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Associations between opioid and nicotine dependence in nationally representative samples of United States adult daily smokers

Maria A. Parker[a,c,#], **Joanna M. Streck**[a,b], and **Stacey C. Sigmon**[a,b,c]

[a]Vermont Center on Tobacco Regulatory Science, University of Vermont, 1 South Prospect Street, SATC-UHC, Burlington, VT 05401, USA

[b]Department of Psychological Science, University of Vermont, 438 College Street, Burlington, VT 05401, USA

[c]Department of Psychiatry, University of Vermont, 111 Colchester Avenue, Burlington, VT 05401, USA

Abstract

Introduction—Smoking prevalence among adults with opioid dependence far exceeds that of the general population, and cessation outcomes in this group are one-fourth that of smokers without a substance use disorder. Understanding the reasons underlying these poor outcomes is critical for developing more effective smoking interventions in this group. Elevated baseline severity of nicotine dependence is associated with lower rates of smoking cessation over time. We examined whether nicotine dependence severity among smokers may vary as a function of opioid dependence status using nationally representative samples of adult smokers.

Methods—Data were derived from multiple years of the National Survey on Drug Use and Health (NSDUH, 2006–2014; n=58,971). Nicotine dependence was measured by the Nicotine Dependence Syndrome Scale (NDSS) and the first item (i.e., time to first cigarette) of the Fagerström Test for Nicotine Dependence (FTND). Opioid dependence was assessed using the Diagnostic and Statistical Manual of Mental Disorders criteria.

Results—Opioid-dependent smokers exhibited greater severity of nicotine dependence compared to non-opioid dependent smokers, as evidenced by higher mean NDSS scores ($p<0.05$). On both NDSS and FTND measures of nicotine dependence, opioid-dependent smokers were also

[#]**Correspondence:** Maria A. Parker, Vermont Center on Tobacco Regulatory Science, University of Vermont, 1 South Prospect Street, SATC-UHC, Burlington, VT 05401, Tel.: +1 802 656 0206, maria.parker@uvm.edu.

Contributors

MAP designed the study and performed the data analyses. MAP, JMS, and SCS conducted literature searches and participated in all drafts of the paper. All authors have approved the final article.

Conflict of Interest

No conflict declared.

approximately twice as likely to be dependent on nicotine than those not dependent on opioids (p's<0.05).

Conclusions—Opioid dependence is associated with increased severity and prevalence of nicotine dependence among smokers. Considering the disproportionate societal and economic burdens of smoking and smoking-related consequences in this vulnerable population, continued investigations are needed to better understand opioid-dependent individuals' poor cessation outcomes.

Keywords

Nicotine Dependence; Opioid Dependence; Cigarette Smoking; Tobacco

1. Introduction

Cigarette smoking is the leading preventable cause of morbidity and mortality in the United States (US; US Department of Health and Human Services, 2014). While smoking has steadily declined in the general population, it remains entrenched among vulnerable populations. Individuals with substance use disorders are over represented among cigarette smokers and bear a disproportionate burden of smoking-attributable disease and premature death (Hser et al., 1994). The disproportionate burden of smoking and smoking-related consequences is especially evident among individuals who misuse opioids (i.e., heroin, prescription opioids). Prevalence and persistence of cigarette smoking in individuals with opioid dependence (OD) far exceeds that of the general US adult population (Goodwin et al., 2014; Guydish et al., 2011; Jamal, 2016). Smoking in this group is also associated with significant morbidity and mortality; the mortality rate of OD smokers is four times that of OD nonsmokers (Hser et al., 1994; Hurt et al., 1996).

Most opioid-maintained patients are aware of the serious health risks associated with smoking and express interest in smoking cessation (Clemmey et al., 1997; Richter et al., 2001). However, their responses to smoking interventions are notoriously poor, with quit rates onefourth that of non-substance abusing smokers (Miller and Sigmon, 2015; Nahvi et al., 2006). Understanding the reasons underlying these poor outcomes is critical for developing more effective cessation interventions in this group. One possibility is that OD smokers may experience more severe withdrawal upon discontinuing smoking, which could undermine quit attempts. Recent data from our group, however, have suggested remarkably similar withdrawal severity between OD and non-OD smokers during abstinence (Streck et al., 2018). Another potential factor is that OD smokers may present with a greater severity of nicotine dependence (ND) more generally, and elevated baseline severity of ND is associated with lower rates of smoking cessation over time (Breslau and Johnson, 2000). The association between elevated baseline severity and poor treatment outcomes has been widely documented for other forms of drug use and clinical populations (Kampman et al., 2004; Potter et al., 2013).

In this study, we aimed to examine the association between OD status and ND severity among smokers using nationally representative data. This is the first study to our knowledge to examine whether ND severity among smokers may vary as a function of OD status. We

also sought to replicate previously reported demonstrations of elevated ND prevalence associated with OD more generally.

2. Material and Methods

2.1 Data source and sample

The National Survey on Drug Use and Health (NSDUH) is a nationally representative cross-sectional survey administered annually to assess prevalence of drug use and correlates of health among members of the US civilian, non-institutionalized population aged ≥12 years (Substance Abuse and Mental Health Services Administration, 2017). For these analyses, we used NSDUH data collected between 2006–2014 from 344,900 adult respondents (≥18 years old). We began by identifying current adult cigarette smokers who smoked in the past month. We then refined the sample to focus on daily cigarette smokers, defined as those who reported smoking every day for the past month (i.e., 30 smoking days; n=58,971 or 15.2% [weighted] of the total NSDUH sample). We focused on daily smokers, as this is the clinical population experiencing serious adverse health consequences of their smoking and showing disproportionately poor response to smoking cessation interventions (Miller and Sigmon, 2015; Nahvi et al., 2006). Prevalence of daily smoking was 71.8% (95% CI: 68.6%, 74.7%) and 61.9% (95% CI: 61.4%, 62.4%) among OD and non-OD adult smokers, respectively.

2.2 Measures

2.2.1 Opioid dependence—The NSDUH survey included questions evaluating prevalence of opioid misuse, asking respondents whether they had used prescription opioids or heroin without a prescription, to get “high” or for the experience/feeling it caused, over the past year. For those who endorsed opioid misuse in the past year, OD was assessed using the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994). Current OD was defined as endorsement of ≥3 of the following seven items: (a) spending a great deal of time over a month getting, using, or getting over the effects of opioids; (b) being unable to keep limits on use or using opioids more often than intended; (c) needing more opioids to achieve desired effect; (d) being unable to cut down or stop opioid use when intended; (e) continued opioid use despite it causing recurrent psychological or physical problems; (f) reducing or giving up activities due to opioid use; and (g) meeting criteria for opioid withdrawal syndrome.

2.2.2 Nicotine dependence—Nicotine dependence was assessed among current daily smokers using the two measures available in the NSDUH. The Nicotine Dependence Syndrome Scale (NDSS; Shiffman et al., 2004) is a 17-question validated multidimensional assessment of ND that includes questions on five domains: smoking drive, nicotine tolerance, continuous smoking, behavioral priority, and stereotypy. Each question is scored from 1 to 5 with the overall score calculated as the average and a score of ≥2.75 reflecting ND (Benowitz and Henningfield, 1994). ND was also assessed using the first item (i.e., How soon after waking do you smoke your first cigarette?) of the Fagerström Test of Nicotine Dependence (FTND; Heatherton et al., 1989), a widely used single-item measure of ND. Respondents who reported smoking within 30 minutes after waking were considered to be ND (Baker et al., 2007).

2.2.3 Statistical methods—To estimate the relationship between OD and ND in daily smokers, descriptive statistics and simple/multiple logistic regression analyses were conducted. DSM-IV criteria for current OD was the primary exposure variable; ND was the outcome variable. Twelve potential covariates were identified based upon evidence in the literature that these variables are associated with nicotine dependence: age, race/ethnicity, education, employment status, marital status, age of first daily cigarette use, cigarettes per day, presence/absence of alcohol, cannabis, and stimulant dependence, depression and anxiety. Age was based on the median year of 17 age categories from the NSDUH codebook (i.e., 18, 19, 20, 21, 22–23, 24–25, 26–29, 30–34, 35–49, 50–64, ≥65). Race/ethnicity was self-ascribed into four categories: non-Hispanic white, non-Hispanic black, Hispanic, and Other (non-Hispanic Asian, non-Hispanic Native American/Alaskan Native, non-Hispanic Native Hawaiian/ Other Pacific Islander, or non-Hispanic more than one race). Four categories were used to reflect educational level (less than high school, high school graduate, some college, college graduate). Employment also had four categories (employed full-time, employed part-time, unemployed, other [students, persons keeping house or caring for children full time, retired or disabled person, other persons not included in the labor force]). Marital status was coded as married versus unmarried (never married, divorced, and widowed). Age of first daily cigarette use and cigarettes per day, predictors of ND (Donny et al., 2008), were measured in a continuous fashion. Presence/absence of alcohol, cannabis, and stimulant dependence were represented by a NSDUH composite variable assessed similar to OD. Depression and anxiety were based on a doctor saying the respondent had the condition in the past year. All of these covariates significantly differed between OD and non-OD smokers and were adjusted for in subsequent regression models. Finally, one additional variable, survey year, was included in all multiple regression models. A linear regression model was conducted to examine whether ND severity, as represented by the mean NDSS score, differed between OD vs. non-OD smokers. Analysis and estimation steps were conducted using Stata Version 14 software procedures for regression models and complex analysis-weighted survey data (Stata Corp, 2015).

3. Results

3.1 Sample characteristics

Among the full adult daily smoker sample, the overall weighted prevalence of DSM-IV OD was 2.3% (95% CI: 2.1%, 2.4%). Demographic characteristics for OD (unweighted n=2,051) and non-OD (unweighted n=56,920) daily smokers are presented in Table 1. Relative to non-OD smokers, OD smokers were younger, more often male, white, and non-married. As noted previously, subsequent analyses adjusted for the variables on which the two groups differed.

3.2 Associations between OD and ND

With regard to the association between OD and ND severity, mean NDSS scores were significantly higher for OD vs. non-OD smokers after controlling for the characteristics that differed between groups ($\hat{\beta}$= 0.16, 95% CI: 0.12, 0.19; unadjusted $\hat{\beta}$= 0.34, 95% CI: 0.30, 0.38). Adjusted mean NDSS scores were 2.86 for OD daily smokers versus 2.70 for non-OD daily smokers. A higher prevalence of ND also was observed among OD vs. non-OD

smokers, with 80.6% and 56.6% meeting NDSS criteria for ND, respectively ($p<0.05$). A similar result was seen on the FTND, with 78.9% and 64.1% of OD and non-OD daily smokers meeting criteria for ND, respectively ($p<0.05$). In unadjusted logistic regression models, OD was significantly associated with increased odds of ND, with the odds of ND 2–3 times higher in OD vs. non-OD smokers (OR and 95% CI's = 3.2 (2.7, 3.9) and 2.0 (1.8, 2.4), respectively; Supplementary Table 1). OD represented the strongest univariate association observed with ND. The next strongest associations were seen with other forms of drug dependence (e.g., alcohol, cannabis) followed by past year depression and anxiety. In subsequent models that adjusted for the variables that differed significantly between groups, the association between OD and ND was attenuated but remained significant (Table 2). Odds of ND was about 2 times greater in OD vs. non-OD daily smokers (OR and 95% CI's = 2.0 (1.6, 2.5) and 1.6 (1.3, 1.8), respectively). Consistent with the unadjusted outcomes, the strongest associations were between OD status and ND followed by alcohol and cannabis dependence.

4. Discussion

Smoking cessation outcomes among OD smokers are one-fourth that of smokers without a substance use disorder. An improved understanding of the factors underlying these poor outcomes can aid efforts to achieve improved cessation rates in this group. While elevated ND severity is associated with lower rates of smoking cessation over time in the general smoker population, no one to our knowledge has examined whether OD is uniquely associated with greater ND severity. Using multi-year, nationally representative data we demonstrated that severity of ND varies as a function of OD status. Given the elevated severity of ND among OD smokers, efforts to develop more effective cessation interventions in this group are warranted. Combining behavioral and pharmacological treatment components that operate by different mechanisms (e.g., nicotine replacement plus cognitive–behavior therapy), for example, may produce complementary and potentially additive effects in more dependent smokers (Stitzer, 1999).

We also sought to replicate prior reports of elevated ND prevalence associated with OD more generally. Our findings are consistent with prior studies showing generally elevated rates of smoking and ND among OD individuals (Guydish et al., 2011; Wu et al., 2016). Among the demographic and drug use variables examined, the strongest relationship was found between OD status and ND. This association was attenuated but remained significant after controlling for numerous variables that differed at baseline. The association between OD and ND was consistently observed across two different measures of ND and over nine survey years.

Several potential limitations are worth noting. First, the cross-sectional nature of the NSDUH does not support causal inferences, and further studies should aim to more directly examine the relationship between OD and ND while considering the interaction with demographic characteristics. Second, while severity of ND was significantly greater among daily smokers with OD relative to non-OD smokers, this translated to an adjusted mean difference of 0.16 points on the 5-point NDSS scale, and the clinical significance of this difference is unclear. Third, our focus in this report was on daily smokers, as this is the

clinical population that is experiencing staggering adverse health consequences of their smoking and showing disproportionately poor response to smoking cessation interventions. However, future studies should examine whether OD status is associated with increased ND severity in less severe smokers, including those who smoke less than daily.

Taken together, opioid dependence is associated with increased severity of nicotine dependence among smokers. Considering the disproportionate societal and economic burdens of smoking and smoking-related consequences in this vulnerable population, continued investigations are needed to better understand opioid-dependent individuals' poor cessation outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Cessation outcomes among opioid-dependent smokers are 25% that of other smokers.
- We examined nicotine dependence severity in smokers with and without opioid dependence (OD).
- Opioid dependence was associated with increased nicotine dependence severity.
- Findings support efforts to develop more intensive interventions in OD smokers.

Table 1

Sample demographics by opioid dependence status among adult daily smokers using data from the NSDUH, 2006-2014 (n=58,971)

	Opioid Dependence n=2,051	Non-Opioid Dependence n= 56,920
Age, mean, years	**34.4 (0.8)**	**46.5 (0.1)**
Male	**61.2 (1.6)**	**52.0 (0.3)**
Race/ethnicity		
Non-Hispanic White	**84.3 (1.3)**	**78.0 (0.3)**
Non-Hispanic Black	**6.0 (0.9)**	**9.8 (0.2)**
Hispanic	7.1 (1.1)	7.6 (0.2)
Other	**2.6 (0.5)**	**4.5 (0.1)**
Education		
College graduate	**6.9 (0.9)**	**12.1 (0.2)**
Some college	29.9 (1.7)	27.0 (0.3)
High-school grad	38.7 (1.7)	39.7 (0.4)
Less than high-school	24.5 (1.5)	21.1 (0.3)
Employment		
Employed full-time	**41.1 (1.8)**	**53.5 (0.4)**
Employed part-time	13.4 (1.0)	11.8 (0.2)
Unemployed	**18.1 (1.2)**	**7.9 (0.2)**
Other (not in labor force)	27.5 (1.5)	26.8 (0.3)
Married	**19.3 (1.6)**	**41.6 (0.3)**
Age of first daily cigarette use, mean, years	**16.4 (0.2)**	**18.0 (0.04)**
Cigarettes per day, mean	**17.7 (0.3)**	**15.7 (0.1)**
Alcohol dependence	**21.8 (1.6)**	**6.5 (0.1)**
Cannabis dependence	**11.8 (1.0)**	**2.0 (0.1)**
Stimulant dependence	**7.4 (1.0)**	**0.2 (0.02)**
Depression	**30.9 (1.6)**	**11.5 (0.2)**
Anxiety	**27.8 (1.5)**	**9.5 (0.2)**

Note. All estimates are weighted percentages with standard errors and may not add to 100% due to rounding. Bolded text denotes statistical significance ($p < 0.05$).

Table 2

Adjusted odds ratios associated with nicotine dependence by opioid dependence among adult daily smokers using data from the NSDUH, 2006–2014

	NDSS		FTND	
	AOR	**95% CI**	**AOR**	**95% CI**
Opioid Dependence	**2.02**	1.64, 2.48	**1.56**	1.32, 1.84
Male	**0.77**	0.72, 0.82	**0.81**	0.75, 0.87
Race/ethnicity				
Non-Hispanic White (ref)	1.00		1.00	
Non-Hispanic Black	**0.77**	0.69, 0.86	**1.60**	1.41, 1.80
Hispanic	**0.85**	0.75, 0.96	**0.69**	0.61, 0.78
Other	**0.83**	0.71, 0.96	0.92	0.78, 1.07
Education				
College graduate (ref)	1.00		1.00	
Some college	**1.17**	1.07, 1.29	**1.36**	1.20, 1.54
High-school grad	**1.12**	1.03, 1.23	**1.66**	1.47, 1.86
Less than high-school	**1.23**	1.11, 1.36	**2.08**	1.81, 2.40
Employment				
Employed full-time (ref)	1.00		1.00	
Employed part-time	**1.13**	1.03, 1.25	**1.15**	1.05, 1.26
Unemployed	**1.36**	1.23, 1.50	**1.43**	1.29, 1.59
Other (not in labor force)	**1.34**	1.22, 1.48	**1.35**	1.23, 1.47
Married	**0.92**	0.87, 0.98	**0.82**	0.76, 0.87
Age of first cigarette	**0.95**	0.94, 0.96	**0.96**	0.95, 0.97
Cigarettes per day	**1.55**	1.52, 1.59	**1.60**	1.56, 1.64
Alcohol dependence	**1.76**	1.60, 1.94	**1.34**	1.22, 1.47
Cannabis dependence	**1.74**	1.46, 2.09	**1.33**	1.15, 1.56
Stimulant dependence	1.09	0.74, 1.61	1.15	0.79, 1.69
Depression	**1.37**	1.24, 1.52	**1.28**	1.15, 1.41
Anxiety	**1.28**	1.15, 1.42	**1.14**	1.01, 1.30

Note.

Abbreviations: AOR = adjusted odds ratio; CI = confidence interval; NDSS = Nicotine Dependence Syndrome Scale; FTND = Fagerström Test for Nicotine Dependence (time to first cigarette<30 minutes). Bolded text denotes statistical significance ($p < 0.05$). Final multiple logistic regression models included all variables in the table with NDSS and FTND as the outcome variable, respectively. Cigarettes per day was transformed to represent a 5-cigarette difference for a meaningful change in smoking. Age and survey year were also included in the model as nominal variables.