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The relationship between smoking cessation and binge drinking, depression, and anxiety symptoms among smokers with serious mental illness

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ABSTRACT

Introduction: Concerns about the adverse effects of smoking cessation on alcohol use and mental health are a barrier to cessation for smokers with serious mental illness (SMI). The purpose of this study is to examine how incident smoking cessation affects binge drinking and symptoms of depression and anxiety among smokers with SMI.

Methods: The present study is a secondary analysis of the OPTIN trial, which demonstrated the effectiveness of proactive outreach for smoking cessation among Minnesota Health Care Programs enrollees. Participants with ICD-9 codes indicating schizophrenia spectrum disorders, psychotic disorders, bipolar disorders, or severe/recurrent major depressive disorder were categorized as having SMI (n = 939); remaining smokers were categorized as non-SMI (n = 1382). Multivariable regressions modeled the association between incident smoking cessation and binge drinking, PHQ-2 depression scores, and PROMIS anxiety scores in the two groups.

Results: Quitting smoking was not associated with binge drinking among those with SMI, but was associated with less binge drinking among those without SMI (p = 0.033). Quitting smoking was not associated with PHQ-2 depression scores among those with or without SMI. However, quitting smoking was associated with lower mean PROMIS anxiety scores for those with SMI (p = 0.031), but not those without SMI.

Conclusion: Quitting smoking was not associated with heightened binge drinking or symptoms of depression and anxiety among smokers with SMI. These findings suggest that quitting smoking is not detrimental for these patients, and provide evidential support for facilitating access to cessation resources for patients with serious mental illness who smoke.

1. Introduction

The prevalence of smoking among those with mental health disorders is two to three times higher than that of the general US population, depending on clinical diagnosis (Gfroerer et al., 2013). Those with diagnoses consistent with serious mental illness (SMI) like major depressive disorder (Crum et al., 2013; Grant and Harford, 1995) and schizophrenia (Drake and Mueser, 2002) are also more likely to engage in alcohol abuse behaviors. Furthermore, evidence suggests that there is a high prevalence of concurrent smoking and alcohol dependence; nicotine-dependent smokers have nearly 3-times higher risk of becoming alcohol dependent compared to nonsmokers (Breslau, 1995). The high co-occurrence of smoking and alcohol dependence among those with SMI is a grave public health concern. In addition to the independent risks associated with these behaviors (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2014; Rocco et al., 2014), combined use is associated with a multiplicative increase in the risk for some cancers, including head and neck and esophageal cancer (Blot et al., 1988). The increased prevalence of these deleterious health behaviors contributes to the heightened mortality rate observed in this population, and individuals with SMI die an average of 25 years earlier than those in the general population (Parks et al., 2006).

Many smokers with alcohol dependence report using smoking as a way to cope with urges to drink (Monti et al., 1995) making the prospect of quitting seem overwhelming and unattainable. Furthermore, there is concern that nicotine withdrawal symptoms may threaten sobriety from alcohol, contributing to a reluctance to treat these

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conditions simultaneously (Berg et al., 2015; Kozlowski et al., 1989; Romberger and Grant, 2004). Some research partially validates the concern that smoking cessation exacerbates alcohol use, as several studies have demonstrated an association between smoking cessation and increased alcohol use (Carmelli et al., 1993; Perkins et al., 1990). One trial of smokers with alcohol dependence who were randomized to either concurrent smoking cessation treatment or delayed smoking cessation treatment found that participants in the concurrent treatment condition reported lower rates of abstinence from alcohol than those in the delayed condition (Joseph et al., 2004). However, a similar trial conducted among alcohol-dependent smokers found that alcohol use did not differ significantly between participants receiving concurrent versus delayed smoking cessation treatment (Cooney et al., 2015). Furthermore, several more recent studies have shown that alcohol use does not substantially change following smoking cessation (Kahler et al., 2010) or is reduced (Berg et al., 2015). It has been suggested that methodological problems including small sample size (Perkins et al., 1990) and an inability to establish temporal ordering (Carmelli et al., 1993) may account for these inconsistent findings (Berg et al., 2015).

Another key barrier to smoking cessation among patients with SMI is the perception that quitting smoking may exacerbate mental health symptoms. Evidence suggests that smokers with SMI may use nicotine as a form of self-medication to help reduce the experience of negative affect and anxiety associated with their condition(s) (Glassman, 1993; Thornton et al., 2012) and qualitative work has shown that these smokers expect that their mental health will deteriorate following a quit attempt (Kerr et al., 2013). This is also a concern among healthcare providers, some of whom believe quitting smoking may increase depressive symptoms among their patients (Hall and Prochaska, 2009; Hitsman et al., 2009).

Despite the concerns of both smokers and healthcare providers regarding the potentially deleterious mental health consequences associated with smoking cessation, a growing body of evidence suggests that quitting smoking may lead to improvements in mental health symptoms among the general population (Kahler et al., 2011; Taylor et al., 2015, 2014). Other research has shown similarly beneficial effects of smoking cessation on mental health symptoms among smokers with diagnoses of mood and/or anxiety disorders (Cavazos-Rehg et al., 2014).

The inconsistent findings regarding the association between smoking cessation and alcohol use highlight the need for continued research exploring this issue. As such, the first aim of the present study is to assess the association between smoking cessation and binge drinking among socioeconomically disadvantaged smokers enrolled in Minnesota Health Care Programs (MHCP). We focused on binge drinking because of the pronounced deleterious health risks associated with drinking to excess (Gupta et al., 2010; Llerena et al., 2015; Samokhvalov et al., 2010) and because binge drinking is a predictor of alcohol dependence (Bonomo et al., 2004). There is also a lack of research exploring whether the association between smoking cessation and alcohol use differs by SMI status; an important clinical consideration when approaching the treatment of smoking for those with mental health disorders due to the high co-morbidity of these conditions (Grant et al., 2004; Grant and Harford, 1995). We address this gap in the literature by examining the association between smoking cessation and binge drinking among those with SMI and without SMI, respectively.

The second aim of this study is to explore the association between smoking cessation and mental health symptoms among our low-income sample. Continued research in this area is essential in order to better inform both smokers and physicians on what to expect when approaching cessation, an issue of particular importance for smokers with SMI. We address this issue by examining the association between smoking cessation and symptoms of depression and anxiety among smokers with SMI and without SMI.

2. Methods

2.1. Study design

This is a secondary analysis of data from the "Proactive Smoking Cessation Treatment for Minnesota Priority Populations" (OPTIN) study (N = 2406) (Fu et al., 2014). This study was a two-arm randomized controlled trial conducted among a sample of smokers enrolled in Minnesota Health Care Programs (MHCP), which is a state-funded health insurance plan for low-income persons. As described previously, this study demonstrated the effectiveness of proactive outreach relative to usual care for boosting rates of 6-month prolonged smoking abstinence (Fu et al., 2016). The study population sample was stratified by insurance program (Medicaid or MinnesotaCare), age group (18–24, 25–34, 35–64), and sex (male or female). MHCP insurance claims drawn from a 2-year period prior to study initiation were used to obtain ICD-9 codes for participants in both the usual care condition and proactive outreach condition. Participants with ICD-9 codes indicative of schizophrenia spectrum disorders, psychotic disorders, bipolar I and II disorders, or severe/recurrent major depressive disorder were categorized as having SMI (n = 939). Participants without one of these codes were categorized as not having SMI (n = 1382), and those who did not have insurance claims data for the 2-period period prior to study initiation were not included in these analyses (n = 85). The OPTIN study was approved by the Institutional Review Boards at the University of Minnesota and the Minnesota Department of Human Services (DHS), and all participants provided informed consent prior to enrollment.

2.2. Measures

The demographic measures of insurance program, age, and sex were drawn from MHCP administrative and claims data, as were the ICD-9 codes used to assess participants' mental health diagnoses. All remaining measures were obtained from the OPTIN baseline and 12-month follow-up surveys.

2.2.1. Smoking cessation

A self-report measure was used to assess 6-month prolonged smoking abstinence at 12-month follow-up (Hughes et al., 2003). Participants were asked whether they had smoked 1) at least once on 7-consecutive days, or 2) at least once on 2-consecutive weekends in the 6-month period prior to the follow-up survey. Those who responded yes to either question was considered continuing smokers.

2.2.2. Demographics

Insurance program, age, sex, race/ethnicity, education, employment status, and yearly income were assessed.

2.2.3. Alcohol

Participants with an ICD-9 code in the range of 303.90–303.99 were considered to have alcohol dependence. An item from the Behavioral Risk Factor Surveillance System (BRFSS) was used to assess binge drinking asking on how many days in the past 30 the participant had consumed 5 or more drinks (4 or more drinks for women) (Centers for Disease Control and Prevention (CDC), 2010). Participants were placed into "0 days", "1 day", "2–3 days", or "more than 3 days" categories. Items from the BRFSS were also used to assess the number of drinking days in the past 30 days, and the number of drinks consumed on a typical occasion in the past 30 days.

2.2.4. Mental health diagnoses

Participants with at least one ICD-9 code in the range of 1) 295.00–295.94 were considered to have a schizophrenia spectrum disorder, 2) 297.00–298.90 were considered to have a psychotic disorder, 3) 296.23–296.25 and/or 296.3–296.36 were considered to have

severe or recurrent major depressive disorder, 4) 296.00–296.13 and/or 296.4–296.9 were considered to have a bipolar disorder.

2.2.5. Mental health symptoms

A Patient-Reported Outcomes Measurement Information System (PROMIS) instrument was used to assess anxiety symptoms (PROMIS Cooperative Group, 2009). This measure took the sum of 7 items assessed on a scale from 1 to 5, with higher scores indicating greater anxiety. A T-score was then calculated by multiplying the summed score by 7 and dividing by the number of items that the participant answered. The Patient Health Questionnaire 2-item (PHQ-2) measure was used to assess depressive symptoms (Kroenke et al., 2003). This measure took the sum of 2 items assessed on a scale from 0 to 3, with higher scores indicating greater depressive thoughts.

2.2.6. Social environment

A composite variable measured participants' perceived social support for cessation by taking the mean of two variables that assessed perceived social support for quitting and others' desire for the participant to quit smoking, respectively (University of San Diego, 2010). Both items were assessed on a 5-point scale, with higher scores indicating greater levels of social support. Participants reported the proportion of their close friends and family who were smokers. Participants also reported whether they lived with a child under the age of 18, whether they lived with another smoker, and the smoking rules within their home.

2.2.7. Healthcare provider factors

Healthcare Effectiveness Data and Information Set (HEDIS) tobacco performance measures were used to assess participants' self-reported past year healthcare experiences (Davis, 1997). Items assessed whether participants had someone they thought of as their regular doctor, whether they received doctor-delivered advice to quit, advice to use cessation medications, and advice to use ways (besides products) to help with quitting. A composite variable of perceptions of healthcare provider bias was created by summing 3-items from the Physician Bias and Interpersonal Cultural Competence Measures Scale (Johnson et al., 2004). These items assessed whether the participant felt they were treated with respect, the healthcare provider's understanding of the participant's background and values, and the participant's perception of whether the healthcare provider looked down on their way of life. Each item was assessed on a 5-point scale, with higher values indicating greater perceptions of healthcare provider bias. Analyses conducted on the summary measure created for these items yielded an unadjusted Cronbach's alpha reliability score of 0.74.

2.2.8. Smoking history

Standard questions from the California Tobacco Survey (University of San Diego, 2010) and the BRFSS (Centers for Disease Control and Prevention (CDC), 2010) assessed smoking history, including lifetime duration of smoking, time until first cigarette, and any quit attempts in the past year.

2.2.9. Cessation beliefs

Self-efficacy for quitting was measured on a scale from 1 to 10, with higher values indicating greater confidence in quitting (Baldwin et al., 2006). The Contemplation Ladder assessed readiness to quit on a scale from 1 to 10, with higher values indicating a greater readiness to quit (Biener and Abrams, 1991).

2.3. Statistical analysis

2.3.1. Bivariate analyses

Bivariate analyses, using t-tests and Pearson's chi-square tests, compared participants with and without SMI across demographic, alcohol use, mental health, social environment, healthcare provider, smoking history, cessation beliefs, and smoking abstinence measures. In order to provide additional information on the mental health characteristics of these groups, we compared smokers with SMI to those without SMI across a series of mental health diagnoses that were not included in the SMI definition (see Supplementary Table 1).

2.3.2. Regression analyses

Multivariable multinomial regression modeled the association between 6-month prolonged smoking abstinence (yes vs. no) and the 4-level binge drinking outcome variable at 12-month follow-up, stratified by SMI category (SMI vs. non-SMI). A baseline measure of binge drinking was included in these models.

Multivariable linear regressions modeled the association between 6-month prolonged smoking abstinence and PHQ-2 depression score and PROMIS anxiety score at follow-up, stratified by SMI category. Baseline measures of each outcome variable were included in the respective models.

2.3.3. Covariate adjustment

A series of bivariate analyses were conducted in order to identify differences between those who achieved 6-month prolonged smoking abstinence and those who did not achieve 6-month prolonged smoking abstinence. In addition to checking for differences in the rates of membership in the proactive outreach intervention, the groups were compared across select demographic, social environment, smoking history, and cessation beliefs variables (see Supplementary Table 2).

In addition to the models adjusting only for baseline levels of the outcome variable (model 1), hierarchical models were used to incrementally adjust for the effects of the intervention (model 2), the demographic variables of insurance program, age, sex, race/ethnicity, and income (model 3), the proportion of close friends and family who smoke (model 4), and the smoking history/cessation beliefs variables of cigarettes smoked per day and readiness to quit (model 5). When describing the results of regression analyses, we focus on the most fully adjusted model (model 5). For the purposes of these regression analyses, the "American Indian or Alaska Native", "Hispanic or Latino", and "Asian or Pacific Islander" categories were collapsed into one category due to the small sizes of these groups.

3. Results

3.1. Comparison of smokers with SMI vs. without SMI

3.1.1. Baseline characteristics

Compared to non-SMI smokers (n = 1382), those with SMI (n = 939) were more likely to be enrolled in Medicaid, were older, and more likely to be female. Smokers with SMI also tended to have lower levels of education and income and were less likely to be currently employed (see Table 1). Smokers with SMI had significantly more symptoms of depression and anxiety at baseline and were more likely to have a diagnosis of alcohol dependence (21.0% vs. 3.9%), but had lower levels of current binge drinking, drinking days in the past 30 days, and typical number of drinks per occasion. Smokers with SMI also had more smokers in their peer groups and less restrictive home smoking rules. Smokers with SMI were more likely to report having a regular doctor and received more advice to quit and to use cessation treatments than smokers without SMI. Smokers with SMI reported less time until smoking their first cigarette after waking and were heavier smokers but reported a similar age of smoking initiation as those without SMI. Smokers with SMI had lower quitting self-efficacy but reported similar readiness to quit as those without SMI.

3.1.2. Follow-up characteristics

There was a lower rate of 6-month prolonged smoking abstinence among those with SMI compared to those without SMI (12.0% vs. 15.5%, p = 0.044).

Table 1
Baseline Demographic, Alcohol, Mental Health, Social Environment, Healthcare Provider, Smoking History, and Cessation Belief Characteristics of SMI vs. Non-SMI Smokers.

Characteristic	SMI N = 939 No. (%) or Mean ± SD	Non-SMI N = 1382 No. (%) or Mean ± SD	p Value
Demographics			
Insurance Program			**< 0.001**
Medicaid	779 (83.0)	895 (64.8)	.
MnCare	160 (17.0)	487 (35.2)	.
Age			**< 0.001**
18-24	143 (15.2)	308 (22.3)	.
25-34	307 (32.7)	496 (35.9)	.
35-64	489 (52.1)	578 (41.8)	.
Male	250 (26.6)	436 (31.6)	**0.011**
Race/Ethnicity			0.217
White	720 (76.7)	1093 (79.1)	.
Black or African American	116 (12.4)	136 (9.8)	.
Amer Indian or Alaskan Native	71 (7.6)	92 (6.7)	.
Hispanic or Latino	14 (1.5)	28 (2.0)	.
Asian or Pacific Islander	18 (1.9)	33 (2.4)	.
Education			**0.005**
Grade 11/lower	145 (15.8)	173 (12.8)	.
HS grad/GED	305 (33.3)	457 (33.8)	.
Some college	389 (42.5)	552 (40.8)	.
College grad/higher	77 (8.4)	171 (12.6)	.
Employment			**< 0.001**
Employed/self-employed	303 (33.0)	838 (61.8)	.
Student	74 (8.1)	84 (6.2)	.
Out of work	144 (15.7)	155 (11.4)	.
Unable to work/disabled	352 (38.3)	195 (14.4)	.
Homemaker	46 (5.0)	85 (6.3)	.
Yearly income			**< 0.001**
Less than $10k	453 (50.2)	385 (29.3)	.
$10,001–$20k	265 (29.4)	433 (33.0)	.
$20,001–$40k	137 (15.2)	332 (25.3)	.
More than $40k	47 (5.1)	164 (12.5)	.
Alcohol			
Alcohol dependence	205 (21.8)	(3.9)	**< 0.001**
Binge drinking (past month)			**< 0.001**
0 days	583 (66.3)	716 (54.3)	.
1 day	79 (9.0)	160 (12.1)	.
2–3 days	93 (10.6)	206 (15.6)	.
> 3 days	124 (14.1)	236 (17.9)	.
Drinking days (past month)			**< 0.001**
0	427 (46.6)	376 (27.7)	.
1	122 (13.3)	205 (15.1)	.
2 to 3	154 (16.8)	316 (23.3)	.
4 to 10	120 (13.1)	251 (18.5)	
11 to 19	44 (4.8)	115 (8.5)	.
20 to 30	49 (5.4)	94 (6.9)	.
Drinks per occasion (past month)			**< 0.001**
0	414 (45.4)	368 (27.0)	.
Less than 1	14 (1.5)	24 (1.8)	.
1	49 (5.4)	106 (7.8)	.
2 to 3	177 (19.4)	335 (24.6)	.
4 to 5	121 (13.3)	218 (16.0)	.
6 to 7	67 (7.4)	145 (10.7)	.
> 8	69 (7.6)	165 (12.1)	.
Mental Health			
Depressive symptoms	2.4 ± 1.9	1.3 ± 1.5	**< 0.001**[a]
Anxiety symptoms	60.0 ± 10.4	52.3 ± 9.9	0.324
Social Environment			
Friends/family who smoke			**< 0.001**
Almost all	239 (25.7)	240 (17.5)	.
Over half	203 (21.8)	294 (21.4)	.
About half	201 (21.6)	397 (28.9)	.
Less than half	126 (13.5)	212 (15.5)	.
Very few	141 (15.2)	203 (14.8)	.
None	21 (2.3)	26 (1.9)	.
Home smoking rules			**< 0.001**
Smoking is not allowed	410 (43.9)	742 (54.1)	.
Smoking is allowed at times	252 (27.0)	357 (26.0)	.
Smoking is allowed	271 (29.1)	273 (19.9)	.
Healthcare Provider			
Regular doctor	771 (83.6)	986 (72.5)	**< 0.001**
Doctor advised to quit	671 (78.8)	888 (75.0)	**0.048**
Doctor discussed medications	378 (44.7)	488 (41.4)	**0.144**
Doctor discussed ways (besides products) to quit	443 (52.4)	517 (43.7)	**< 0.001**
Healthcare provider bias	5.9 ± 2.9	5.8 ± 2.8	0.348
Smoking History			
Cigs/day	14.7 ± 9.6	13.0 ± 8.8	**< 0.001**[a]
Age of initiation (years)	16.1 ± 4.4	16.3 ± 4.3	0.324
Time until 1st cig (minutes)			**< 0.001**
≤5	299 (32.2)	307 (22.5)	.
6–15	300 (32.3)	380 (27.8)	.
16–30	138 (14.9)	204 (15.0)	.
31–60	85 (9.2)	184 (13.5)	.
> 60	107 (11.5)	290 (21.3)	.
Cessation Beliefs			
Quitting self-efficacy	4.7 ± 3.0	5.2 ± 3.1	**< 0.001**
Contemplation Ladder	6.2 ± 2.9	6.4 ± 2.9	0.219

Boldface indicates statistical significance ($p < 0.05$).
[a] Satterthwaite test.

3.2. Binge drinking at follow-up in smoking quitters vs. non-quitters

3.2.1. SMI group

In the fully adjusted model (model 5), smokers who quit did not have significantly different odds of binge drinking for one day (OR = 1.20, 95% CI: 0.46–3.16), 2–3 days (OR = 0.69, 95% CI: 0.24–2.05), or more than 3 days (OR = 0.43, 95% CI: 0.12–1.49) in the past month compared to smokers who did not quit (p = 0.518) (see Table 2).

3.2.2. Non-SMI group

In the fully adjusted model, smokers who quit had significantly lower odds of binge drinking for one day (OR = 0.95, 95% CI: 0.48–1.89), 2–3 days (OR = 0.65, 95% CI: 0.32–1.30), or more than 3 days (OR = 0.30, 95% CI: 0.13-0.68) in the past month smokers who did not quit (p = 0.033) (see Table 2).

3.3. PHQ-2 scores at follow-up in smoking quitters vs. non-quitters

3.3.1. SMI group

In the fully adjusted model, smokers who quit did not have significantly different mean depression scores compared to smokers who did not quit (2.12 vs. 2.28, p = 0.481) (see Table 3).

3.3.2. Non-SMI group

In the fully adjusted model, smokers who quit did not have significantly different mean depression scores compared to smokers who did not quit (0.89 vs. 1,10, p = 0.108) (see Table 3).

3.4. PROMIS anxiety scores at follow-up in smoking quitters vs. non-quitters

3.4.1. SMI group

In the fully adjusted model, smokers who quit had significantly lower mean anxiety scores than smokers who did not quit (57.43 vs. 60.37, p = 0.009) (see Table 4).

3.4.2. Non-SMI group

In the fully adjusted model, smokers who quit did not have significantly different mean anxiety scores compared to smokers who did

Table 2
Binge Drinking at 12-Month Follow-Up in Smoking Quitters vs Non-Quitters by SMI Group.

Model	Smoking Quitter[a]	Binge Drinking	SMI (N = 585)		Non-SMI (N = 934)	
			OR (95% CI)	p Value	OR (95% CI)	p Value
1	Yes vs No	0 days	–	0.156	–	**0.031**
		1 day	1.40 (0.58-3.36)	.	0.80 (0.43-1.47)	.
		2-3 day	0.66 (0.24-1.81)	.	0.57 (0.31-1.08)	.
		> 3 days	0.33 (0.11-0.98)	.	0.35 (0.17-0.72)	.
2	Yes vs No	0 days	–	0.218	–	**0.028**
		1 day	1.39 (0.58-3.35)	.	0.79 (0.43-1.46)	.
		2-3 day	0.66 (0.24-1.80)	.	0.56 (0.30-1.06)	.
		> 3 days	0.37 (0.12-1.10)	.	0.35 (0.17-0.71)	.
3	Yes vs No	0 days	–	0.361	–	**0.011**
		1 day	1.61 (0.65-3.98)	.	0.74 (0.40-1.39)	.
		2-3 day	0.76 (0.27-2.15)	.	0.56 (0.29-1.07)	.
		> 3 days	0.47 (0.15-1.50)	.	0.27 (0.13-0.59)	.
4	Yes vs No	0 days	–	0.424	–	**0.013**
		1 day	1.50 (0.60-3.74)	.	0.82 (0.43-1.57)	.
		2-3 day	0.75 (0.26-2.12)	.	0.57 (0.29-1.12)	.
		> 3 days	0.47 (0.15-1.52)	.	0.27 (0.12-0.60)	.
5	Yes vs No	0 days	–	0.518	–	**0.033**
		1 day	1.20 (0.46-3.16)	.	0.95 (0.48-1.89)	.
		2-3 day	0.69 (0.24-2.05)	.	0.65 (0.32-1.30)	.
		> 3 days	0.43 (0.12-1.49)	.	0.30 (0.13-0.68)	.

Model 1 is adjusted for baseline binge drinking.
Model 2 is adjusted for baseline binge drinking and intervention.
Model 3 is adjusted for baseline binge drinking, intervention, and demographics.
Model 4 is adjusted for baseline binge drinking, intervention, demographics, and social environment.
Model 5 is adjusted for baseline binge drinking, intervention, demographics, social environment, and smoking characteristics.
Note: Reported Ns are for Model 1.
Boldface indicates statistical significance ($p < 0.05$).
[a] Achieved 6-month prolonged smoking abstinence.

Table 3
PHQ-2 Depression Scores at 12-Month Follow-Up in Smoking Quitters vs Non-Quitters by SMI Group.

Model	Smoking Quitter[a]	SMI (N = 585)			Non-SMI (N = 882)		
		12-M Mean	Mean Diff	p Value	12-M Mean	Mean Diff	p Value
1	Yes	2.16	0.17	0.413	0.93	0.23	0.053
	No	2.33	.	.	1.16	.	.
2	Yes	2.14	0.19	0.356	0.93	0.24	**0.045**
	No	2.33	.	.	1.17	.	.
3	Yes	2.10	0.15	0.496	0.85	0.23	0.063
	No	2.24	.	.	1.08	.	.
4	Yes	2.04	0.15	0.481	0.84	0.23	0.069
	No	2.19	.	.	1.07	.	.
5	Yes	2.12	0.16	0.481	0.89	0.22	0.108
	No	2.28	.	.	1.10	.	.

Model 1 is adjusted for baseline PHQ-2 score.
Model 2 is adjusted for baseline PHQ-2 score and intervention.
Model 3 is adjusted for baseline PHQ-2 score, intervention, and demographics.
Model 4 is adjusted for baseline PHQ-2 score, intervention, demographics, and social environment.
Model 5 is adjusted for baseline PHQ-2 score, intervention, demographics, social environment, and smoking characteristics.
Note: Reported Ns are for Model 1.
Boldface indicates statistical significance ($p < 0.05$).
[a] Achieved 6-month prolonged smoking abstinence.

Table 4
PROMIS Anxiety Scores at 12-Month Follow-Up in Smoking Quitters vs Non-Quitters by SMI Group.

Model	Smoking Quitter[a]	SMI (N = 664)			Non-SMI (N = 980)		
		12-M Mean	Mean Diff	p Value	12-M Mean	Mean Diff	p Value
1	Yes	57.39	3.22	**0.002**	50.27	1.20	0.126
	No	60.61	.	.	51.47	.	.
2	Yes	57.27	3.37	**0.001**	50.28	1.18	0.133
	No	60.64	.	.	51.46	.	.
3	Yes	57.53	2.91	**0.006**	49.83	1.15	0.154
	No	60.44	.	.	50.98	.	.
4	Yes	57.25	2.94	**0.006**	49.82	0.94	0.250
	No	60.19	.	.	50.77	.	.
5	Yes	57.43	2.94	**0.009**	49.48	1.35	0.125
	No	60.37	.	.	50.83	.	.

Model 2 is adjusted for baseline PROMIS anxiety score and intervention.
Model 3 is adjusted for baseline PROMIS anxiety score, intervention, and demographics.
Model 4 is adjusted for baseline PROMIS anxiety score, intervention, demographics, and social environment.
Model 5 is adjusted for baseline PROMIS anxiety score, intervention, demographics, social environment, and smoking characteristics.
Note: Reported Ns are for Model 1.
Boldface indicates statistical significance ($p < 0.05$).
[a] Achieved 6-month prolonged smoking abstinence.

not quit (49.48 vs. 50.83, p = 0.125) (see Table 4).

4. Discussion

Quitting smoking was not associated with a significant difference in the odds of past month binge drinking compared to continuing smoking for those with SMI, and quitting was associated with reduced odds of binge drinking for those without SMI. In addition, quitting smoking was not associated with differences in depression scores in either group. Quitting smoking was associated with significant reductions in anxiety scores for those with SMI but was not associated with differences in anxiety scores among those without SMI.

The finding that smoking cessation was not associated with heightened binge drinking has important implications for our low-income sample. Foremost, it challenges a long-held assumption that quitting smoking and coping with nicotine withdrawal symptoms may prompt other substance use behaviors (Asher et al., 2003; Kozlowski et al., 1989). Our results suggest that any potential uptick in problematic alcohol use directly following cessation, if present at all, does not persist once an individual has been quit for a prolonged period of time.

These findings have particular relevance for smokers with SMI. First, while only a subset of smokers with SMI had a diagnosis of alcohol dependence (21.0%), this rate is far higher than that observed among those without SMI (3.9%) and among the general US population (3.5%) (Esser et al., 2014). Despite this finding, smokers with SMI also had lower overall rates of current binge drinking at baseline compared to those with SMI. This suggests that smokers with SMI, and particularly those with comorbid alcohol dependence, may be working harder to maintain their sobriety. As such, the perception that attempting cessation will exacerbate alcohol abuse behaviors likely plays a more significant role in discouraging cessation among these smokers. Our findings contradict this perception and provide additional evidence that cessation should be encouraged among smokers with SMI. It should also be noted that the SMI smokers in our sample tended to have lower self-efficacy for quitting than the non-SMI smokers, a finding which is consistent with past research (Clyde et al., 2015; Haukkala et al., 2010; Kerr et al., 2013). Providing these smokers with accurate information regarding the consequences of smoking cessation may help to boost self-efficacy for quitting by providing them with a more complete picture of how cessation could affect their propensity to drink.

In assessing our secondary aim, we were able to replicate past findings that quitting smoking is not associated with exacerbated mental health symptoms among those with mental health disorders (Cavazos-Rehg et al., 2014). Our study was also one of the first to demonstrate the beneficial effects of cessation on symptoms of anxiety among those with SMI. These results bolster the case for prioritizing smoking cessation for these smokers and increasing access to treatment.

Although baseline analyses indicate that smokers with SMI were provided with relatively high rates of cessation and treatment utilization advice from their healthcare providers, the use of individualized feedback to address cessation barriers may help to maximize the effectiveness of this advice. The Barriers to Quitting Smoking in Substance Abuse Treatment scale (BQS-SAT) can be used to assess perceived barriers to quitting (Martin et al., 2016), including concerns regarding the potential effects of cessation on mental health. Using this measure, physicians can assess these concerns and then provide smokers with more accurate information on the quitting process, thereby increasing motivation and self-efficacy for quitting.

Quitting smoking is a daunting prospect for any smoker, but it can be particularly challenging for those with a history of alcohol dependence. The high prevalence of smoking among those involved in alcohol recovery organizations like Alcoholics Anonymous (AA) may actually have a detrimental impact on these individuals' motivation to quit. While AA no doubt provides an important support network for those living with alcohol dependence, smoking remains highly prevalent among those attending AA meetings (Reich et al., 2008) and may be used as a means of coping with the urge to drink. By providing organizations such as AA with data showing that quitting smoking is not associated with higher rates of binge drinking, it may be possible to lessen its role as an effective "crutch" for those with alcohol dependence.

4.1. Limitations

A limitation of this study is that we did not have access to measures of functional impairment, which would have helped validate the SMI categorizations by verifying that these smokers were experiencing a high degree of impairment at the time of the surveys. These data were also analyzed as observational, meaning that there is the potential for unmeasured confounding to bias our effect estimates. It is possible that those who were able to quit smoking may differ from non-quitters in ways that are difficult to control for using standard covariate adjustment. The OPTIN trial was not sufficiently powered to examine whether the proactive outreach intervention itself had an effect on binge drinking, depression, or anxiety. This is an important area of research to pursue if we are to demonstrate that efforts to promote smoking cessation, including population-level interventions like OPTIN, are effective for improving mental health. In addition, while rates of smoking cessation were comparatively high in our study relative to similar trials, only 12.0% (n = 82) of those in the SMI group and 15.5% (n = 157) of those in the non-SMI group achieved prolonged smoking abstinence. This limited the power of our analyses, particularly for the binge drinking outcome. Despite these methodological limitations, our study benefitted from a much larger sample size than one of the previous studies that found a link between smoking cessation and increases in alcohol consumption (Perkins et al., 1990). We were also able to clearly establish the temporal ordering of the smoking cessation exposure and the binge drinking and mental health outcomes, which was a limitation of another study that noted a positive relationship between smoking cessation and alcohol consumption (Carmelli et al., 1993).

4.2. Conclusion

This additional evidence that quitting smoking is unlikely to exacerbate problematic binge drinking or negative mental health symptoms strengthens the case for providing all smokers with advice to quit and access to cessation resources, including those with comorbid SMI and alcohol dependence. As smoking is responsible for much of the excess mortality experienced by those with SMI (Brown et al., 2000; Campion et al., 2008), it is vital to act on evidence that smoking cessation is one of the most pressing treatment priorities for this population. Going forward we must work to disseminate this information to healthcare providers, organizations like AA, and to smokers themselves in order to eliminate this health disparity.

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Contributors

Concept and design (PJH, SSF, HAL, RW, DJE, BCT); acquisition of data (PJH, BC); analysis and interpretation of data (PJH, SSF, HAL, RW, DJE, BCT); drafting of the manuscript (PJH); critical revision of the manuscript for important intellectual content (PJH, SSF, HAL, BCT,

RW, DJE, AMJ); statistical analysis (PJH, DJE, BCT, BC) provision of patients or study materials (SSF, AMJ); obtaining funding (SSF, AMJ). All authors have read and approve the final manuscript.

Conflicts of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2018.08.043.

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