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Original investigation

Serious Psychological Distress and Smoking During Pregnancy in the United States: 2008–2014

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Abstract

Introduction: The current study examined the relationship between acute (past 30 day) and recent (past year but not past 30 day) serious psychological distress (SPD) and smoking during pregnancy among women in the United States overall, stratified by demographic characteristics, and described the change in the prevalence of prenatal smoking among women with and without SPD, from 2008 to 2014.

Methods: Data were drawn from the National Survey on Drug Use and Health (NSDUH), an annual cross-sectional study of US persons aged 12 and over. SPD and smoking in the past 30 days among pregnant women, aged 18 and older, were examined using logistic regression models. Heterogeneity in this association by demographic characteristics, trends over time, and level of cigarette consumption was also examined.

Results: Prenatal smoking was common. Almost 40% of pregnant women with acute SPD reported smoking, 23% of pregnant women with recent SPD smoked, and 11.7% of pregnant women without recent SPD smoked. No significant change was found in the prevalence of prenatal smoking from 2008 to 2014 in any of these groups. Robust relationships were found between acute (*OR* = 5.05 [3.64–6.99]) and recent SPD (*OR* = 2.37 [1.74–3.24]) and smoking; these findings remained after adjusting for demographics.

Conclusions: SPD and smoking during pregnancy are strongly associated; this relationship is present across all sociodemographic groups and the prevalence of smoking in pregnancy has remained relatively unchanged over the past decade both in the presence and absence of SPD.

Implications: SPD and smoking in pregnancy are robustly linked; the prevalence of smoking in pregnancy is extremely high in women with SPD. Screening women with mental health problems

for prenatal smoking, as well as screening pregnant smokers for mental health problems, seems warranted and may assist more women in seeking and utilizing treatment options. Efforts to reduce the prevalence of smoking during pregnancy might specifically target women with SPD, where the potential for impact is substantial.

Introduction

Prenatal smoking has been associated with multiple hazards to the developing fetus,[1] including but not limited to increased risk of low birth weight,[2] premature birth,[3] cognitive development,[4] respiratory health,[5,6] congenital gastrointestinal disorders,[7] higher risk of smoking during adolescence,[8] and potential neurodevelopmental disorders.[9–11] Despite these risks, it is estimated that one in ten pregnant women in the United States smoke cigarettes.[12]

Over the past several decades, the prevalence of cigarette smoking has declined significantly among some but not all segments of the adult population in the United States.[13] Along with increasing socioeconomic disparities in smoking in the general population,[14] numerous reports have suggested mental health disparities in smoking rates.[15,16] Specifically, recent data suggest that smoking appears to be declining among those without mental health problems while the prevalence of smoking has remained unchanged or may be increasing among those with mental health problems.[17] Evidence suggests smoking rates among pregnant women have remained relatively stable over the previous decade,[12] however the role of mental health disparities and smoking among pregnant women has not been examined.

Smoking during pregnancy disproportionately affects particular groups of women. Rates of smoking are highest among those who are younger, have lower educational status, and lower income.[2] Despite the identification of these risk groups, epidemiological research has yet to generate adequately actionable knowledge of modifiable risk factors for smoking in pregnancy. While mental health problems vary in prevalence among pregnant women depending on the population, many mental health problems are infrequently detected.[18] In addition, depressed pregnant women are less likely to report smoking to a clinician.[19] Yet, mental health problems, such as depression and anxiety, are "modifiable" (ie, highly treatable in a majority of cases) and treatment benefits both the mother and fetus. In addition to the positive mental health benefits to the mother, direct links between poor mental health and risk to offspring have been documented fairly extensively.[20–23] Prior studies have shown that mental health problems are associated with increased likelihood of prenatal tobacco use,[24,25] and may be a barrier to smoking cessation during pregnancy.[26,27] Findings however, are mixed and it is possible that there are interactions between depression and various demographic characteristics in terms of whether depression predicts cessation and increases risk of relapse.[28–30] Epidemiologic studies from various countries including the United States,[25,31] the Netherlands,[32] Scotland, and other nations[33,34] have demonstrated that pregnant women with high levels of psychosocial stress, depression or anxiety are more likely to report prenatal tobacco use, compared with those without. Several studies suggest smoking leads to increased anxiety and depression[35–39] as well as the reverse (ie, mental related to increased smoking).[40,41] The relationship between mental health and smoking status may well be bidirectional and could result from uncontrolled confounding due to exposure to common risk factors for both smoking and mental health problems. Results from studies among nonpregnant adults in the community suggest that the relationship between smoking and mental health problems may well be causal and bidirectional but the weight of the evidence to date does not suggest the entire relationship is due to confounding.[42] A comprehensive longitudinal assessment of the relationship between mental health and smoking among pregnant women has not been completed.

Several questions, therefore, remain unclear. First, current information on the relationship between mental health problems and smoking among pregnant women is needed, as the most recent data on the link between mental health problems and prenatal smoking in the United States are nearly a decade old,[25] though recent data from various countries suggest a persistent problem.[43] Second, in previous research, the timeframes used for the assessment of mental health problems in terms of the proximity to cigarette use during pregnancy were approximate.[25,43] It remains unclear whether the positive associations are limited to pregnant women whose mental health problems are current, or if those with a recent history of mental health problems are also at risk for prenatal smoking. Understanding the degree of smoking risk in terms of history versus current mental health problems could be critical in directing interventions to target pregnant women to those who are most vulnerable. Third, while both prenatal smoking and mental health problems are disproportionately common among those of lower socioeconomic status, to the best of our knowledge, no prior US study has examined the relationship between mental health problems and prenatal tobacco use stratified by important demographic characteristics. This is critical for at least two reasons. In terms of resource allocation and identification of intervention targets, it is necessary to determine if specific vulnerable segments of the population are bearing disproportionate risk for prenatal tobacco use. Further, it is important to understand whether mental health problems are more strongly linked with prenatal tobacco use in some segments of the population than others so that tailored interventions and treatments are made accessible to those in greatest need. Fourth, to our knowledge, the degree to which mental health problems are associated with higher levels of cigarette consumption during pregnancy, compared to increased likelihood of any cigarette consumption, remains unclear. As prior studies in the general population have suggested a dose–response relationship between prenatal exposure to tobacco and risk to the fetus,[44–46] a better understanding of the level of exposure that prenatal mental health problems pose in terms of in utero tobacco exposure is warranted.

The current study aims to begin to fill these gaps by addressing four main aims. First, the study investigates the relationship between acute (past 30 day) and recent (past year, but not past 30 day) mental health problems and prenatal cigarette use compared to pregnant women without mental health problems in the United States. Second, the study investigates the relationship between acute and recent mental health problems and prenatal cigarette use by demographic subgroups. Third, the study investigates the change in the prevalence of cigarette use among pregnant women with, compared to pregnant women without, mental health problems, from 2008 to 2014, adjusting for changes in demographic characteristics. Fourth, the study examines the relationship between acute and recent mental

health problems and level of cigarette consumption, among pregnant women in the United States who smoke.

Methods

Data and Population

Data were drawn from the public-use data files from the National Survey on Drug Use and Health (NSDUH) years 2008–2014. As described in detail elsewhere, the NSDUH provides annual cross-sectional national data on the use of tobacco, other substance use, and mental health in the United States. [47–54]

There were a total of 391 753 NSDUH respondents for the years 2008–2014. Of these, we excluded 187 979 men and 95 080 women aged <18 or >44. Of the 108 694 women aged 18–44, N = 5520 women (4.04%, population weighted) reported being pregnant at the time of the interview. We further excluded a small number who could not be classified with regard to smoking category (N = 78), resulting in a total study population of N = 5442.

Measures

Serious Psychological Distress

Non-specific psychological distress was assessed among NSDUH respondents aged 18 and over using the K6 screening instrument,[55,56] which has been validated in pregnant women.[57] The K6 is a 6-item scale measuring the frequency during which a respondent has felt nervous; hopeless; restless or fidgety; sad or depressed; that everything was an effort; or down on oneself, no good, or worthless in the past 30 days or past year. Responses were on a 1 to 5 scale with 1 representing "all of the time" and 5 representing "none of the time." After transforming the responses so that "none of the time" was coded as 0 and "all of the time" as 4, scores of 13 or greater on this scale were classified as indicating serious psychological distress (SPD). Beginning in 2008, these symptoms were assessed for two time points, over the past 30 days or during the month in the past year when the participant felt the most distressed, if this was a time period other than the past 30 days. For the current analysis, pregnant women were classified into three groups: (1) experiencing SPD in the past month ("acute SPD"), (2) experiencing SPD in the past year but not the past month ("recent SPD"), or (3) not experiencing SPD in the past year (also referred to as "no SPD").

Smoking

Pregnant women were categorized as currently smoking if they: (1) responded "yes" to the question "During the past 30 days, have you smoked part or all of a cigarette?" and (2) reported a lifetime use of 100 or more cigarettes. They were classified as not currently smoking if they responded "no" to the question about past 30-day use, or reported never having smoked part or all of a cigarette. The small number (n = 78) of women who reported cigarette smoking in the past 30 days but fewer than 100 cigarettes used within their lifetimes were excluded from analyses. Among current smokers, the number of cigarettes per day (CPD) was calculated based on the number of days in the past month that they reported smoking and the average number of cigarettes smoked per day that cigarettes were used.

Covariates

The following demographic covariates, identified in the literature as commonly linked to both smoking rates and mental health status, were incorporated into these analyses in order to address potential confounding and to explore heterogeneity in the association between SPD and smoking during pregnancy: respondent age, highest level of education, current marital status, current household income, and race. Categorical measures were used for each covariate as shown in Table 1.

Statistical Analysis

To describe the population, the frequency of demographic characteristics among pregnant women overall and by the 3-group SPD category were calculated and differences by SPD group were assessed using chi-squared tests. To determine whether SPD was associated with current prenatal smoking and whether this relationship differed by past 30 day and past year, but not past 30-day SPD, logistic regression models were fit to regress current smoking status by the 3-group SPD variable, unadjusted and adjusted for demographic covariates and calendar year (categorical). SPD × covariate product terms were added to the model to produce stratum-specific odds ratios and to test for interaction on the multiplicative scale.

To determine whether the prevalence of smoking among pregnant women changed over the 2008–2014 time period, and whether time trends varied depending on the presence and timing of SPD, the annual prevalence of current smoking by the 3-group SPD were calculated, and logistic regression models were fit using a linear term for calendar year, and year × SPD interaction. Thus, an odds ratio below 1.0 estimated from the coefficient for the linear year term would indicate a decrease over the study period in the prevalence of smoking during pregnancy. Time was modeled using a linear term because the question of interest was whether an overall change had occurred over the study period not necessarily during any 1 year.

Finally, to determine whether SPD was related to the quantity of prenatal smoking, the mean daily number of cigarettes smoked over the past 30 days was calculated by the 3-group SPD category for current smokers only. A linear regression model examining the number of cigarettes smoked per day associated with SPD category was fit, and reported for the unadjusted and adjusted for covariates models. All analyses were conducted using SAS-callable SUDAAN version 11.0.1 (RTI International, Research Triangle Park, NC) and incorporated survey weights to account for the complex sampling design. All results, other than raw counts, were adjusted for sampling weights.

Results

Demographic Characteristics of US Pregnant Women Aged ≥18, Overall and by the Presence of SPD

Overall, one-half of pregnant women in the United States during this time period were between the ages of 26–34; the majority were married and were white; and the range of income and education levels were represented across the spectrum (see Table 1). The distribution of each characteristic examined varied significantly (p < .05) by category of SPD. Specifically, pregnant women with acute SPD were most likely to fall into the youngest age category (18–25), followed by women with recent SPD. Pregnant women with acute SPD were less likely to be married than those in the other two groups; and were about twice as likely to be widowed/married/divorced or to be never married than were those with no SPD (see Table 1). Having a high school or less than high school education was more common among pregnant women with acute SPD than among those in the other two groups. Pregnant women with acute SPD were twice as likely to be in the lowest income group as those with no SPD and less likely to be in the highest income group. White women made up

a greater proportion of those with recent SPD relative to other categories, while black women were more frequent among those with acute SPD.

SPD and Current Smoking Among Pregnant Women

Overall, 14.01% of pregnant women were current smokers (Table 2). Of pregnant women with acute SPD, 40% reported current smoking (see Table 2). Acute SPD was associated with a significantly greater likelihood of prenatal smoking compared to pregnant women with no SPD (40.03% vs. 11.69%; odds ratio [*OR*] = 5.05 [3.64, 6.99]; see Table 2), and this association remained after adjusting for demographic characteristics (adjusted odds ratio [*AOR*] = 3.04 [1.88, 4.93]). Recent SPD was also associated with significantly increased prevalence of prenatal smoking compared to pregnant women with no SPD (23.91%; vs. 11.69% *OR* =2.37 [1.74, 3.24]). This association was modestly attenuated and remained significant following adjustment for demographics (*AOR* = 1.98 [1.36, 2.89]).

Table 1. Demographic Characteristics of US Pregnant Women Aged ≥18, Overall and by the Presence of SPD, NSDUH 2008–2014

			By 3-group SPD category						
	Overall (*N* = 5442)		None (*N* = 4620)		Past year/not past month (*N* = 454)		Past month (*N* = 368)		
Characteristic	%	(*SE*)	%	(*SE*)	%	(*SE*)	%	(*SE*)	*p**
Age									<.0001
18–25	37.0	(1.0)	35.0	(1.1)	46.6	(3.6)	57.3	(4.3)	
26–34	50.0	(1.0)	52.0	(1.1)	36.4	(3.9)	33.9	(4.4)	
≥35	13.0	(0.9)	13.0	(0.8)	17.0	(3.6)	8.8	(3.3)	
Marital status									<.0001
Married	61.2	(1.1)	63.6	(1.1)	53.4	(4.0)	30.6	(4.2)	
Widowed/divorced/separated	6.2	(0.5)	5.7	(0.5)	10.0	(2.1)	10.3	(2.3)	
Never married	32.6	(1.0)	30.7	(1.1)	36.7	(3.7)	59.2	(4.3)	
Education									<.0001
<High school	15.3	(0.7)	14.9	(0.8)	13.3	(2.1)	26.3	(3.2)	
High school graduate	25.8	(0.9)	24.6	(1.0)	27.4	(3.1)	44.4	(3.9)	
Some college	25.3	(1.0)	24.9	(1.1)	33.1	(4.1)	21.8	(3.6)	
College grad or above	33.6	(1.2)	35.7	(1.4)	26.2	(3.6)	7.5	(2.3)	
Income									<.0001
≤$20 000	22.1	(0.9)	20.8	(1.0)	24.9	(3.0)	41.1	(4.4)	
$20–49 999	30.5	(1.2)	30.1	(1.2)	30.0	(3.1)	38.2	(4.3)	
$50–74 999	17.1	(0.7)	17.4	(0.8)	16.8	(2.9)	12.8	(3.0)	
≥$75 000	30.3	(1.2)	31.7	(1.3)	28.4	(3.7)	7.9	(2.5)	
Race									.013
White	59.1	(1.2)	58.5	(1.3)	67.9	(2.9)	57.1	(4.4)	
Black	14.0	(0.8)	14.0	(0.8)	11.2	(1.9)	18.6	(3.6)	
Hispanic	18.2	(0.9)	18.5	(0.9)	14.1	(1.9)	19.3	(3.4)	
Other	8.7	(0.7)	9.0	(0.7)	6.7	(1.6)	5.1	(1.5)	

NSDUH = National Survey on Drug Use and Health; *SE* = standard error; SPD = Serious Psychological Distress. Acute SPD reflected in past month; Recent SPD reflected in past year/not past month.

*From chi-square test for difference in characteristic distribution between 3 SPD categories.

Table 2. The Association of Current Smoking With Past-Month and Past-Year SPD Among Pregnant Women, NSDUH 2008–2014

	Prevalence of current smoking			Unadjusted *OR*	*p*	Adjusted *OR*[a]	*p*
	N	%	(*SE*)	(95% CI)		(95% CI)	
All pregnant women[b]	1020	14.01	(0.7)	—	—	—	—
By 3-group SPD category							
Past-month SPD	153	40.03	(3.87)	5.05 (3.64, 6.99)[c]	<.0001	3.04 (1.88, 4.93)[c]	<.0001
Past-year/not past-month SPD	128	23.91	(2.70)	2.37 (1.74, 3.24)	<.0001	1.98 (1.36, 2.89)	.0005
No past-year SPD	739	11.69	(0.66)	Ref	—	Ref	—

CI = confidence interval; NSDUH = National Survey on Drug Use and Health; *OR* = odds ratio; *SE* = standard error; SPD = Serious Psychological Distress. Acute SPD reflected in past month; Recent SPD reflected in past year/not past month.

[a]Adjusted for age, education, income, marital status, and race, using categories as shown in Table 1; and calendar year (categorical).

[b]Based on 5442 women aged ≥18 who reported being pregnant at the time of the survey. All statistics other than raw counts have been weighted to account for the survey.

[c]Unadjusted *OR* for smoking among pregnant women reporting past-month SPD differed from *OR* for smoking among pregnant women reporting past-year/no past-month SPD ($p = .0017$). Adjusted estimates did not significantly differ ($p = .17$).

SPD and Smoking Among Pregnant Women, Stratified by Demographic Characteristics

Age and Marital Status

There was no statistical evidence of variation in the association between acute and recent SPD and smoking among pregnant women by age or marital status (see Table 3).

Race

The association between acute SPD and prenatal smoking was stronger among Hispanic women (*OR* = 11.65 [3.96, 34.27]) than among white women (*OR* = 2.99 [1.58, 5.63]) and those of Other race (*OR* = 3.11 [1.04, 9.26]; p_{int} = .07 for Hispanic vs. white women). Recent SPD was only associated with increased smoking during pregnancy among white women (*OR* = 1.82 [1.19, 2.79]), however the *OR* estimates did not vary significantly between categories of race (see Table 3).

Education and Income

The association between acute SPD and prenatal smoking was significantly stronger among those with a higher education (college degree or above) (*OR* = 60.19 [12.05, 300.63]) compared to women in the lower education categories with *OR*s ranging from 2.05 (1.06, 3.96) for high school graduates to 3.17 (1.39, 7.22) for those with less than a high school education (p_{int} < .05 for comparisons vs. each of the three other categories). Likewise, the association between recent SPD and prenatal smoking was significantly stronger among those with a college degree or above (*OR* = 6.41 [1.79–22.93]) versus those with some college or less than high school (1.57 [0.83–2.98] and 1.53 [0.74–3.17], respectively). For income categories, the strength of the association between acute SPD and odds of smoking increased with increasing income (*OR* [95% CI] = 24.3 [3.84, 153.2] for income ≥$75 000 vs. 1.93 [1.13, 3.30] for income ≤$20 000; see Table 3). The association between recent versus no SPD and prenatal smoking did not vary by income level.

Time Trends in Prevalence of Current Smoking Among Pregnant Women From 2008 to 2014, Overall and by SPD

The prevalence of smoking (past 30 days) among pregnant women in the United States decreased significantly from 2008 to 2014 (15.6% vs. 10.72%, *OR* [95% CI = 0.95 {0.90, 1.00}], however this decline was no longer statistically significant after adjusting for demographic differences [*AOR* = 0.97 {0.91, 1.03}], see Table 4).

Annual estimates for the prevalence of smoking by SPD category are shown in Supplementary Figure 1. Among pregnant women with acute SPD, the prevalence of current prenatal smoking did not change from 2008 to 2014 (33.44% vs. 41.33%, *OR* = 1.00 [0.85, 1.17] see Table 4), nor was a significant linear trend observed for the prevalence of smoking among pregnant women with recent SPD (21.1% vs. 30.17%, *OR* = 0.96 [0.82, 1.12]). Among pregnant

Table 3. The Association of Current Smoking With Past-Month and Past-Year SPD Among Pregnant Women, by Demographic Characteristics, NSDUH 2008–2014

	Unadjusted prevalence of current smoking						
	Past-month SPD	Past-year, not past-month SPD	No past-year SPD	Past-month SPD vs. no SPD		Past-year/not past-month vs. no SPD	
Characteristic	% (*SE*)	% (*SE*)	% (*SE*)	*OR*[a] (95% CI)	p_{int}*	*OR*[a] (95% CI)	p_{int}*
Age							
18–25	40.1 (3.7)	30.2 (3.2)	16.3 (0.8)	2.70 (1.90, 3.83)	.53	1.92 (1.37, 2.68)	.58
26–34	41.1 (8.5)	19.3 (5.1)	9.9 (1.1)	3.80 (1.40, 10.33)	Ref	2.40 (1.10, 5.24)	Ref
≥35	35.5 (19.8)	16.4 (8.9)	6.5 (1.6)	2.64 (0.05, 147.4)	.86	1.42 (0.34, 5.88)	.52
Marital status							
Married	32.2 (8.0)	11.9 (3.3)	5.8 (0.6)	4.17 (1.47, 11.83)	Ref	1.93 (0.88, 4.25)	Ref
Widowed/divorced/separated	60.1 (10.1)	54.8 (11.0)	37.4 (4.9)	1.97 (0.54, 7.20)	.37	2.51 (0.76, 8.29)	.72
Never married	40.6 (4.6)	33.0 (4.1)	19.1 (1.2)	2.79 (1.64, 4.76)	.51	1.89 (1.24, 2.88)	.96
Education							
<High school	53.3 (6.8)	40.3 (7.2)	22.1 (2.1)	3.17 (1.39, 7.22)	.002	1.53 (0.74, 3.17)	.05
High school graduate	33.9 (6.0)	32.4 (6.0)	18.0 (1.3)	2.05 (1.06, 3.96)	.001	2.14 (1.21, 3.79)	.11
Some college	34.8 (8.3)	22.4 (5.0)	14.0 (1.7)	2.83 (1.13, 7.12)	.002	1.57 (0.83, 2.98)	.05
College grad or above	44.6 (15.9)	8.6 (4.4)	1.4 (0.4)	60.19 (12.05, 300.6)	Ref	6.41 (1.79, 22.93)	Ref
Income							
≤$20 000	40.3 (5.1)	34.0 (5.0)	22.7 (1.5)	1.93(1.13, 3.30)	.01	1.72 (0.98, 2.99)	.53
$20–49 999	32.0 (6.2)	34.9 (5.6)	15.3 (1.3)	2.16 (1.08, 4.32)	.02	2.25 (1.23, 4.10)	.84
$50–74 999	53.3 (13.7)	13.5 (6.1)	8.5 (1.3)	7.49 (1.86, 30.22)	.34	1.63 (0.41, 6.44)	.61
≥$75 000	56.2 (16.2)	9.6 (4.1)	2.9 (0.6)	24.26 (3.84, 153.2)	Ref	2.54 (0.89, 7.24)	Ref
Race							
White	52.3 (5.2)	29.0 (3.5)	15.8 (1.0)	2.99 (1.58, 5.63)	Ref	1.82 (1.19, 2.79)	Ref
Black	22.8 (7.5)	16.0 (5.6)	11.1 (1.6)	1.62 (0.62, 4.24)	.30	2.23 (0.84, 5.89)	.70
Hispanic	18.9 (6.8)	5.3 (2.5)	2.0 (0.4)	11.65 (3.96, 34.27)	.03	2.74 (0.88, 8.57)	.49
Other	44.9 (15.9)	24.7 (11.1)	6.0 (1.2)	3.11 (1.04, 9.26)	.95	4.29 (0.94, 19.68)	.29

CI = confidence interval; NSDUH = National Survey on Drug Use and Health; *OR* = odds ratio; *SE* = standard error; SPD = Serious Psychological Distress. Acute SPD reflected in past month; Recent SPD reflected in past year/not past month. Acute SPD reflected in past month; Recent SPD reflected in past year/not past month.

[a]Adjusted for all other variables listed in the table, and calendar year (categorical).

*p_{int}, *p*-value from *t* test for product term beta = 0; test for multiplicative interaction.

Table 4. The Prevalence of Current Smoking by Past-Year or Past-Month SPD Among Pregnant Women by Year, NSDUH 2008–2014

									Linear trend			
	Total	2008	2009	2010	2011	2012	2013	2014	Crude *OR* (95% CI)	*p*	Adjusted *OR*2[a] (95% CI)	*p*
Total												
Current smoker, %	14.0	15.6	12.2	19.0	14.9	11.9	13.7	10.7	0.95 (0.90, 1.00)	0.03	0.97 (0.91, 1.03)	0.27
SE	0.7	2.0	1.5	2.0	1.9	1.3	2.0	1.4				
By 3-group SPD category												
With past-month SPD												
Current smoker, %	40.0	33.4	48.3	54.4	32.0	35.2	41.4	41.3	1.00 (0.85, 1.17)	0.98	1.07 (0.85, 1.35)	0.57
SE.	3.9	9.1	10.5	10.9	9.9	8.9	11.5	9.4				
With past-year, not past-month SPD												
Current smoker, %	23.9	21.1	32.9	37.2	19.7	10.4	18.4	30.2	0.96 (0.82, 1.12)	0.59	0.93 (0.75, 1.15)	0.49
SE.	2.7	6.7	7.3	10.7	8.0	4.1	5.8	8.2				
Without past-year SPD												
Current smoker, %	11.7	14.2	8.8	16.4	13.2	10.7	11.2	7.2	0.93 (0.88, 0.98)	0.01	0.95 (0.89, 1.01)	0.10
SE.	0.7	2.1	1.3	2.1	1.9	1.6	2.1	1.2				
F test for time trends vary by SPD category									*F*(2 df) = 0.42;		*F*(2 df) = 0.50;	
p-value for variation in time trends by SPD category									*p* = .66		*p* = .61	

CI = confidence interval; NSDUH = National Survey on Drug Use and Health; *OR* = odds ratio; *SE* = standard error; SPD = Serious Psychological Distress. Acute SPD reflected in past month; Recent SPD reflected in past year/not past month.

[a]Adjusted for age (18–25, 26–34, ≥35); education (<HS, HS grad, some college, ≥college grad); income (≤$20 000, 20–49 999, $50–74 999, ≥$75 000); marital status (married, widowed/divorced/separated, never married) and race (white, black, Hispanic, other).

women with no SPD, the prevalence of current smoking declined over this time period (14.15% vs. 7.2%, *OR* = 0.93 [0.88, 0.98]), though the change ceased to retain statistical significance after adjusting for demographics (*AOR* = 0.95 [0.89, 1.01]).

SPD and CPD Among Pregnant Women Currently Smoking

Among current smokers, the mean number of CPD did not differ significantly between pregnant women who reported acute SPD (*M* = 9.37 [1.05]), recent SPD (*M* = 8.83 [1.25]) and no SPD (*M* = 8.12 [0.37] see Supplementary Table 1). No change in these results was seen after adjusting for demographic characteristics.

Discussion

The overarching goal of this study was to investigate the relationship between psychological distress and cigarette use among pregnant women in the United States, and to examine these relationships by demographic groups and over time. A strong relationship between mental health problems and prenatal smoking was found; the closer the temporal proximity of the mental health problems (acute SPD), the stronger the relationship. Second, the prevalence of smoking during pregnancy was similarly high among women with acute SPD across all levels of education and income. This is in contrast to the decreasing prevalence of prenatal smoking seen with increasing levels of education and income. Third, there has been no decline in prenatal smoking in recent years and those with mental health problems continue to bear a disproportionate burden of prenatal cigarette use. Finally, no relationship between mental health problems and level of cigarette consumption among pregnant women who smoke was observed.

Our results extend upon previous research and suggest that across all demographic groups, the timing (ie, the acute/immediate presence of SPD during pregnancy) is a critical factor in the link with prenatal tobacco use. We found women with acute SPD had levels of prenatal smoking over four times higher than that of those women who did not report SPD (40.03% vs. 11.69%) and a threefold increase in odds of prenatal smoking remained after adjusting for demographic factors. Recent, but not acute SPD was also associated with twofold increase in odds of current prenatal smoking, versus no SPD.

Our findings build upon prior research in the measurement of mental health problems in several ways. Prior population-based studies[25] could not confirm that the report of mental health problems occurred during pregnancy since time periods were limited to the assessment of past-year and/or lifetime mental health conditions. Therefore, it is conceivable from prior reports that the mental health condition was not concurrent with pregnancy/prenatal smoking. The current study overcomes this limitation with this assessment. A second distinction is that current study used a composite measure of mental health while prior studies have specifically assessed depression and anxiety. The K6 is a valid measure of a wider spectrum of mental health problems and may capture better women at risk for smoking while including features of anxiety and depression.[58]

The finding of mental health related to prenatal smoking has critical implications for both clinical intervention and future research. Other studies among nonpregnant or a random general population of adults have found that a history of remitted depression was not associated with smoking.[59] If that were the case among pregnant women as well, then the implications for interventions might exclusively focus on pregnant women with acute mental health concerns and not pregnant women with a history of mental health problems. However, we found that overall pregnant women with recent SPD without acute/current SPD had increased odds of prenatal smoking even after adjusting for important demographic factors. This finding points to the need to address women's mental health before and between pregnancies to target reduction of smoking during pregnancy. In fact, there is growing awareness that to achieve optimum health during pregnancy, clinicians, and public health practitioners must focus on periconceptual health.[60] Furthermore, acute SPD was strongly associated with increased prenatal smoking overall and among nearly every demographic subgroup particularly Hispanic women, and pregnant women with higher education and income, due potentially to the very low rates of prenatal smoking among women with no SPD from these subgroups.

It is notable that SPD was most strongly associated with greater prevalence of cigarette smoking among those with higher education/income. This finding is the result of particularly low baseline rates of smoking among pregnant women with no SPD. For example, among those in the highest education category (college grad or above) only 1.4% of pregnant women with no SPD reported smoking cigarettes, compared to 44.6% of those with SPD. This pattern of findings suggests that SPD accounts for a substantially greater "proportion" of smoking among pregnant women with high income/education (ie, higher attributable proportion). Among pregnant women with lower education/income, smoking prevalence was high even among those with no SPD (eg, 22.1% among those with less than high school education). More research is needed to understand prenatal smoking specifically in these vulnerable and distinct subgroups of pregnant women.

The direction of this relationship—and whether or not it may be causal—cannot be determined from these data. Given the strength of the relationships observed, further research on the mechanisms underlying these links is needed in order to develop effective preventive and intervention strategies. In addition, our lack of information on several potentially relevant confounders, such as trauma and negative life events, the possibility that the link is affected by uncontrolled and unmeasured confounding remains. Regardless, in terms of suggestions for updating clinical services, our finding suggests that women who smoke during pregnancy are likely to be suffering from and in need of improved mental health screening, assessment, and access to mental health care services. Among pregnant women who were current smokers, 14.4% had acute SPD, versus 3.5% of pregnant women who were not current smokers. Likewise, among pregnant women who were current smokers, 12.5% had recent SPD, versus 6.5% of pregnant women who were not current smokers. While traditional prenatal smoking screening programs have focused on messages of smoking cessation, our results suggest that women screening positive for prenatal smoking may be in need of additional mental health evaluation and/or services to improve both their mental health and their likelihood of smoking cessation. Since a majority of mental health problems in pregnancy are missed,[18] screening for prenatal smoking, which is routinely conducted during prenatal care, could also serve as a useful indicator for further mental health evaluations.

Our finding that there has been no overall change in the prevalence of prenatal smoking in the United States from 2008 to 2014 is concerning but consistent with previous research.[2] The stagnant rate of prenatal smoking is concerning and highlights the ineffective messages and screening programs developed that target and resonate with pregnant

women. Given the myriad negative effects associated with smoking for both the mother and developing fetus, this finding highlights the need for innovative approaches that address this public health issue. Our findings suggest that a holistic approach that addresses both smoking cessation and mental health might be part of such innovative solutions.

Our failure to find a link between mental health problems and level of cigarette consumption was somewhat surprising, as a number of studies in the past have suggested a dose–response relationships between mental health problems and cigarette consumption in the general population.[61] Yet, more recent data suggest that this overall trend may be changing perhaps due to the increased cost of cigarette and the promotion of smoke-free regions that may contribute to the decline in the number of cigarettes despite the fairly constant prevalence of "any smoking/being a smoker."[62] It is potentially of interest, however, to note that the number of CPD is fairly substantial—with the mean number of daily cigarettes averaging at 10 per day. As prior studies have suggested, the level of in utero exposure is directly related to potentially teratogenic effects on the fetus,[63–67] this is cause for concern and further work both in terms of intervention and prevention. While smoking cessation is the goal for optimal health effects for mother and offspring, even reduction to fewer cigarettes (ie, harm reduction) would be beneficial. Future studies that can equally target smoking reduction and smoking cessation will be needed.

In light of the risks associated with mental health problems that can directly harm the developing fetus, and the mounting evidence relating mental health to prenatal smoking, an increased emphasis on universal mental health screening in early pregnancy,[68] may have the potential to reduce both prenatal tobacco use and improve maternal and infant outcomes.

Supplementary Material

Supplementary data are available at *Nicotine & Tobacco Research* online.

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Declaration of Interests

None declared.

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