	—	385.71**	480.14**
Smoke heavily				
SAD	74/389 (19.0)	1.90 (1.56–2.31)**	1.25 (0.98–1.59)	1.08 (0.84–1.39)
PD ± agoraphobia	46/205 (22.4)	2.29 (1.71–3.06)**	1.45 (0.95–2.21)	1.29 (0.84–1.96)
GAD	59/231 (25.5)	2.75 (2.21–3.43)**	2.09 (1.59–2.75)**	1.68 (1.28–2.22)**
PTSD	49/204 (24.0)	2.51 (1.96–3.21)**	2.04 (1.46–2.86)**	1.74 (1.23–2.45)**
Total Sample	660/5,692 (11.6)			
Likelihood ratio test	—	—	332.00**	374.81**
Nicotine dependent				
SAD	40/389 (10.3)	3.08 (2.05–4.62)**	1.77 (1.14–2.76)*	1.45 (0.92–2.30)
PD ± agoraphobia	21/205 (10.2)	2.95 (1.72–5.09)**	1.19 (0.67–2.11)	1.05 (0.58–1.93)
GAD	29/230 (12.6)	3.83 (2.69–5.47)**	2.28 (1.54–3.39)**	1.75 (1.10–2.79)*
PTSD	29/203 (14.3)	4.41 (2.86–6.81)**	2.82 (1.91–4.16)**	2.39 (1.63–3.50)**
Total sample	230/5,692 (4.0)			
Likelihood ratio test	—	—	122.63**	161.11**

Note. ORs represent bivariate associations between individual anxiety disorders and specified smoking variable. AOR = adjusted odds ratio; GAD = generalized anxiety disorder; OR = odds ratio; PD = panic disorder; PTSD = posttraumatic stress disorder; SAD = social anxiety disorder.

^aAORs-1 were adjusted for each variable listed above plus age, ethnicity, education, marital status, and income.

^bAORs-2 included the variables used with AOR-1 plus alcohol abuse/dependence, drug abuse/dependence, and depression.

p* < .05; *p* < .01.

Smoking behavior and panic attacks

We also tested the associations between panic attacks and smoking outcomes. Bivariate associations between 12-month panic attack history and smoking outcomes are presented in Table 3. Analyses indicated significant associations among panic attacks and daily and heavy smoking status and nicotine dependence. Multivariate analyses also were conducted in which demographics

and anxiety disorders were covaried. PD diagnosis was not included in these analyses, given its redundancy with panic attack history. Panic attack history remained significantly associated with smoking variables. Further analyses using substance use and depression as additional covariates were also conducted. Again, panic attack history was found to be uniquely associated with each smoking variable.

Table 3. Prevalence of 12-month and lifetime smoking outcomes by 12-month and lifetime panic attack status with bivariate and multivariate analyses predicting smoking variables

	N (%)	OR (95% CI)	AOR-1 ^a (95% CI)	AOR-2 ^b (95% CI)
12-month panic attack history				
12-month smoke daily	223/639 (34.9)	2.00 (1.71–2.34)**	1.55 (1.33–1.79)**	1.38 (1.17–1.62)*
12-month smoke heavily	121/639 (18.9)	1.95 (1.54–2.46)**	1.52 (1.18–1.95)**	1.34 (1.04–1.72)*
12-month nicotine dependent	59/639 (9.2)	2.93 (2.07–4.15)**	1.82 (1.26–2.62)**	1.53 (1.04–2.26)*
Lifetime panic attack history				
Lifetime history of unsuccessful quit attempt	546/941 (58.0)	1.71 (1.43–2.04)**	1.31 (1.09–1.58)** ^c	1.23 (1.02–1.48)* ^c

Note. ORs represent bivariate associations between panic attack history and specified smoking variable. AOR = adjusted odds ratio; OR = odds ratio.

^aAORs-1 were adjusted for PTSD, GAD, and SAD diagnosis plus age, ethnicity, education, marital status, and income.

^bAORs-2 included the variables used with AOR-1 plus alcohol abuse/dependence, drug abuse/dependence, and depression.

^cAORs included lifetime rather than 12-month diagnoses.

p* < .05; *p* < .01.

Table 4. Relationships between number of anxiety disorders and smoking outcomes

	Number of anxiety disorder diagnoses					
	1 vs. no		2 vs. no		3 or 4 vs. no	
	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)
Lifetime analyses						
<i>n</i>	900		279		128	
Ever smoked regularly	1.49 (1.28–1.73)**	1.40 (1.20–1.62)**	2.12 (1.62–2.76)**	1.66 (1.28–2.17)**	2.12 (1.57–2.85)**	1.49 (1.04–2.12)*
Ever smoked heavily	1.54 (1.30–1.82)**	1.50 (1.21–1.85)**	2.17 (1.69–2.80)**	1.82 (1.36–2.42)**	1.90 (1.30–2.76)**	1.35 (0.88–2.06)
Nicotine dependent	2.85 (2.31–3.52)**	1.98 (1.54–2.54)**	3.60 (2.83–4.57)**	1.88 (1.39–2.55)**	5.08 (3.58–7.22)**	2.14 (1.42–3.22)**
History of unsuccessful quit attempt	2.09 (1.76–2.48)**	1.76 (1.49–2.08)**	2.45 (1.85–3.25)**	1.77 (1.33–2.35)**	2.94 (2.16–4.00)**	1.98 (1.38–2.84)**
12-month analyses						
<i>n</i>	567		133		60	
Smoke regularly	1.75 (1.52–2.01)**	1.42 (1.20–1.67)**	2.45 (1.77–3.39)**	1.53 (1.11–2.12)**	3.29 (2.01–5.39)**	1.95 (1.06–3.46)*
Smoke heavily	1.78 (1.49–2.12)**	1.47 (1.13–1.92)**	2.71 (1.84–3.99)**	1.88 (1.22–2.88)**	4.24 (2.65–6.79)**	2.77 (1.55–4.97)**
Nicotine dependent	2.91 (2.03–4.17)**	2.06 (1.40–3.03)**	4.75 (2.79–8.08)**	2.38 (1.31–4.30)**	6.89 (3.70–12.84)**	2.50 (0.99–6.27)

Note. ORs represent bivariate associations between number of anxiety disorders (vs. no anxiety disorder) and specified smoking variable. AORs were adjusted for age, ethnicity, education, marital status, income, alcohol abuse/dependence, drug abuse/dependence, and depression. AOR = adjusted odds ratio; OR = odds ratio.

The role of lifetime panic history in smoking cessation failure also was examined. Overall, those with lifetime panic attack history showed elevated levels of cessation failure. Furthermore, multivariate analyses controlling for demographics and lifetime anxiety disorders, depression, and substance use comorbidity showed that panic attack history remained uniquely associated with cessation failure. SAD, PD, and PTSD also remained uniquely associated with cessation failure in this analysis.

Relationship between number of anxiety disorders and smoking outcomes

The role of frequency of comorbid anxiety disorder diagnoses was examined in a series of analyses presented in Table 4. Comparisons were made between individuals with one anxiety disorder versus no anxiety disorder, two anxiety disorders versus no anxiety disorder, and three or four anxiety disorders versus no anxiety disorder. Bivariate analyses indicated significant relationships between having one, two, or three or four anxiety disorder diagnoses and each smoking outcome of interest. Significant relationships were found for both 12-month and lifetime diagnoses and smoking variables. Additional multivariate analyses were also conducted that covaried for demographic and substance use variables and depression. Overall, the associations between one or more anxiety disorder diagnoses and smoking variables remained significant, with the exception that having three or four anxiety disorder diagnoses were only marginally associated with lifetime heavy smoking and 12-month nicotine dependence. These nonsignificant findings were likely due to low power.

Additional analyses were also conducted using a continuous variable representing number of anxiety disorder diagnoses (0 = none, 1 = one, 2 = two, 3 = three or four). Significant

bivariate associations between number of anxiety disorder diagnoses and likelihood of smoking outcome were revealed. Multivariate analyses controlling for demographic and substance use variables and depression revealed that the associations between lifetime number of anxiety disorder diagnoses and lifetime smoking variables remained significant. Identical findings emerged for 12-month anxiety disorder and smoking analyses.

In order to examine the role of number of anxiety disorders in explaining the associations between panic attacks and smoking variables, we conducted additional analyses. Presence of 12-month panic attacks was entered along with demographic and substance use variables, depression, and number of anxiety disorders (GAD, PTSD, and SAD; 0–3) into separate regression models predicting each 12-month smoking variable. Panic attack history was uniquely associated with regular smoking, heavy smoking, and nicotine dependence. A similar analysis of lifetime panic attacks (also using lifetime diagnostic variables) revealed that panic attacks were uniquely associated with lifetime history of difficulty quitting.

Comparison of treatment users and nonusers with anxiety disorders

In an attempt to explore whether previous findings demonstrating higher rates of smoking among individuals with PD (McCabe et al., 2004) were due to the use of treatment-seeking samples, 12-month rates of smoking behavior among respondents with anxiety disorders who had received treatment during the past 12 months were compared with those who had not been using chi-squared analyses. Rates of treatment utilization among individuals with 12-month SAD, GAD, PD, and PTSD were 22.3%, 28.7%, 30.1%, and 31.0%, respectively. Overall, no significant differences were found.

Discussion

The findings of the current study suggest that different anxiety disorders are uniquely associated with daily and heavy smoking, nicotine dependence, and smoking cessation failure. Moreover, these significant associations were found after controlling for other anxiety disorders, depression, and substance abuse/dependence comorbidity. Greater number of anxiety disorders was uniquely associated with greater prevalence of smoking outcomes. Lifetime and 12-month smoking outcomes were consistently associated with PTSD, though interestingly, PD was only uniquely associated with 12-month daily smoking. GAD was uniquely associated with most smoking outcomes, including lifetime daily smoking, nicotine dependence, and cessation failure and 12-month heavy smoking and nicotine dependence. SAD was not uniquely associated with any 12-month smoking outcomes but it was associated with lifetime heavy smoking, nicotine dependence, and unsuccessful quit attempt.

The present study found an absence of significant relationships between PD and smoking outcomes in all but one 12-month multivariate analysis. Though higher prevalence estimates of smoking outcomes were found among individuals with PD, multivariate analyses indicate that these associations were generally due to comorbid conditions. Additional analyses found that panic attacks were uniquely associated with all 12-month smoking outcomes of interest as well as lifetime cessation failure. This suggests that panic attacks are more relevant to smoking than PD diagnosis, findings that are also consistent with the hypothesized relationship of Zvolensky, Schmidt, and Stewart (2003) between panic and smoking and some empirical data from a nonrepresentative sample (Zvolensky, Lejuez, Kahler, & Brown, 2004).

Our findings differ in some respects from previous research. For example, McCabe et al. (2004) found higher rates of daily and heavy smoking among individuals with PD compared with those with SAD and obsessive-compulsive disorder, though we found prevalence estimates of daily and heavy smoking that were roughly equivalent among those with PD and SAD in univariate analyses and a nonsignificant association between PD and different smoking outcomes in multivariate analyses. Interestingly, the prevalence of daily smoking among individuals with PD in our study (39.5%) was nearly identical to the smoking rates for participants with PD in their study (40.4%), though their rates of current smoking among those with SAD (19.6%) were lower than those for NCS-R respondents with SAD (33.9%). There was no apparent association between treatment users and nonusers in terms of smoking patterns; thus, the differences in findings do not appear to be related to their use of a treatment-seeking sample.

Previous research found relatively low smoking rates among individuals with anxiety disorders without substance abuse or dependence (Baker-Morissette et al., 2004), while a separate epidemiological study found that only substance use disorders were associated with smoking after controlling for psychiatric comorbidity (Black et al., 1999). The data analyzed in this study demonstrated higher prevalence estimates of smoking among those with certain anxiety disorders even after controlling for substance use disorders. These findings suggest that important differences are likely to have existed in the makeup of the popu-

lations or sample sizes (and hence, power) studied across these studies. There is relatively little research examining processes involved with smoking among individuals with GAD, though the current study found strong associations between GAD and smoking that were not accounted for by psychiatric or substance abuse comorbidity. GAD is a disorder characterized by difficulties regulating emotions and marked avoidance of negative affect (Borkovec & Roemer, 1995; Mennin, Heimberg, Turk, & Fresco, 2002). Smoking among this population may represent a method by which individuals avoid or ameliorate negative emotions. Certain safety-seeking behaviors that also are carried out to avoid or relieve anxiety are thought to maintain (Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999) and even exacerbate anxiety (Deacon & Maack, 2008) in certain contexts as well as interfere with exposure-based treatments for anxiety disorders (Powers, Smits, & Telch, 2004; Sloan & Telch, 2002). Smoking may possibly exert similar deleterious effects among individuals with GAD. This suggests that smoking cessation might contribute to reductions in GAD symptoms.

The current study has a number of interpretative caveats. First, the data are cross-sectional and, in some instances, relied on lifetime histories of disorders and smoking patterns. The data therefore do not imply a causal relationship between anxiety disorders and smoking behavior. Second, our descriptive analysis of lifetime regular smoking and anxiety disorder onset indicated that regular smoking most often preceded anxiety disorder for individuals with PTSD, PD, and GAD. This may be due to the fact that smoking is generally initiated at a very young age. Smoking also may have increased risk for these anxiety disorders or some third variable increased risk for both. Third, data on tobacco use history only allowed us to assess lifetime, but not 12-month history, of cessation attempts. In this and in other lifetime analyses, it is possible that smoking problems occurred during points of time that were separate from the occurrence of anxiety disorders. Fourth, our analyses of comorbidity were somewhat limited in that our attention was given to whether anxiety disorders were uniquely associated with smoking outcomes. We did not assess whether different diagnostic profiles (e.g., comorbid PD and PTSD) were associated with greater risk, though we did examine whether the association between anxiety disorders and smoking could be accounted for by the number of anxiety disorders. These analyses found that greater number of anxiety disorders was associated with greater prevalence of smoking outcomes, though even the presence of one anxiety disorder was uniquely associated with greater smoking prevalence.

Together, the current study found that PTSD was associated with greater prevalence of daily and heavy smoking, nicotine dependence, and cessation failure. The associations with smoking outcomes were generally stronger and more consistent for PTSD than other anxiety disorders. A number of explanations have been proposed for the associations between PTSD and smoking. Individuals with PTSD are more likely to report smoking to reduce negative affect (Beckham et al., 2005). Research has found a particularly strong link between nicotine dependence and PTSD avoidance symptoms (Baschnagel, Coffey, Schumacher, Drobles, & Saladin, 2008), which suggests that smoking may act as a type of distraction to individuals with PTSD use to focus their attention away from distressing thoughts and emotions. Chronic pain, which is associated with greater

smoking (Zvolensky, McMillan, Gonzalez, & Asmundson, 2009) and is sometimes a consequence of traumatic injury, may also influence smoking cravings in this population. Such findings, when considered along with those from the current study, suggest that smoking cessation among individuals with PTSD may be most successful after their symptoms have been treated. Indeed, one study of smokers with PTSD found that smoking cessation outcomes were improved if both PTSD and smoking were treated simultaneously through an integrated treatment rather than if smoking problems were treated separately from PTSD (McFall et al., 2005). There is also evidence that the relationship between PTSD and smoking is actually bidirectional and that smoking may increase risk of PTSD (Van der Velden, Grievink, Olf, Gersons, & Kleber, 2007). If smoking functions to exacerbate symptoms, this would suggest that amelioration of PTSD symptoms might be facilitated through smoking cessation.

In the current report, associations between GAD and smoking also were evident, though the relationships between SAD and smoking were less consistently found. In addition, panic attack history, rather than PD diagnosis, was consistently associated with smoking difficulties. Further research is needed to help clarify the relationships between anxiety disorders such as GAD and smoking and the underlying mechanisms accounting for these relationships. Experimental research examining the potential bidirectionality of these associations, along with work involving comprehensive assessment of emotion regulation among anxious smokers, would assist in our understanding of this topic. Overall, the findings of this study are consistent with the perspective that smokers who have difficulties quitting are more likely to have psychiatric diagnoses that contribute to these difficulties. Furthermore, these findings suggest that researchers seeking to facilitate smoking cessation may better achieve their goals through the amelioration of anxiety psychopathology and the prevention of panic attacks.

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Declaration of Interests

None declared.

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Role of comorbidity

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