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Differential Prevalence of Established Risk Factors for Poor Cessation Outcomes among Smokers by Level of Social Anxiety

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Abstract

Background and Objectives—Despite clear associations between social anxiety (SA), high prevalence of smoking, and cessation failure, little is known about factors contributing to these relationships. Moreover, the extent to which smokers with moderate SA represent an at-risk group of smokers is also unknown. This study examined the extent to which established risk factors for poor cessation (e.g., sociodemographic, smoking history, mental health comorbidity) are prevalent among smokers with low, moderate, and high levels of SA.

Methods—Participants (N = 2,637) were adult smokers from a web-based smoking cessation trial. Nineteen characteristics considered risk factors for poor cessation outcomes were assessed at baseline. Those associated with social anxiety were subsequently compared by SA level.

Results—Regression models indicated that 10/19 risk factors were associated with SA. Compared to smokers with low SA, those with moderate and high SA endorsed 4/10 and 10/10 risk factors as more prevalent or severe, respectively. Compared to smokers with low SA, High SA was associated with greater sociodemographic risk factors, while both moderate and high SA was associated with more severe mental health symptoms.

Conclusions and Scientific Significance—Smokers with moderate and high levels of SA endorse more risk factors for poor cessation outcomes than those with low levels of SA, particularly mental health symptoms. These factors may help explain the differential smoking outcomes of socially anxious smokers. Results suggest that smokers with both moderate and high levels of SA would likely benefit from cessation interventions that address and consider these risk factors.

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INTRODUCTION

Of the 40 million current adult smokers in the United States¹, an estimated 14.3 million (36%) meet lifetime criteria for social anxiety disorder (SAD)². Compared to those without lifetime SAD, individuals with lifetime SAD have nearly double the rates of nicotine dependence (33% vs 17%)³ and are significantly less likely to quit smoking with standard treatment (28.6% vs. 36%)⁴. Despite this, they remain largely understudied in the tobacco treatment literature. In order to develop more effective smoking interventions for this group of smokers, several important gaps in the literature need to be addressed.

One major gap in the literature is lack of research and knowledge about smokers with moderate or sub-threshold levels of social anxiety. A distinction between smokers with and without SAD overlooks evidence that individuals with moderate or subthreshold levels of social anxiety (a continuous construct^{5–7}) also demonstrate significant levels of functional impairment and often resemble individuals who meet criteria for SAD^{8–10}. Regarding smoking, current smoking (68% vs 32%)¹⁰ and nicotine dependence (21% vs 9.1%)⁸ occur at disproportionate rates among individuals who experience elevated levels of social anxiety, but do not meet criteria for SAD^{11–13}. Although a few studies have included these individuals by using continuous measures of social anxiety^{12,14–16}, these studies do not discuss results or implications that are specific to smokers with moderate levels of social anxiety. Research explicitly examining smokers with moderate levels of social anxiety is needed to fully understand the relationship between social anxiety and smoking.

Second, little is known about the degree to which socially anxious smokers endorse a variety of known risk factors for continued smoking and relapse. Several studies have demonstrated that social anxiety is associated with coping-motivated cigarette smoking^{17,18} and craving^{19,20}—two robust predictors of poor cessation outcomes. For example, socially anxious smokers have a proclivity to smoke in order to cope with symptoms of social anxiety^{16,21}, negative affect^{14,15,22}, and internal smoking cues such as physical sensations, thoughts, and feelings^{23,24}. Socially anxious smokers also report particularly high levels of craving and urges during periods of abstinence compared to their less socially anxious counterparts^{15,16,21}. While two of these studies did not control for other factors^{16,22}, in four of these studies^{14,15,21,23}, social anxiety was a unique predictor of these outcomes after controlling for relevant factors such as depression, anxiety sensitivity, negative affect, and generalized anxiety. Specifically, social anxiety was a robust predictor of craving in two laboratory-based studies^{15,21} and indices of coping-motivated smoking in two cross-sectional studies^{14,23}. Although social anxiety is associated with a number of other established predictors of continued smoking and relapse (e.g., female gender^{3,8,25–27}, unemployment^{9,10,28–30}, sexual orientation^{31–33}, mental health comorbidity^{2,3,25,34–37}, and problematic alcohol use^{3,26,38–40}), much less is known about which of these factors may contribute to differences in smoking outcomes for socially anxious smokers. The degree to which these risk factors are prevalent among smokers with high and moderate levels of social anxiety has potential to inform treatment interventions for these smokers.

Current Study

The overarching goal of this study is to develop a better understanding of socially anxious smokers. Specifically, we aimed to identify: (1) which risk factors for poor cessation outcomes are associated with social anxiety and (2) which are more prominent among smokers with high and moderate levels of social anxiety relative to those with low social anxiety. We expect there to be a positive relationship between level of social anxiety and number of associated risk factors. Potential implications stemming from this study are twofold. First, this study may foster a better understanding of what factors may contribute differential rates of smoking and cessation among socially anxious smokers. Second, these results may lend insight into what interventions should entail to address the needs of socially anxious smokers.

METHODS

Participants

Participants (N = 2,637) were cigarette smokers (79% female; 73% Caucasian) recruited as part of an ongoing, randomized trial for web-based smoking treatment. Participants were recruited nationally via web-based (e.g., Facebook) and traditional methods of recruitment (e.g., press-release media). Individuals were eligible if they: (1) were 18 years of age; (2) smoked 5 cigarettes per day for the past 12 months; (3) self-reported desire to quit within 30 days (y/n); (4) were able and willing to read English; (5) were willing to be randomized to one of two websites for smoking cessation; (6) lived in the US; (7) had weekly access to Internet; (8) were not participating in other smoking interventions; and (8) never used Smokefree.gov (one of the interventions in the trial) for smoking treatment. All procedures were approved by the Institutional Review Board of the Fred Hutchinson Cancer Research Center. Data reported in this manuscript include screening and baseline responses from all participants randomized into the trial.

Measures

Social Anxiety—The Mini-Social Phobia Inventory (Mini-SPIN)⁴¹, a 3-item screening tool for SAD, assessed social anxiety. Responses are rated on a 5-point scale, where 0 = “not at all” and 4 = “extremely.” In addition to using the continuous score, we transformed scores into categorical variables. We classified participants into three severity groups (high, moderate, and low) based on Mini-SPIN scores. We anchored our definitions of high (HighSA; n = 797) and moderate (ModSA; n = 166) levels of social anxiety to the recommended Mini-SPIN cut-offs for SAD (score ≥ 6)^{41–43} and subthreshold SAD (score = 5)⁴², respectively. A score of six has a sensitivity of 88.7%, specificity of 90.0%, positive predictive value (PPV) of 52.6%, and negative predictive value (NPV) of 98.5%⁴¹ for predicting SAD. For predicting subclinical SAD, a score of five has an AUC of 0.82, a sensitivity of 72.4%, specificity of 78.6%, PPV of 24.7%, and NPV of 96.7%⁴². Participants were considered to have low of social anxiety (LowSA; n = 1667) if they scored four or less.

Risk Factors for Continued Smoking and Poor Cessation Outcomes—The 19 risk factors included in this study are known predictors of smoking maintenance and poor

cessation that were available in the baseline survey. These risk factors included variables such as: gender^{25–27,44}, education^{27,45–47}, marital status^{45,46}, unemployment^{29,30}, sexual orientation^{32,33}, problematic use of alcohol^{26,39,40,48}, use of other nicotine and tobacco products^{49–51}, mental health symptoms and comorbidity^{2,25,36,37}, number of previous quit attempts^{39,44,52,53}, and various smoking characteristics (e.g., nicotine dependence, heavy smoking)^{25,39,54,55}. Assessments of these variables are described below.

Participants self-reported six demographic variables including age, gender, education, marital and work status, and sexual orientation. Five variables assessed smoking behaviors such as heavy smoking (i.e., ≥ 21 cigarettes per day), number of past year quit attempts, frequency of past month electronic cigarette (e-cigarette) and other tobacco product use, and cigarette dependence. The Fagerström Test for Cigarette Dependence (FTCD)⁵⁶ is a six-item questionnaire used to assess cigarette dependence. The FTCD yields scores from 0 to 10, with higher scores representing greater dependence.

Baseline measures included three commonly used self-report measures of mental health symptoms: depression, generalized anxiety, and post-traumatic stress. The Center for Epidemiologic Studies-Depression (CES-D)⁵⁷ is a 20-item self-report measure used to assess depressive symptoms. Participants indicate past week symptom frequency on a scale of 0 (*rarely or none of the time*) to 3 (*most or all of the time*); scores range from 0 to 60. The Generalized Anxiety Disorder 7-item Scale (GAD-7)⁵⁸ was used to assess generalized anxiety. Items on the GAD-7 range from 0 (*not at all*) to 3 (*nearly every day*), with scores ranging from 0 to 21. Finally, level of post-traumatic stress was assessed using the Abbreviated PTSD Checklist (PCL-6)⁵⁹. The PCL-6 is comprised of six items with response options ranging from 0 (*not at all*) to 4 (*extremely*); scores range from 0 to 24. Creating two variables, participants self-reported (y/n) if they had a serious mental illness (SMI) (i.e., bipolar disorder, schizophrenia), or alcohol or drug abuse.

Participants answered three questions regarding past 30-day alcohol use. Questions were based on the Alcohol Use Disorders Identification Test (AUDIT-C)⁶⁰ and assessed: (1) how many alcoholic drinks participants consumed on a typical drinking day, (2) how many days per week they consumed alcohol, and (3) the number of times they consumed five or more alcoholic beverages.

Analyses

Regression models for binary, count, and continuous outcomes were used as applicable to determine if social anxiety was associated with each outcome variable. For models indicating a significant relationship, follow-up analyses were conducted to compare the LowSA, ModSA, and HighSA groups. T-tests and chi-square tests were used to compare groups on continuous and categorical variables, respectively. Negative binomial regression models were used to compare groups with count data. All statistical tests were two-sided, with $\alpha = 0.05$. We controlled for multiple comparisons in the regression models and follow-up analyses using the Holm procedure^{61,62}. Statistical analyses were completed using R 3.2.0⁶³.

RESULTS

Regression Models

Descriptive statistics are presented in Table 1. Social anxiety was significantly associated with 10 of the 19 risk factors. These risk factors include: age ($p < .0001$), education ($p < .0001$), marital status ($p < .001$), sexual orientation ($p < .01$), cigarette dependence ($p < .0001$), use of other tobacco products ($p < .0001$), co-occurring mental health symptoms (post-traumatic stress, generalized anxiety, and depression) ($ps < .0001$), and self-reported SMI ($p < .0001$). Risk factors not associated with social anxiety ($ps > .05$) included gender, employment status, heavy smoking, number of past year quit attempts, e-cigarette use, a self-reported alcohol or drug condition, number of alcoholic drinks per day, number of drinking days per week, and number of binge episodes.

Follow-up analyses were conducted for the significant 10 risk factors to develop a better understanding of the relationship at different levels of social anxiety (Table 2).

Group Comparisons: HighSA vs. LowSA

As expected, significant group differences between the HighSA and LowSA groups were found for all 10 risk factors assessed in follow-up analyses. Smokers with HighSA endorsed more severe mental health symptoms on all objective indices including post-traumatic stress symptoms, generalized anxiety, and depression ($ps < .0001$). Of particular note, smokers with HighSA had nearly three times higher odds of self-reporting SMI ($OR = 2.92$; 95% $CI = 2.19-3.89$; $p < .0001$).

Group Comparisons: ModSA vs. LowSA & HighSA

As expected, some risk factors were more prevalent among individuals with ModSA compared to LowSA. Specifically, individuals with ModSA exhibited more severe mental health symptoms including post-traumatic stress ($M_{\text{difference}} = 3.5$; 95% $CI = 2.7-4.3$; $p < .0001$), generalized anxiety ($M_{\text{difference}} = 3.3$; 95% $CI = 2.4-4.1$; $p < .0001$), and depression ($M_{\text{difference}} = 9.1$; 95% $CI = 7.3-10.8$; $p < .0001$). Individuals with ModSA also had two times higher odds of self-reporting SMI ($OR = 2.21$; 95% $CI = 1.31-3.73$; $p < .01$).

The only differences found between the ModSA and HighSA groups were on the objective mental health indices such that the HighSA group endorsed more severe symptoms ($ps < .0001$).

DISCUSSION

Social anxiety was associated with 10 of the 19 risk factors for poor cessation outcomes assessed in this study. To better understand these relationships, we compared smokers with low, moderate, and high levels of social anxiety. Overall, results suggest that smokers with high and moderate levels of social anxiety endorse risk factors to a greater extent than smokers with low social anxiety.

Most notably, both the HighSA and ModSA groups endorsed more severe mental health symptoms and comorbidity than the LowSA group. Average scores on the three objective

measures of mental health (post-traumatic stress, generalized anxiety, and depression) in the HighSA group were above the recommended cutoffs, compared to two in the ModSA group (post-traumatic stress and depression), and none in the LowSA group. Both the HighSA and ModSA groups were more likely to report co-morbid SMI. These findings have a number of implications. First, smokers with high and moderate levels of social anxiety are likely to have a number of mental health comorbidities. As having multiple mental health diagnoses is a major barrier to cessation^{4,64,65}, the high rates of co-morbidity may contribute to the poor outcomes among socially anxious smokers. Related, the level of comorbidity seen among smokers with ModSA suggests that they represent a group of smokers that should be included in future research and treatment development efforts for socially anxious smokers. Second, explicitly addressing symptoms of social anxiety and other mental health symptoms in the context of smoking treatment (e.g., discussions of the relationships between mental health and smoking, teaching adaptive coping mechanisms) may be beneficial for socially anxious smokers (i.e., smokers with high and moderate social anxiety). Similarly, given the extent of co-morbid mental health conditions, they may also benefit from targeted approaches that address transdiagnostic vulnerabilities (i.e., factors common across mental health diagnoses)^{4,66}. An integrated care approach where smoking is addressed within the context of mental health treatment may also be of benefit given that it yields promising outcomes for smokers with other mental health diagnoses⁶⁷, but may be of limited utility given the low rates of treatment utilization among individuals with social anxiety^{10,34}. Future research is needed to determine the optimal way to treat concurrent smoking and social anxiety.

Contrary to previous research on SAD, social anxiety was not associated with female gender^{3,8}, unemployment^{9,10}, or problematic alcohol use^{3,38}. It is possible that these associations with social anxiety are not significant among socially anxious smokers and thus may not uniquely contribute to differential smoking outcomes for socially anxious smokers. However, the HighSA group differed from the LowSA group on a number of other sociodemographic variables such as age, marital status, education level, and sexual orientation. These findings are in line with research regarding correlates of SAD^{3,8–10,31,68}. Although these variables would not be targeted as change processes, these factors may help explain differences in smoking outcomes for socially anxious smokers and should be considered when developing interventions for socially anxious smokers (e.g., needs-assessment questions during focus groups, more representative examples in intervention content).

In line with previous research^{8,13,24,64,69}, smokers with HighSA reported higher levels of cigarette dependence relative to those with LowSA. However, we did not find evidence that social anxiety was associated with heavy smoking (i.e., smoking ≥ 21 cigarettes per day) or e-cigarette use. This is consistent with previous research that found a relationship between SAD and nicotine dependence, but not cigarettes per day⁴. Taken together, it also seems unlikely that heavy smoking and e-cigarette use mediate the relationship between social anxiety and poor smoking outcomes given that these were unrelated to social anxiety.

It is important to note that there is no agreed upon definition of moderate or subthreshold social anxiety and researchers have used a variety of definitions to distinguish these

categories^{5,8,9,70,71}. We used the Mini-SPIN to assess social anxiety, the recommended cutoff score of six⁴¹ to identify individuals with “high” social anxiety, and a score of five⁴² to identify individuals with “moderate” of social anxiety. Thus, only individuals who scored a five on the Mini-SPIN were categorized as ModSA. Considering the PPV of the Mini-SPIN, approximately 47% of individuals who scored a six or higher would not meet criteria for SAD, but would likely have subthreshold symptoms. This further highlights the potential importance of smokers with moderate and subthreshold levels of social anxiety. That is, it is plausible that group differences would be more disparate (particularly between LowSA and ModSA) if social anxiety was categorized differently in future studies (e.g., SAD vs. ModSA vs LowSA). Future research is needed to determine the best way to classify smokers with varying levels of social anxiety and to determine the reliability of these results if ModSA were categorized differently.

The limitations of this study should also be kept in mind. First, the measure used to assess social anxiety in this study was designed as a screening tool for assessing SAD. Related, all mental health conditions were assessed via self-report questionnaires. Future research examining the intersection of social anxiety and smoking should utilize more comprehensive assessments of social anxiety and other mental health conditions (e.g., diagnostic interviews). Second, although smoking rates are higher among men than women¹, like many comparable studies^{72–75}, the majority of participants in this sample were women. It is unclear if these results would generalize to male smokers, particularly as social anxiety tends to occur at higher levels in women^{3,8,76}. Third, results from this study are based on treatment-seeking smokers with Internet access. Although the results can be used to inform the development of future interventions for these smokers, the results may not generalize to those who did not meet study-specific eligibility criteria. Replicating these findings with a broader population of smokers is warranted to understand these relationships among smokers not ready to quit. Fourth, this study was limited to a cross-sectional design. Thus, causal or temporal relationships between social anxiety, risk factors, and cessation outcomes could not be assessed. Future prospective research is needed to determine which risk-factors (mental health and others) mediate or partially mediate the relationship between social anxiety and smoking outcomes and which explain the most unique variance.

Conclusions

This study adds to the growing body of knowledge regarding the relationship between social anxiety and smoking in two important ways. First, it is the first to explicitly examine smokers with moderate levels of social anxiety and provide further evidence that they may represent an at-risk group of smokers that should be a focus of future research and treatment development efforts pertaining to comorbid social anxiety and smoking. Additionally, the prevalence and severity of these risk-factors among socially anxious may help explain the poor cessation outcomes of this group^{2,4} and suggests that these smokers may benefit from targeted smoking interventions. These interventions should address modifiable risk-factors (e.g., mental health comorbidity, use of other tobacco products) and take into consideration those that are not modifiable (e.g., demographic risk-factors).

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Table 1

Group Descriptives

	LowSA ^a		ModSA ^b		HighSA ^c	
	M(SD)	n(%)	M(SD)	n(%)	M(SD)	n(%)
Established Risk Factors						
<i>Demographics</i>						
Age	47.7(13.1)		44.9(13.6)		43.3(13.4)	
Gender (female)		1300(78%)		133(80%)		653(82%)
HS education or less		419(25%)		46(28%)		266(33%)
Marital status (married)		669(40%)		60(36%)		225(32%)
Unemployed		238(14%)		22(13%)		148(19%)
LGB		145(9%)		15(9%)		93(12%)
<i>Smoking History</i>						
Heavy smoker (21+ cpd)		554(33%)		49(30%)		268(34%)
Nicotine dependence	5.5(2.2)		5.6(2.1)		5.9(2.1)	
# of past yr quit attempts	1.6(4.5)		1.3(2.2)		1.9(6.2)	
Past month e-cig use		--		--		--
None		1099(66%)		112(67%)		510(64%)
Intermittent		426(26%)		46(28%)		219(27%)
Daily		142(9%)		8(5%)		68(9%)
Other tobacco use		248(15%)		30(18%)		177(22%)
<i>Mental Health/Substance</i>						
Post-traumatic stress	12.5(4.8)		16.1(5.0)		19.2(5.5)	
Generalized Anxiety	5.6(5.0)		8.9(5.3)		11.9(5.5)	
Depression	14.2(10.0)		23.3(10.8)		30.0(12.0)	
Self-report SMI		92(6%)		19(11%)		116(15%)
Self-report drug/alcohol		83(5%)		9(5%)		65(8%)
# drinks per day	1.3(2.4)		1.7(2.9)		1.6(3.8)	
# of drinking days/week	1.4(2.0)		1.4(1.9)		1.4(2.0)	
# of binge episodes	1.1(3.7)		1.1(3.4)		1.5(4.2)	

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Among the LowSA group, sample sizes for continuous variables range from 1622-1667
Among the ModSA group, sample sizes for continuous variables range from 164-166
Among the HighSA group, sample sizes for continuous variables range from 772-797

Group Comparisons of Established Risk Factors Significantly Associated with Mini-SPIN Scores

Table 2

Established Risk Factors	LowSA vs. ModSA		LowSA vs HighSA		ModSA vs HighSA	
	<i>M</i> _{difference} (95% <i>CI</i>)	<i>OR</i> (95% <i>CI</i>)	<i>M</i> _{difference} (95% <i>CI</i>)	<i>OR</i> (95% <i>CI</i>)	<i>M</i> _{difference} (95% <i>CI</i>)	<i>OR</i> (95% <i>CI</i>)
<i>Demographics</i>						
Age	-2.7(4.8,-0.6)	--	-4.4(-5.5,-3.2) $\diamond$	--	-1.6(-3.9, 0.7)	--
HS education or less	--	1.14(0.79,1.62)	--	1.49(1.24,1.79) $\checkmark$	--	1.31(0.90,1.89)
Marital status (married)	--	0.84(0.60,1.17)	--	0.70(0.59,0.84) $\S$	--	0.83(0.59,1.18)
LGB	--	1.04(0.57,1.77)	--	1.39(1.05,1.83) $\checkmark$	--	1.33(0.75,2.36)
<i>Smoking History</i>						
Nicotine dependence	-0.1(-0.5,0.2)	--	0.4(0.2-0.5) $\S$	--	0.2 (-0.1,0.6)	--
Other tobacco use	--	1.26(0.82,1.89)	--	1.63(1.32,2.02) $\diamond$	--	1.29(0.84,1.99)
<i>Mental Health/Substance</i>						
Post-traumatic stress	3.5(2.7,4.3) $\diamond$	--	6.6(6.2, 7.1) $\diamond$	--	3.1(2.2,4.0) $\diamond$	--
Generalized Anxiety	3.3(2.4,4.1) $\diamond$	--	6.3(5.8-6.7) $\diamond$	--	3.0(2.1,3.9) $\diamond$	--
Depression	9.1(7.4,10.7) $\diamond$	--	15.8(14.8-16.8) $\diamond$	--	6.7(4.9,8.6) $\diamond$	--
Self-report SMI	--	2.21(1.28,3.65) $\checkmark$	--	2.92(2.19,3.89) $\diamond$	--	1.32(0.79,2.21)

NOTE: "--" indicates a value in that cell is not applicable

 $\square$ $p < .01$ $\checkmark$ $p < .05$ $\S$ $p < .001$ $\diamond$ $p < .0001$