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Relationships Between Self-Reported Smoking, Household Environmental Tobacco Smoke Exposure and Depressive Symptoms in a Pregnant Minority Population

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Abstract This study sought to examine relationships between depressive symptoms and prenatal smoking and/or household environmental tobacco smoke exposure (HH-ETSE) among urban minority women. We analyzed private, audio computer-assisted self interview data from a clinic-based sample of 929 minority pregnant women in Washington, DC. Depressive symptoms were assessed via the Beck Depression Inventory Fast Screen. HH-ETSE, current smoking, and former smoking were assessed via self-report. Depression levels and demographic characteristics were compared: (1) among nonsmokers, for those reporting HH-ETSE versus no HH-ETSE; and (2) among smokers, for those reporting current smoking (in last 7 days) versus former smokers. Measures associated with HH-ETSE/current smoking in bivariate analysis at $P < 0.20$ were included in adjusted logistic regression models. HH-ETSE, as a possible indicator of a social smoking network, was assessed as a mediator for the relationship between depression and current smoking. Results: Non-smokers reporting moderate-to-severe depressive symptoms showed significantly higher adjusted odds of prenatal HH-ETSE (AOR 2.5, 95% CI [1.2, 5.2]). Smokers reporting moderate-to-severe or mild depressive symptoms showed significantly higher adjusted odds of current smoking (AOR 1.9, 95% CI [1.1, 3.5] and AOR 1.8, 95% CI [1.1, 3.1], respectively). Among smokers, HH-ETSE was a significant mediator for the association between moderate-to-severe symptoms and current smoking. In conclusion, health care providers should be aware that depressed urban minority women are at risk of continued smoking/HH-ETSE during pregnancy. Interventions designed to encourage behavior change should include screening for depression, and build skills so that women are better able to address the social environment.

Clinical trial registration: ClinicalTrials.gov, http://www.clinicaltrials.gov: NCT00341432.

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Background

Nicotine exposure during pregnancy increases health risks for fetuses. Both active smoking and environmental tobacco smoke exposure (ETSE) during pregnancy are associated with adverse maternal conditions [1, 2] and poor pregnancy outcomes such as neonatal mortality and stillbirth, preterm delivery, low birthweight and sudden infant death syndrome [3–8].

Despite declines in smoking and ETSE [9–11], 11.4% of pregnant American women smoked in 2002 [7]; their estimated rates of ETSE range from 21% [12] to 37% [13] to 52% [14].

Although rates of smoking in African American (AA) women are generally the same as Whites, (19.2% AA, 19.8% White, 9.8% Hispanic) [10], AA women and their infants experience more negative effects from smoking and ETSE than Whites [15–17]. AA smokers have consistently higher serum cotinine levels per cigarette than White smokers [18]. Among nonsmokers with ETSE, AA women also have higher cotinine levels [19], in part attributable to possible biological differences. Benowitz et al. [20] proposed that cotinine clearance is slower in AAs than in Whites because of slower oxidative metabolism of nicotine to cotinine and slower *N*-glucuronidation. AA children with ETSE have significantly higher levels of cotinine than white children, despite lower reports of ETSE [16]. AAs are also at higher risk for ETSE, with an estimated ETSE rate of 55.9% as compared with 40.1% in the general US population [11].

Links Between Depressive Symptoms, Active Smoking, and ETSE

The association between active smoking and depressive symptoms or psychological distress is well-documented [21, 22]: over 60% of American adults with depression have smoked at some point in their lives [23]. Pregnant women who smoke are more likely to report depressive symptoms [24] or have an anxiety disorder [25] than those who never smoked. Some research asserts that depressive symptoms lead individuals to initiate smoking, as nicotine is self-medicating [26–28]. Limited longitudinal studies have suggested that causality is in the opposite direction; i.e., that smoking causes depression [22, 29]. Regardless of causal direction, a more complete understanding of the relationship between depression and smoking is essential, because smokers who are depressed have difficulty quitting [23]. Additionally, correlates such as degree of nicotine addiction [30] and social support [31, 32] may mediate or moderate the relationship between depression and smoking.

Compared to active smoking, few studies report on relationships between depressive symptoms and ETSE. Data from recent United States population-based surveys have demonstrated significant associations between depressive symptoms and ETSE [33], and between depression and the absence of smoking bans in the workplace and at home [34]. A Japanese population-based workplace survey showed that both smokers and non-smokers who reported ETSE were more likely to report depressive symptoms than those without ETSE [35].

Depressive Symptoms and Smoking/ETSE During Pregnancy

Rates of depression among pregnant women are higher than for the general population (15.7% vs. 7% among US adults) [23, 36]. Research indicates that depressive symptoms independently contribute to continued smoking during pregnancy [24, 37–42]. Much less is known about links between ETSE and depression in pregnant populations. Published ETSE interventions among pregnant smokers rarely assess for depressive symptoms [43–46]; we only know of one [47]. Understanding the relationship between depression and smoking/ETSE among pregnant populations is essential for the design of effective interventions to reduce nicotine exposure among women and their infants.

The Current Study

The current study seeks to examine relationships between active smoking, ETSE, and depression, using data from two randomized controlled trials (RCTs) of smoking interventions in a sample of minority urban pregnant women. In support of the goals of these studies, our primary objective was to identify factors that inhibited women in our population from reducing smoking/ETSE during pregnancy.

We hypothesize that: (1) among non-smokers, women who report depressive symptoms will be at higher risk for prenatal ETSE; (2) among women who smoked prior to pregnancy, those who report depressive symptoms will be at higher risk for continued smoking during pregnancy; (3) that among continued smokers, household (HH) ETSE, as a possible indicator of a woman's immediate smoking network, will account for some of the relationship between depression and her inability to quit.

Methods

Study Design, Population and Procedures

This paper presents results from a secondary analysis of audio computer-assisted self interview (A-CASI) screening data, collected at a single timepoint to determine women's eligibility to participate in one of two related clinic-based RCTs. The "NRT study" evaluated the efficacy of transdermal patches combined with cognitive behavioral therapy to facilitate smoking cessation among confirmed active smokers in their first or second trimester of pregnancy [48]. The "ETSE study" evaluated a clinic-based intervention to reduce post-natal ETSE, administered to women with ETSE beginning in their third trimester of pregnancy.

Participants for the RCTs were drawn from women seeking care at three prenatal care sites in Washington, DC between July 2006 and December 2009. Women were asked to participate in a screening to determine if they were eligible to receive one of two special clinic services. The same A-CASI screener was used to determine initial self-reported eligibility for all. Women were demographically eligible for either RCT if they were: residents of the District of Columbia (DC) metropolitan area; self-identified as Black, African American, or Hispanic; English speaking; at least 18 years of age; and with a current singleton pregnancy. Smoking/ETSE data were collected for all women to determine behavioral eligibility for the NRT versus ETSE studies. Depressive symptoms were assessed to identify women with possible suicidal ideation; such women were excluded and referred to appropriate care.

The secondary analysis was performed using A-CASI screening data from all demographically eligible women, including women who were non-smoking/non-ETSE. To retain focus on an urban population, those living outside of DC city limits were excluded.

Measures

Depressive symptoms recalled from the past 2 weeks were assessed using the 7-item Beck Depression Inventory Fast Screen validated for use in minority women [49]; a total score of 10 or more indicates "severe" symptoms; 7–9, "moderate"; 4–6, "mild"; and 3 or below, "low" [50].

"Smokers" were defined as women who recalled and reported current smoking (at least a puff in the past week) or former smoking (at least a puff during the 6 months prior to pregnancy; or smoking during pregnancy, but not in the past week). "Non-smokers" were those with an absence of current or former smoking. Current household (HH-)ETSE was defined as a recollection of at least one puff of a cigarette smoked within their home during the past week.

A-CASI Data Collection

Research has demonstrated that the odds of reporting sensitive behaviors such as risky sexual behavior and drug/alcohol/tobacco use are higher when obtained from private, A-CASI administered surveys than interviewer-administered surveys [51–55]. A-CASI is a preferred, cost-effective tool for obtaining data on sensitive topics including smoking status, and it has been widely used in minority/disadvantaged populations, including urban minority pregnant women [43–47, 54–58].

Statistical Analysis

All available demographic measures were used in the analysis; i.e., age, education, marital status, employment and trimester of pregnancy (third vs. first/second). The entire analysis was performed separately for smokers and non-smokers, as defined above. Dependent variables (DVs) of interest were current smoking (among smokers), and current HH-ETSE (among non-smokers).

Each demographic measure was compared by DV group using Fisher exact tests for categorical measures and *t* tests for continuous measures. The association between depressive symptom category and the DV was assessed via Fisher exact tests and Mantel-Haenzel chi-square trend tests. Unadjusted logistic regression modeling of the DV was performed for each baseline demographic measure and for depressive symptoms. All demographic measures associated with the DV in unadjusted models at $P < 0.20$ were included in adjusted logistic regression models. During modeling, moderate and severe depressive symptoms were combined into one category, due to low numbers of women who reported severe symptoms.

Individual potential sources of ETSE, including HH-ETSE, were contrasted between non-smokers, former smokers and current smokers using Fisher exact tests. To explore if HH-ETSE is a possible indicator for smoking networks, it was correlated with social sources of ETSE, using Fisher exact tests. Finally, for smokers, HH-ETSE was analyzed as a potential mediator for the relationship between depression and the DV (current smoking). This was done in two ways. The first followed the causal steps method of Baron and Kenny [59] which is comprised of: (1) fitting a logistic regression model to predict HH-ETSE based on depressive symptoms; (2) fitting a logistic regression model to predict current smoking based on HH-ETSE; (3) if the models in 1 and 2 are significant, then fitting a logistic regression model to predict current smoking based on depression, adjusting for HH-ETSE. Mediation is said to occur if depression is less significant (or non-significant, in the case of total mediation) as a predictor of current smoking after adjustment for

Table 1 Demographic characteristics

	Non-smokers			Smokers		
	No HH-ETSE (n = 306)	Current HH-ETSE (n = 161)	*P* value	Former smokers (n = 212)	Current smokers (n = 250)	*P* value
Age [mean (SD)]	26.1 (5.6)	24.4 (5.7)	0.0025	24.7 (5.2)	27.3 (5.8)	<.0001
Trimester [% (n)]			0.2206			0.0004
1st/2nd	67.3 (206)	61.5 (99)		58.0 (123)	74.0 (185)	
3rd	32.7 (100)	38.5 (62)		42.0 (89)	26.0 (65)	
Race [% (n)]			1.0000			0.2554
Black/AA	94.4 (289)	94.4 (152)		97.6 (207)	99.2 (248)	
Latina	5.6 (17)	5.6 (9)		2.4 (5)	0.8 (2)	
Education [% (n)]			0.1400			<.0001
<HS	13.7 (42)	19.2 (31)		13.2 (28)	28.8 (72)	
≥HS/GED	86.3 (264)	80.8 (130)		86.8 (184)	71.2 (178)	
Work [% (n)]			0.6950			0.3494
FT/PT	42.2 (129)	44.1 (71)		30.2 (64)	26.0 (65)	
Not working	57.8 (177)	55.9 (90)		69.8 (148)	74.0 (185)	

HH-ETSE household environmental tobacco smoke exposure. Current ETSE is defined as a report of at least 1 day of ETSE in the home in the past 7 days, *AA* African American, *HS* high school, *FT/PT* full-time or part-time

HH-ETSE. In the second mediator analysis, the change in the coefficient for depression before and after adjustment for HH-ETSE in the model to predict current smoking was tested according to the method of Freedman and Schatzkin [60, 61].

Analyses were performed using *SAS v9.1* (Cary, NC). Results with $P < 0.05$ were considered statistically significant.

Participants

During the course of the study, 8,363 approaches were made to patients, resulting in 1,209 women A-CASI screened. Primary reasons for non-participation in the screening include non-English speaking (22%), not being pregnant (21%), previously approached by study staff (18%), being less than 18 years old (11%), and/or refusal to participate (10%). Ninety-four (8%) women became demographically ineligible post A-CASI screening; primary reasons were not being pregnant (21%), uncertainty about pregnancy status (55%), and/or being under 18 years of age (17%). An additional 186 (15%) participants who lived outside DC were excluded from the current analysis, resulting in a final analysis sample of 929 women.

Results

Of the 929 women in our sample, 467 (50%) were non-smokers and 462 (50%) were former or current smokers. Of non-smokers, 161 (34%) reported current HH-ETSE and 306 (66%) reported no HH-ETSE in the past week. Of smokers, 250 (54%) were current smokers and 212 (46%) were former smokers, of whom 171 (81%) only smoked prior to pregnancy. Demographic characteristics of the 929 and comparisons of DV groups are shown in Table 1. Among non-smokers, women with current HH-ETSE were younger than those with no HH-ETSE (24.4 ± 5.7 years vs. 26.1 ± 5.6 years, $P = 0.003$). Among smokers, women currently smoking were older (27.3 ± 5.8 years vs. 24.7 ± 5.2 years, $P < 0.0001$); more likely to be in their first or second trimester (74% vs. 58%, $P = 0.0004$); or to have not completed high school (29% vs. 13%, $P < 0.0001$), compared to former smokers.

Overall, 15% of women reported mild symptoms of depression, 8% moderate, and 3% severe, with the remainder reporting low symptoms. Figure 1 depicts the distribution of depressive symptoms by smoking/HH-ETSE status. Among non-smokers, those with current HH-ETSE reported more depressive symptoms than those with no HH-ETSE (12% vs. 8%, mild symptoms; 9% vs. 4%, moderate; and 2% vs. 1%, severe), with the remainder reporting low symptoms (76% vs. 87%). Increasing levels of depressive symptoms among non-smokers were associated with current HH-ETSE (Fisher Exact $P = 0.03$, Mantel-Haenzel Trend $P = 0.003$). Among smokers, current smokers (in the past 7 days) reported more depressive symptoms than former smokers (24% vs. 17%, mild symptoms; 13% vs. 6%, moderate symptoms; and 5.2% vs. 4.7%, severe symptoms), with the remainder reporting low symptoms (57% vs. 73%). Increasing levels of depressive symptoms among smokers were associated with current

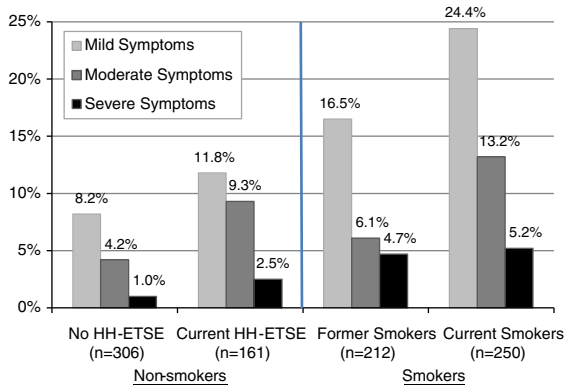

Fig. 1 Distribution of depressive symptoms. The remaining women in each group reported low symptoms and are included in the denominator. *HH-ETSE* household environmental tobacco smoke exposure. *Current HH-ETSE* is defined as a report of at least 1 day of ETSE in the home in the past 7 days

smoking (Fisher Exact $P = 0.003$, Mantel-Haenzel Trend $P = 0.004$).

Table 2 presents results of logistic regression models of the DVs. Among non-smokers, unadjusted modeling showed significantly higher odds of current HH-ETSE for women reporting moderate-to-severe depressive symptoms (OR 2.6, 95% CI [1.3, 5.1]) compared to women with low symptoms. Older women had decreased rates of HH-ETSE (OR 0.95, 95% CI [0.91, 0.98]). In a model jointly adjusted for all factors with unadjusted $P < 0.20$, the odds ratio for moderate-to-severe symptoms decreased slightly, to 2.5, 95% CI [1.2, 5.2].

Among smokers, unadjusted models revealed significantly higher odds of current smoking (in the past 7 days) for women with moderate-to-severe depressive symptoms (OR 2.2, 95% CI [1.2, 3.7]) or mild symptoms (OR 1.9, 95% CI [1.2, 3.0]) compared to low symptoms. Women who were older were at increased risk (OR 1.1, 95% CI [1.1, 1.1]), as well as those who did not complete high school (OR 2.7, 95% CI [1.6, 4.3]). Women in their third trimester were at decreased risk (OR 0.49, 95% CI [0.33, 0.72]). In a model jointly adjusted for all factors with unadjusted $P < 0.20$, the odds ratios for moderate-to-severe depressive symptoms decreased to 1.9, 95% CI [1.1, 3.5]), and the odds ratio for mild symptoms was decreased to 1.8, 95% CI [1.1, 3.1].

Table 3 shows the distribution of various potential sources of ETSE among non-smokers, former smokers, and current smokers. Reports of all ETSE sources were significantly higher among smokers than non-smokers. Current smokers reported significantly more sources of ETSE than former smokers, including more ETSE in the home (77% vs. 60%, $P = 0.0001$), personal ETSE (in the same room or car) (88% vs. 66%, $P < 0.0001$), resident ETSE (living with a smoker) (67% vs. 55%, $P = 0.007$), partner ETSE (75% vs. 66%, $P = 0.03$), visitor ETSE (63% vs. 42%, $P < 0.0001$), and at least 1 day of ETSE in the home in the past week (78% vs. 54%, $P < 0.0001$).

Resident and visitor ETSE, both social sources of ETSE, were also significantly associated with current HH-ETSE. Of women reporting current HH-ETSE versus those not

Table 2 Odds of current HH-ETSE/smoking (in the past 7 days), from logistic regression modeling

	Non-smokers (outcome: current HH-ETSE) [N = 467]				Smokers (outcome: current smoking) [N = 462]			
	Unadjusted OR (CI)	*P* value	Adjusted OR* (CI)	*P* value*	Unadjusted OR (CI)	*P* value	Adjusted OR* (CI)	*P* value*
Depressive symptoms								
Moderate/severe	2.6 (1.3, 5.1)	0.0084	2.5 (1.2, 5.2)	0.0109	2.2 (1.2, 3.7)	0.0062	1.9 (1.1, 3.5)	0.0304
Mild	1.6 (0.9, 3.1)	0.1272	1.6 (0.8, 3.1)	0.1506	1.9 (1.2, 3.0)	0.0092	1.8 (1.1, 3.1)	0.0180
Low	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Age in years	0.95 (0.91, 0.98)	0.0029	0.95 (0.91, 0.98)	0.0035	1.1 (1.1, 1.1)	<0.0001	1.1 (1.1, 1.2)	<0.0001
3rd Trimester	1.3 (0.9, 1.9)	0.2089	N.I.	N.I.	0.49 (0.33, 0.72)	0.0003	0.48 (0.32, 0.73)	0.0006
Latina (vs. African American)	1.0 (0.4, 2.3)	0.9877	N.I.	N.I.	0.33 (0.06, 1.74)	0.1928	0.22 (0.04, 1.18)	0.0772
<HS education	1.5 (0.9, 2.5)	0.1194	1.3 (0.8, 2.2)	0.3404	2.7 (1.6, 4.3)	<0.0001	3.0 (1.8, 5.1)	<0.0001
FT/PT work	1.1 (0.7, 1.6)	0.6868	N.I.	N.I.	0.81 (0.54, 1.22)	0.3176	N.I.	N.I.

HH-ETSE household environmental tobacco smoke exposure. Current ETSE is defined as a report of at least 1 day of ETSE in the home in the past 7 days, *Ref* reference level, *N.I.* not included in adjusted model as it was not significant in the unadjusted analysis ($P > 0.20$), *HS* high school, *FT/PT* full-time or part-time

* Simultaneously adjusted for all other covariates in the model

Table 3 Distribution of potential sources of ETSE

ETSE source	Non-smokers: All (n = 467)	Smokers: Former (n = 212)	Smokers: Current (n = 250)	*P* value*	Smokers: All (n = 462)	*P* value$^{\theta}$
1. Home	36.6% (171)	60.4% (128)	77.2% (193)	0.0001	69.5% (321)	<0.0001
2. Personal	45.0% (210)	66.0% (140)	88.4% (221)	<0.0001	78.1% (361)	<0.0001
3. Resident	37.0% (173)	54.7% (116)	67.2% (168)	0.0072	61.5% (284)	<0.0001
4. Partner	43.5% (203)	65.6% (139)	74.8% (187)	0.0319	70.6% (326)	<0.0001
5. Caregiver	38.3% (179)	45.8% (97)	50.8% (127)	0.3046	48.5% (224)	0.0019
6. Visitors	22.5% (105)	42.0% (89)	63.2% (158)	<0.0001	53.5% (247)	<0.0001
7. Days in the home in the past week						
1+ days[a]	34.5% (161)	53.8% (114)	77.6% (194)	<0.0001	66.7% (308)	<0.0001
2+ days	20.1% (94)	34.9% (74)	60.4% (151)	<0.0001	48.7% (225)	<0.0001

Descriptive statistics are reported as % (n)

Participants could respond affirmatively to multiple sources; percents are not additive within smoking category

ETSE environmental tobacco smoke exposure

* *P* value comparing former smokers to current smokers, from Fisher exact test

$^{\theta}$ *P* value comparing all non-smokers to all smokers, from Fisher exact test

[a] Analysis definition of household ETSE (HH-ETSE)

Wording of A-CASI question

1. "Home": Since you learned you were pregnant, has anyone you live with or have any visitors smoked cigarettes inside your home?

2. "Personal": During a typical week, are there times when you are in the same room or in a car with someone who is smoking a cigarette?

3. "Resident": Not including yourself, how many cigarette smokers currently live in your home? (response of 1 or more)

4. "Partner": Does the father of your unborn baby, or your current partner, boyfriend or husband smoke cigarettes, pipes, cigars or other tobacco products?

5. "Caregiver": Think about the people who may help you care for your new baby, such as the baby's grandparents, other family members, and other possible caregivers. Do any of these people smoke cigarettes, pipes, cigars, or other tobacco products?

6. "Visitors": Do any of your neighbors, friends, or family members who come to visit you on a regular basis (e.g., one or more times a week) smoke cigarettes inside your home?

7. "Days in the past week": On how many of the past 7 days did anyone else, other than yourself, smoke even a puff of a cigarette inside your home? (response of 1 or more/2 or more)

reporting it, 78% (vs. 29%) also report living with a smoker; furthermore 74% (vs. 12%) also reported visitor ETSE ($P < 0.0001$, each). Analysis of HH-ETSE as a mediator for the relationship between depression and current smoking using the causal steps method showed the following results. First, smokers with moderate-to-severe depressive symptoms were at increased risk for current HH-ETSE (OR 2.2, 95% CI [1.1, 4.2]). Next, smokers with current HH-ETSE were at increased risk for current smoking (OR 3.4, 95% CI [2.2, 5.4]). When the model for current smoking presented in Table 2 was additionally adjusted for current HH-ETSE, the odds ratio for moderate-to-severe depressive symptoms was no longer significant (AOR 1.7, 95% CI [0.9, 3.1]). Thus, HH-ETSE accounts for a portion of the relationship between moderate-to-severe depressive symptoms and current smoking; the change in the coefficient for moderate-to-severe symptoms after adjustment for HH-ETSE (from 1.9 to 1.7) was highly significant ($P < 0.0001$). In contrast, the relationship between mild depressive symptoms and current smoking was nominally mediated by HH-ETSE, possibly because mild symptoms were not significantly associated with HH-ETSE (data not shown).

Discussion

Our results support those of other studies that show a strong association between depressive symptoms and cigarette smoking during pregnancy. To our knowledge, this is the first study conducted among urban pregnant minority women that demonstrates a similar correlation among non-smokers between depression symptoms and ETSE (in this case, HH-ETSE). Also unique in this study is the evidence that HH-ETSE accounts for some of the association between depression and continued smoking during pregnancy.

Household ETSE and Depression

Among pregnant non-smokers, women who showed depressive symptoms were at increased risk for HH-ETSE.

The brief screening instrument did not collect additional explanatory data. The concept of Locus of Control (LOC) [62], as described in psychosocial literature, offers a possible explanation for this relationship. LOC theory states that persons with greater stress, depression, and addiction exhibit a greater reliance on environmental and social factors (i.e., have an "external" LOC) [63, 64]; women with depressed symptoms have a perceived absence of control over their home environment [65, 66]. Applied to our study, depressed women have a decreased ability to regulate their home environment, and thus adversely affect their own and their baby's health due to ETSE. In fact, the literature shows that women who exhibit general self-confidence and minimal perceived difficulty in preventing ETSE are more likely to enforce home smoking bans in their first year postpartum [67].

In the only previous study examining ETSE and depression among pregnant women, Blake et al. [47] examined correlates of avoidance of personal ETSE among pregnant non-smokers with at least one partner/family/friend who smoked. Those who avoided ETSE were more likely to report household smoking bans, support from family and friends to prevent ETSE, and/or greater self confidence in stopping ETSE. Consistent with LOC theory, women who successfully avoided ETSE also reported a greater ability to self-regulate negative mood states (depressive thoughts and behaviors), though the directionality of this relationship would need to be confirmed. No significant associations were found between depression and personal ETSE (at home or elsewhere) among pregnant non-smokers. Our study is different in that we specifically examined household ETSE, as opposed to personal ETSE. It may be that depression is more integrally related to the home environment.

Prenatal Smoking and Depression

Confirming previous research, our results show that pregnant smokers who exhibit depressive symptoms continue smoking during pregnancy. Previous research shows smokers with an external LOC may be hindered from quitting [68] unless they have other positive external influences to support them [69]. As further evidence in support of LOC as a theoretical basis, we note that among the subsample of our population who subsequently enrolled in the longitudinal NRT intervention study, those who reported any depressive symptoms in the A-CASI screener were less likely to quit smoking during the trial (32% vs. 67%, $P < 0.05$) [48].

Cofactors in the Relationship Between Smoking and Depression

Other factors may impact the relationship between depression and smoking in our sample. Heavy/frequent smokers have a greater nicotine dependence and more difficulty quitting [70]; persons who are depressed are at greater risk for smoking dependency [71]. Adult depressed smokers tend to smoke their first cigarette within 5 min of rising compared to non-depressed smokers (51% vs. 30%, $P < 0.05$) and are also less likely to quit [23]. One study reports that mood/anxiety disorders among females were not predictive of smoking after adjustment for nicotine dependence [30]. Unfortunately, our brief screener did not assess for degree of smoking addiction and so its potential impact could not be evaluated. Even if addiction accounts for our results, the issue remains that women who are depressed would have greater difficulty breaking the cycle of smoking dependency [23].

Previous research indicates that social influences mediate the depression-smoking relationship [72]. Other studies show that having a smoking partner [32, 73] or seeking social support to quit [74] impacts a woman's ability to quit during pregnancy; and that women with a currently smoking partner were eight times more likely to smoke during pregnancy than women whose partner did not smoke [31].

In our study, current smokers were more likely to report having a smoking partner, regular visitors in the home who smoke, and/or to live with a smoker. Within the context of this discussion, HH-ETSE may act as an indicator for social sources of smoking, due to its high association with ETSE from visitors and/or residents. Additionally, we found that current HH-ETSE mediates the relationship between depressive symptoms and current smoking. If HH-ETSE is a proxy for a woman's smoking network, then that network accounts for, at least in part, a depressed woman's inability to stop smoking. This finding is supported by research showing that a supportive network is vital for a woman's quitting, and by LOC theory, which states that depressed persons need greater social support in order to quit. Also, in a clinical context a brief question assessing recent HH-ETSE may provide valuable information about a woman's smoking network.

Study Strengths and Limitations

Strengths of our study include the screener's assessment of active smoking status along with ETSE. The screener utilized A-CASI methods, an interview technology shown to obtain honest confidential answers about potentially sensitive subjects, including smoking. Measures used in this study were similar to those in previous studies of smoking during pregnancy.

Study limitations include the lack of a measure of nicotine addiction among smokers. Study generalizability is limited to adult, English speaking, lower-income urban minority pregnant women. Data are retrospective and subject to recall bias. While LOC was not specifically measured in the brief

A-CASI survey, this study suggests that potential relationships between depression, LOC, and exposure reduction would be useful to include in future research.

While our limited results indicate that HH-ETSE acts as a surrogate for a woman's smoking network, confirmatory research is needed. The exploration of current HH-ETSE as a mediator for the relationship between depression and smoking necessarily presumes a series of directional relationships: namely, that depression may inhibit women from preventing HH-ETSE; and that HH-ETSE, in turn, inhibits smoking cessation during pregnancy. While these relationships appear to fit with extant literature, longitudinal studies are needed to further elucidate the complex association of depression, the home environment, and continued smoking during pregnancy. Such studies should assess for co-factors such as addiction and include enhanced measures of social support.

Conclusion

To help prevent adverse pregnancy outcomes, health care providers should be aware of possible associations between depressive symptoms and active smoking or ETSE during pregnancy. Interventions designed to encourage behavior change should include screening for depressive symptoms. Cognitive behavioral therapy would support depressed women especially if they are troubled by the imminent predicament of caring for their health and the health of their baby, and their support networks are unreliable. Interventions should build confidence and skills so that women are better able to address their home environment, and involve the very family and friends who smoke in that environment.

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Conflict of interest None of the authors have any competing interests to declare.

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