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Background: Environmental tobacco smoke (ETS) exposure during pregnancy contributes to adverse infant health outcomes. Limited previous research has focused on identifying correlates of ETS avoidance. This study sought to identify proximal and more distal correlates of ETS avoidance early in pregnancy among African-American women.

Methods: From a sample of low-income, black women (n=1044) recruited in six urban, prenatal care clinics (July 2001–October 2003), cotinine-confirmed nonsmokers with partners, household/family members, or friends who smoked (n=450) were identified and divided into two groups: any past-7-day ETS exposure and cotinine-confirmed ETS avoidance. Bivariate and multivariate logistic regression analyses identified factors associated with ETS avoidance. Data were initially analyzed in 2004. Final models were reviewed and revised in 2007 and 2008.

Results: Twenty-seven percent of pregnant nonsmokers were confirmed as ETS avoiders. In multivariate logistic regression analysis, the odds of ETS avoidance were increased among women who reported household smoking bans (OR=2.96; 95% CI=1.83, 4.77; $p<0.0001$), that the father wanted the baby (OR=2.70; CI=1.26, 5.76; $p=0.01$), and that no/few family members/friends smoked (OR=3.15; 95% CI=1.58, 6.29; $p<0.001$). The odds were decreased among women who had a current partner (OR=0.42; 95% CI=0.23, 0.76; $p<0.01$), reported any intimate partner violence during pregnancy (OR=0.43; 95% CI=0.19, 0.95; $p<0.05$), and reported little social support to prevent ETS exposure (OR=0.50; 95% CI=0.30, 0.85; $p=0.01$). Parity, emotional coping strategies, substance use during pregnancy, partner/household member smoking status, and self-confidence in avoiding ETS were significant in bivariate, but not multivariate analyses.

Conclusions: Social contextual factors were the strongest determinants of ETS avoidance during pregnancy. Results highlight the importance of prenatal screening to identify pregnant nonsmokers at risk, encouraging household smoking bans, gaining support from significant others, and fully understanding the interpersonal context of a woman's pregnancy before providing behavioral counseling and advice to prevent ETS exposure.

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Introduction

Adverse effects of tobacco smoke exposure during pregnancy are dose-dependent for active[1] and passive smoking.[2,3] Adverse events associated with smoking include intrauterine growth retardation, small-for-gestational-age, preterm birth, stillbirth, spontaneous abortion, placenta previa, abruptio placenta, and bleeding.[4–6] Low birthweight, intrauterine growth, preterm birth,[2,6,7] vaginal bleeding,[8] and fetal death[2] have been associated with environmental tobacco smoke (ETS) exposure. Nonwhites experience more adverse effects, particularly low birth weight and prematurity, than do whites from smoking[9–12] and ETS exposure.[6] African-American nonsmokers[13,14] and smokers,[15] irrespective of pregnancy, have consistently higher cotinine levels than whites or Hispanics, despite comparable ETS exposure levels or numbers of cigarettes smoked[15]; metabolize cotinine more slowly[16–18]; have a longer cotinine half-life[19]; and are more likely to

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smoke mentholated cigarettes,[16,20,21] which increases cotinine and carbon monoxide levels,[22] increases cotinine half-life,[19] and influences nicotine metabolism and clearance.[23]

Little is known about the prevalence or correlates of ETS exposure among pregnant nonsmokers. It has been reported that 21% of nonsmokers with singleton pregnancies had ETS exposure during pregnancy.[7] In another study,[24] 28% of nonsmokers receiving prenatal care reported ETS exposure either at home or at work. In the Yale Pregnancy Outcome Study, 52% of nonsmokers had detectable levels of urinary cotinine.[25] Among low-income pregnant women in Minnesota, 12% of nonsmokers reported daily ETS exposure of less than 4 hours.[26]

Correlates of ETS exposure among pregnant nonsmokers include being single[27]; being black[27]; having a lower education level and decreased knowledge of ETS exposure risks[27–29]; lower self-efficacy[29]; a husband, partner, or household member(s) who smokes[27,28,30]; and no household smoking bans.[29] None of these studies focused specifically on African-American women who are clearly at increased risk, and although these ETS exposure–specific factors are important targets for behavioral counseling interventions, there may be other psychosocial or social contextual factors[31–32] that influence a woman's ability to limit ETS exposure during pregnancy.

This study examines correlates of ETS avoidance in a population of African-American pregnant women. The hypothesis was that proximal variables to ETS exposure, such as identified household smokers, the presence of household smoking bans, confidence in preventing ETS exposure, perceived harm to exposed infants, and support for reducing exposure would be most predictive. An attempt was also made in this study to identify other, more distal correlates (e.g., individual, social, and contextual factors) that may be useful to consider in designing interventions intended to promote ETS avoidance.

Methods

Research Design and Procedures

Data are cross-sectional and were collected during the baseline assessment of a randomized, multiple–risk behavior intervention trial[33,34] that addressed four risks for adverse pregnancy outcomes: cigarette smoking, ETS exposure, depression,[35] and intimate partner violence (IPV).[36] Participating IRBs that approved this study include Howard University, RTI International, and National Institute for Child Health and Human Development. All other participating institution IRBs relied on Howard University as the IRB of record.

Women, recruited from six prenatal care clinics (July 2001–October 2003), completed a 10-minute audio–computer assisted self-interview (A-CASI) to determine eligibility. Adapted Smoke-Free Families (SFF) screening items[37] identified smokers and nonsmokers. The Beck Depression Inventory (BDI)–FastScreen for Medical Patients identified past-month depression symptoms,[38] and the Abuse Assessment Screen[39] identified past-year IPV. Inclusion criteria were: pregnant, ≤28 weeks gestation, aged ≥18 years, Washington DC resident, self-identification as African American/black or Latina, English-speaking, not suicidal or incarcerated, and reporting one or more designated risk factors. Additional recruitment/screening procedures are described elsewhere.[40]

Eligible women were invited to participate. Consenting women completed a baseline telephone interview within 1 month of screening (M=9.3 +/−8.2 days; median/mode=7 days). Women were randomized by site after the baseline interview. Saliva samples were collected for cotinine analysis at enrollment or at the next scheduled prenatal care visit.

Participants

Of 1398 eligible women, 85% consented: 1070 completed the baseline interview. Latina women (n=22) who were enrolled in the larger study were excluded from this analysis. Respondents who self-identified as African American or black (n=1048) and answered relevant baseline questions (n=1011) were included in this analysis. Women who smoked cigarettes within 6 months of becoming pregnant or since (n=353; 35%); did not have a partner/spouse, household member, or any family/friends whom they saw regularly who smoked cigarettes (n=75; 7%); or did not have baseline cotinine values to confirm self-reports (n=92; 9%) were further excluded in order to assess correlates of ETS avoidance among nonsmokers at risk. Data from 491 women (49%) are therefore presented below.

Measures

Personal and interpersonal factors. Demographic characteristics included maternal age, education, marital status, employment, school enrollment, household income, and receipt of Medicaid or other financial assistance. Reproductive history items included gestational age, number of pregnancies, and number of living children. Happiness about being pregnant, pregnancy ambivalence, and other attitudes toward pregnancy were assessed using Pregnancy Risk Monitoring Assessment System and National Survey of Family Growth[41,42] items. Eight items were combined to create a positive attitudes scale (range=8–80; Cronbach's alpha coefficient=0.70).

Mental health–related items included past-month depression symptoms from the 20-item Hopkins Symptom Checklist–Depression Scale,[43] cognitive–behavioral coping strategies from a 15-item version of the Negative Mood Regulation Scale,[44,45] and alcohol or illicit drug use during pregnancy. Interpersonal factors included having a current partner, the father's desire to have the baby, past-year IPV (as measured by the Revised Conflict Tactics Scale physical assault and sexual coercion subscales),[46] IPV during pregnancy, and perceived emotional support from others and the current partner using the 11-item Support Behaviors Inventory[47,48] (Cronbach's alpha coefficient=0.9; range=11–66).

Environmental tobacco smoke exposure–specific factors. Items were adapted from the SFF,[37] National Health Interview Survey supplements,[49] and ETS exposure intervention studies.[50] Women reported whether their partner, household members, or family/friends smoked. They estimated household exposure for the past 7 days and personal ETS exposure on a typical day at or away from home. Household smoking bans, those who typically smoked at home, self-confidence in preventing ETS exposure, perceived support from significant others, and harmfulness of ETS exposure to the baby's health were assessed. Cotinine level, which is the major proximate metabolite of nicotine and has been widely used as a biomarker of tobacco exposure,[51] was determined using gas chromatography–mass spectrometry (GC/MS) with lower detection limits of 10 ng/ml.

Analysis

Data were initially analyzed in 2004. Final models were reviewed and revised in 2007 and 2008. Receiver operating characteristic (ROC) curves[52,53] identified cotinine cutoff points that maximized sensitivity/specificity for detection of smoking and ETS exposure. Women whose values exceeded the active smoking cutoff point of 17 ng/ml (86.9% sensitivity, 88.2% specificity, and 175.1 sensitivity + specificity) were considered smokers and were excluded from further analyses. Women who reported no past-7-day ETS exposure but whose values exceeded the passive smoking cutoff of 10 ng/ml (giving 18.3% sensitivity, 90.5% specificity, and 108.9 sensitivity + specificity) were classified as having ETS exposure, as were women self-reporting any past-7-day ETS exposure. Women reporting no ETS exposure with cotinine levels of 10 ng/ml were classified as ETS avoiders.

Environmental tobacco smoke avoidance correlates were identified in several stages. Bivariate comparisons were performed using chi-square tests and *t*-tests. Spearman correlation coefficients (*r*) were examined, and highly correlated variables were removed to reduce multicollinearity. Variables significant at $p \leq 0.20$ in bivariate comparisons were included in two initial multivariate logistic regression models to separately examine effects of "personal/interpersonal" and "ETS exposure–specific" variables. Variables significant in initial models at $p \leq 0.20$ were then included in a full regression model. Predictive abilities were examined using the maximum rescaled *R*-square (R^2),[54] which determines the absolute percentage of variation explained, and the area under the ROC curve (AUC or c-statistic). The higher these values, the higher the discriminant power.[55]

Results

Reclassification Results and ROC Curve Analysis

Of self-reported nonsmokers, 8% had cotinine values exceeding the active smoking cutoff (hereafter excluded), 0.4% exceeded the passive smoking cutoff and were reclassified as having ETS exposure, 66% reported ETS exposure, and 25% were confirmed avoiders of ETS. Of the remaining 450 nonsmokers, 73% (n=327) had ETS exposure, and 27% (n=123) were avoiders of ETS.

Respondent Characteristics

Average maternal age was 25 years, with a gestational age of 19 weeks. Most had less than or equal to a high school education (78%) and received some form of federally funded financial assistance (84%): 69% reported household incomes <$2000 per month; 42% were employed; 22% were enrolled in school. Most had a current partner (83%) and were single (73%); 23% lived with their partner/spouse. Psychosocial and behavioral risks included moderate-to-severe depression symptoms (13%), and any IPV (14%), alcohol (14%), or illicit drug use (5%) during pregnancy. Nearly all had a family member/friend (96%) who smoked, but less than half reported a household member (46%) or partner (43%) who smoked.

Bivariate Comparisons

Demographic characteristics were similar among groups (Table 1). A categoric version of maternal age was marginally significant, suggesting that those who avoided ETS were more likely to be aged >30 years (18% vs 10%; $p<0.10$). Fewer women who avoided ETS than those with ETS exposure reported a previous pregnancy. Other reproductive history and attitude variables were comparable, as were depression and alcohol-use levels. Women who avoided ETS used cognitive–behavioral coping strategies more often to handle negative affect. They were less likely to report illicit substance use during pregnancy, to have a current partner, and to report any IPV during pregnancy or the past year, and they were more likely to report that the father wanted the baby.

Nearly all ETS exposure–specific variable comparisons were significant (Table 2). Fewer women who avoided ETS than those exposed to ETS reported that their partner or "most" family members/friends smoked. Women who avoided ETS exposure reported fewer household smokers, fewer cigarettes smoked by partners per day, and less past-7-day household ETS exposure. More women who avoided ETS than those exposed to ETS had a household smoking ban, felt confident they could stop others from smoking around them, and perceived that family/friends would be supportive if asked not to smoke. No differences in perceived harm to the baby from ETS exposure were found.

Multivariate Models

Initial models. Four of eight variables included in the initial model of personal/interpersonal factors were significant (Table 3). The model was marginally predictive of ETS avoidance (max-rescaled R^2=0.08; AUC or c-statistic=0.65). Odds of ETS avoidance were decreased among women reporting prior pregnancies, a current partner, or any IPV during the pregnancy; they

Table 1. Bivariate comparisons of those exposed to ETS versus avoiders of ETS: personal and interpersonal factors[a]

	ETS exposure (*n*=327)	No ETS exposure (*n*=123)	Total (N=450)	*p* value
Demographic characteristics				
Maternal age at enrollment (M [SD])	24.48 (5.06)	25.01 (5.95)	24.63 (5.32)	
Educational level				
≤High school	76 (23.24)	22 (17.89)	98 (21.78)	
High school graduate/GED	172 (52.60)	63 (51.22)	235 (52.22)	
Any college/>college degree	79 (24.16)	38 (30.89)	117 (26.00)	
Currently enrolled in school	66 (20.18)	31 (25.20)	97 (21.56)	
Receive financial assistance (including Medicaid)	275 (84.62)	100 (81.97)	375 (83.89)	
Employment status				
Working full time	78 (24.07)	33 (26.83)	111 (24.83)	
Working part time	54 (16.67)	24 (19.51)	78 (17.45)	
Not working, worked before pregnancy	117 (36.11)	44 (35.77)	161 (36.02)	
Not working, didn't work before pregnancy	75 (23.15)	22 (17.89)	97 (21.70)	
Household income <$2000 per month	158 (68.40)	61 (70.11)	219 (68.87)	
Marital status				
Single	238 (72.78)	89 (72.36)	327 (72.67)	
Separated/divorced	14 (4.28)	6 (4.88)	20 (4.44)	
Married/living with partner	75 (22.94)	28 (22.76)	103 (22.89)	
Reproductive history and attitudes				
Weeks pregnant at baseline (M [SD])	19.32 (6.92)	18.64 (6.64)	19.14 (6.85)	
Any previous pregnancy	276 (84.40)	94 (76.42)	370 (82.22)	*
Number of times pregnant, including current pregnancy (M[SD])	3.48 (2.17)	3.33 (2.29)	3.44 (2.20)	
Children under 18 in household				
No other children	108 (33.03)	49 (39.84)	157 (34.89)	
None	7 (2.14)	2 (1.63)	9 (2.00)	
1 child	116 (35.47)	32 (26.02)	148 (32.89)	
2 children	51 (15.60)	25 (20.33)	76 (16.89)	
≥3 children	45 (13.76)	15 (12.20)	60 (13.33)	
Pregnancy intentions				
Intended	114 (34.86)	48 (39.02)	162 (36.00)	
Mistimed	132 (40.37)	52 (42.28)	184 (40.89)	
Unwanted	81 (24.77)	23 (18.70)	104 (23.11)	
Happiness when became pregnant				
Happy to be pregnant	130 (39.76)	51 (41.46)	181 (40.22)	
Moderately happy	140 (42.81)	50 (40.65)	190 (42.22)	
Unhappy to be pregnant	57 (17.43)	22 (17.89)	79 (17.56)	
Positive pregnancy attitudes (M [SD])	57.52 (14.45)	59.73 (13.96)	58.13 (14.34)	
Mental health–related factors				
Hopkins depression level				
Remission/none	194 (59.33)	81 (65.85)	275 (61.11)	
Mild	90 (27.52)	27 (21.95)	117 (26.00)	
Moderate	26 (7.95)	11 (8.94)	37 (8.22)	
Severe	17 (5.20)	4 (3.25)	21 (4.67)	
Coping strategies (M [SD])				
Negative mood regulation scale	58.72 (10.31)	61.29 (10.01)	59.42 (10.28)	*
General subscale	20.37 (4.21)	21.24 (3.86)	20.61 (4.13)	*
Cognitive subscale	18.37 (4.04)	19.36 (4.14)	18.64 (4.09)	*
Behavioral subscale	19.99 (3.76)	20.70 (3.49)	20.19 (3.70)	
Alcohol and drug use during pregnancy				
Any alcohol use	44 (13.50)	17 (13.82)	61 (13.59)	
Extent of alcohol use (M [SD])	0.29 (1.01)	0.33 (1.11)	0.30 (1.04)	
Any illicit drug use	23 (7.03)	1 (0.81)	24 (5.33)	**
Extent of illicit drug use (M [SD])	0.07 (0.26)	0.01 (0.09)	0.05 (0.22)	***
Interpersonal factors				
Have a current partner	280 (85.63)	94 (76.42)	374 (83.11)	*
Father wants the baby	271 (82.87)	112 (91.06)	383 (85.11)	*
Emotional support				
From others (M [SD])	40.23 (14.17)	42.30 (14.40)	40.80 (14.25)	
From partner (M [SD])[b]	38.57 (19.17)	35.73 (22.13)	37.80 (20.03)	
From father of baby[c]	140 (67.31)	65 (67.71)	205 (67.43)	
Intimate partner violence				
Any IPV since pregnant	52 (15.90)	9 (7.32)	61 (13.56)	*

(continued on next page)

Table 1. *(continued)*

	ETS exposure (n=327)	No ETS exposure (n=123)	Total (N=450)	p value
Physical assault frequency past year, partner–self (M [SD])	3.76 (13.03)	3.23 (18.75)	3.62 (14.79)	
Sexual coercion frequency past year, partner–self (M [SD])	2.11 (8.53)	0.64 (3.45)	1.71 (7.51)	**
Physical assault frequency past year, self–partner (M [SD])	4.23 (10.24)	4.42 (13.06)	4.28 (11.06)	
Sexual coercion frequency past year, self–partner (M [SD])	1.05 (4.64)	0.62 (3.32)	0.93 (4.32)	

[a]n (%) unless otherwise indicated; percentages may not add to 100% because of rounding.
[b]Women who had no current partner were given a value of 0.
[c]Reflects percentage of women reporting that the baby's father was very/extremely supportive
*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.0001$
ETS, environmental tobacco smoke; IPV, intimate partner violence

were increased among those reporting that the father wanted the baby. Variables significant in Table 1, but excluded from this model, were any illicit drug use (because of small numbers of ETS avoiders) and past-year frequency of sexual coercion (so that the effects of overall IPV during pregnancy could be assessed). Correlations with IPV during pregnancy were: r=0.38; p<0.001.

Three of six variables in the initial model of ETS exposure–specific factors were significantly associated with ETS avoidance (Table 3). The model was acceptable (max-rescaled R^2=0.21; AUC or c-statistic=0.75). Odds of ETS avoidance were higher among women with household smoking bans and fewer smoking friends/family members; they were lower among women perceiving less support for ETS exposure prevention. Having a partner or household member who smoked did not contribute to the initial model, potentially because of correlations with other variables, most notably between having any household smokers and a smoking ban (r=0.44; p<0.001).

Variables significant in Table 2, but excluded from this initial model, were the number of cigarettes smoked daily by partners and the number of household smokers, because correlations with having a partner or household member who smoked (which were retained) respectively exceeded r=0.90. Model results were comparable, replacing any household smokers with the number/percentage of household smokers, and replacing a partner who smoked with the number of cigarettes the partner smoked; none of these alternate variables were significant in the initial model. Numbers of past-week household cigarettes smoked were similarly excluded because of strong correlations with household bans (r=0.77; p<0.001). Model results were equally significant, replacing the household smoking ban variable with numbers of cigarettes smoked at home.

Final model. Five variables in the initial model of personal/interpersonal factors, and four from the initial model of ETS exposure–specific factors, were significant at $p \leq 0.20$ and were retained in the final model predicting ETS avoidance (Table 3). The final model was significant (max-rescaled R^2=0.26; AUC or c-statistic=0.77); its predictive power increased slightly over the initial ETS exposure–specific model that excluded personal/interpersonal factors.

Six variables were significantly associated with ETS avoidance in the final model; all were related to social context. The odds of ETS avoidance were nearly threefold higher among women who had household smoking bans, reported that no/few (versus most) friends/family members smoked, and perceived that the father wanted the baby; the odds of ETS avoidance were lower among women who had a current partner, reported any IPV during pregnancy, and had less social support to prevent ETS exposure.

Discussion

This study demonstrates the importance of examining contextual as well as individual characteristics in order to better determine correlates of ETS avoidance. Behavioral, psychosocial, and social contextual factors may overlap and interfere with health behavior change during pregnancy.[56,57] Behavior change efforts focused on only a single risk may be unsuccessful because other risk factors serve as barriers to the desired change.[58,59] Using an integrative approach may serve to improve behavioral counseling in healthcare settings.[60–62] Evidence presented in this study highlights the importance of addressing interactions between personal, interpersonal, and ETS exposure–specific factors concomitantly. This study replicated previous ETS exposure–specific correlates reported in the literature but also identified several important new factors predicting ETS avoidance during pregnancy that warrant consideration in prenatal care interventions to reduce ETS exposure.

Table 2. Bivariate comparisons of those exposed to ETS and ETS avoiders: ETS exposure–specific variables[a]

	ETS exposure (n=327)	No ETS exposure (n=123)	Total (N=450)	p value
Significant others who smoke				
Household smokers				
Any household smokers	158 (48.32)	47 (38.21)	205 (45.56)	
Number of household smokers (M [SD])	0.66 (0.81)	0.43 (0.60)	0.60 (0.76)	***
Percentage of household members who smoke (M [SD])	22.71 (29.31)	18.15 (30.28)	21.46 (29.62)	
Partner smoking				
Current partner smokes[b]	144 (44.04)	49 (39.84)	193 (42.89)	*
Cigarettes smoked per day (M [SD])	3.40 (6.19)	1.73 (3.57)	2.95 (5.65)	****
Family and friends who smoke				****
None	12 (3.67)	5 (4.07)	17 (3.78)	
Few	152 (46.48)	86 (69.92)	238 (52.89)	
Some	71 (21.71)	19 (15.45)	90 (20.00)	
Most	92 (28.13)	13 (10.57)	105 (23.33)	
Household and personal ETS exposure (M [SD])[c]				
Household ETS exposure, total number in past 7 days	28.81 (52.11)	3.99 (16.75)	21.86 (46.42)	****
Personal ETS exposure, number on typical day in past 7 days	7.26 (8.98)	0.00 (0.00)	5.19 (8.27)	****
Household smoking rules				****
No one allowed to smoke in home	115 (35.17)	81 (65.85)	196 (43.56)	
Only special guests allowed to smoke	4 (1.22)	6 (4.88)	10 (2.22)	
Smoking allowed only in certain areas	140 (42.81)	31 (25.20)	171 (38.00)	
Smoking allowed anywhere in home	68 (20.80)	5 (4.07)	73 (16.22)	
Who smokes in home				****
Not sure/don't know	0 (0.00)	1 (0.81)	1 (0.22)	
No household members or visitors smoke	111 (33.94)	75 (60.98)	186 (41.33)	
No household members smoke, but visitors smoke	74 (22.63)	17 (13.82)	91 (20.22)	
Household members smoke, visitors do not	33 (10.09)	16 (13.01)	49 (10.89)	
Household members and visitors smoke	109 (33.33)	14 (11.38)	123 (27.33)	
Support from others to prevent ETS exposure				****
None/not much/some	163 (49.85)	33 (26.83)	196 (43.56)	
A lot	164 (50.15)	90 (73.17)	254 (56.44)	
Self-confidence level in stopping ETS exposure				**
Not very/not at all confident	110 (33.95)	22 (17.89)	132 (29.53)	
Rather confident	49 (15.12)	22 (17.89)	71 (15.88)	
Very confident	165 (50.93)	79 (64.23)	244 (54.59)	
Harm to baby from pregnancy ETS exposure				
Don't know/none/not much	29 (8.87)	9 (7.32)	38 (8.44)	
Some	97 (29.66)	34 (27.64)	131 (29.11)	
A lot	201 (61.47)	80 (65.04)	281 (62.44)	

[a]n (%) unless otherwise indicated
[b]This percentage reflects all women, not just those with partners.
[c]The household ETS exposure variable was derived by multiplying the number of days someone smoked inside the home by the number of cigarettes smoked on a typical day inside the home. The personal ETS exposure variable was derived from the sum of two separate items asking women how many cigarettes were smoked around them on a typical day when someone smoked in the past 7 days (either inside or outside the home).
*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$; ****$p \leq 0.0001$
ETS, environmental tobacco smoke

Unique to this study were social contextual factors reflecting the quality of intimate partner relationships. The fact that women without a current partner were more likely to avoid ETS exposure makes intuitive sense; the opportunity for exposure is by definition reduced with one less potential smoker in the social environment. It is also easy to imagine that pregnant women with a child not wanted by the father, or who fear retaliation/IPV, may be very reticent to request that the father not smoke around them. Conversely, partners who want the baby and are not prone to IPV would be expected to be more protective and less likely to smoke around a pregnant woman.

Literature supports this suggestion, but no studies specifically address ETS exposure and these variables. Pregnancy intentions and feelings have been strongly associated with psychosocial and behavioral risks,[63–67] including ETS exposure,[64] and are influenced by per-

Table 3. Multivariate models predicting ETS avoidance

Characteristic	Initial models[a,b] OR estimate	95% CI	p value	Final model[c] OR estimate	95% CI	p value
Personal and interpersonal factors						
Maternal age at enrollment (per year)	1.03	(0.99, 1.08)		1.02	(0.97, 1.06)	
Any previous pregnancy (no=ref)	0.56	(0.32, 0.97)	*	0.75	(0.41, 1.38)	
Positive pregnancy attitudes (per point)	1.00	(0.99, 1.02)				
Negative mood regulation scale (per point)	1.02	(0.99, 1.04)				
Emotional support from others (per point)	1.00	(0.99, 1.02)				
Has a current partner (no=ref)	0.46	(0.26, 0.80)	**	0.42	(0.23, 0.76)	**
Father wants the baby (no/not sure/don't know=ref)	2.21	(1.08, 4.56)	*	2.70	(1.26, 5.76)	**
Any IPV during pregnancy (no=ref)	0.47	(0.22, 1.01)	*	0.43	(0.19, 0.95)	*
ETS exposure–specific factors						
Any household members who smoke (no=ref)	1.38	(0.81, 2.35)				
Current partner smokes (no=ref)	1.01	(0.63, 1.63)				
Family and friends who smoke (most=ref)			***			***
None/few	3.18	(1.63, 6.23)		3.15	(1.58, 6.29)	
Some	1.51	(0.67, 3.39)		1.40	(0.61, 3.21)	
Household rules about smoking (no household ban=ref)	3.27	(1.95, 5.47)	***	2.96	(1.83, 4.77)	***
Support from others to prevent ETS exposure (a lot of support=ref)	0.50	(0.30, 0.82)	**	0.50	(0.30, 0.85)	**
Self-confidence in stopping ETS exposure (very confident=ref)						
Not at all/not very	0.57	(0.32, 1.04)		0.63	(0.34, 1.15)	
Rather	1.17	(0.63, 2.17)		1.22	(0.65, 2.31)	

[a]Model 1. Initial model of personal and interpersonal factors: R^2=0.06; max-rescaled R^2=0.08; c=0.65.
[b]Model 2. Initial model of ETS exposure–specific factors: R^2=0.14; max-rescaled R^2=0.21; c=0.75.
[c]Model 3. Final model of ETS exposure avoidance: R^2=0.18; max-rescaled R^2=0.2547; c=0.77.
*$p \le 0.05$; **$p \le 0.01$; ***$p \le 0.001$.
ETS, environmental tobacco smoke; IPV, intimate partner violence

ceptions of the father's desire to have a baby.[64,66,68,69] Maternal health behaviors improve when fathers are involved.[70] Men who want to become fathers are more supportive of their partner's health.[71] Similarly, IPV has been associated with increased behavioral risks, including substance use and smoking,[72] but not with ETS exposure. Relationship power imbalances,[73] and other IPV correlates including learned helplessness or fear of being hurt,[74] could influence a woman's reluctance to prevent ETS exposure, even when such exposures are recognized as harmful. Combined, these findings highlight the need to consider the role that relationship quality, and IPV in particular, may play in affecting a woman's ability to be assertive about ETS exposure prevention during pregnancy or to establish household smoking bans. Results additionally suggest the need to approach such discussions sensitively and with caution to ensure that women remain safe.

Our results agree with other studies showing that one of the strongest predictors of ETS avoidance is having established a household smoking ban, a factor that has protected adults, children, and infants against ETS exposure.[75–78] (The number of cigarettes smoked in the home was equally predictive when tested in a separate multivariate model that excluded the household smoking ban variable.) Bans are reported more often in homes with children[79,80] and without smokers.[76,77,80] Only one previous study of pregnant women found a similar protective effect.[29] Two others demonstrated that in the absence of household bans, expectant fathers continue to smoke,[81] and that establishing bans early in pregnancy helps prevent infant ETS exposure postpartum.[82]

Unfortunately, fewer nonsmokers in this study had household bans than has been reported elsewhere among pregnant/postpartum women,[82] low-income minority families irrespective of pregnancy,[83] or in households with smokers.[79] One possible explanation could be that in this study, younger women (mean age=25 years) were often not the head of household but lived with a parent/grandparent, potentially making it more difficult to establish household bans. Another explanation could be that IPV compromised some women's ability to make decisions and implement strategies autonomously within their household environment. Additionally, perceived support from others, which has been previously associated with adopting smoking bans to protect infants from ETS exposure[82] and with smoking cessation during pregnancy,[84,85] but not with ETS exposure during pregnancy, could have played a role. In this study, women who reported that fewer significant others smoked and who perceived greater support in remaining smoke-free were more likely to avoid ETS exposure; however, perceptions of support were lacking in almost half of the population.

Several other findings differed from those in the literature. Demographic characteristics, other than maternal age, were not associated with ETS avoidance, most likely because this was a comparatively homogeneous sample of pregnant, black nonsmokers at high risk. Perceived harmfulness of ETS exposure during pregnancy was low and found to be unrelated to ETS avoidance, whereas in other studies, knowledge of ETS risks was found to be protective.[27–29] The lack of an independent association between ETS avoidance and self-confidence in preventing ETS exposure was surprising because it was predictive in one study[29] and has been a strong determinant of cessation during pregnancy[85–88] and of ETS exposure prevention among infants/children.[82,89] Having a partner/household member who smoked had a significant effect on ETS exposure in previous studies,[27,28,30] but not in this study. The number of cigarettes partners smoked or the number of household smokers also did not have an effect in this study, potentially because of selection criteria; women in this study were required to have significant others who smoked to be included in the analysis, whereas in other studies all pregnant women were included. Instead, where people smoked was a stronger ETS exposure determinant than whether or how much partners/household members smoked. Further research is needed to better understand discrepancies between this finding and previous study findings.

Study strengths include the focus on identifying correlates of ETS avoidance among pregnant nonsmokers at risk, biomarker verification of self-reports, and identification of several important social contextual factors to consider in preventing ETS exposure during pregnancy. Methods and measures paralleled previous studies examining correlates of smoking cessation during pregnancy and expand on the relatively few studies that focus on ETS exposure.

Of the limitations, the most important relates to the lower detection limits for biomarker validation. Budgetary constraints limited more-sensitive biomarker analysis (e.g., $\leq$1.0 ng/ml),[90] which may have resulted in more ETS avoiders having been reclassified as being exposed to ETS, making the results different. By restricting the upper limit for passive smoke exposure to a salivary cotinine value of 17 ng/ml, some women with high-level exposure may also have been eliminated. Findings were cross-sectional, leaving it unclear whether those classified as avoiders of ETS or being exposed to ETS would remain so classified across the prenatal interval. Study generalizability is limited to lower-income, urban, black women at increased risk who seek prenatal care before 28 weeks gestation. Because these women were enrolled in a larger study based on the presence of selected risk factors, including ETS exposure, these findings are not easily compared to other studies.

Conclusion

Results highlight the importance of comprehensive prenatal screening to identify a woman's psychosocial and behavioral risks. Before addressing ETS exposure, it is important to gain a complete understanding of the social context of a woman's pregnancy. While providing behavioral counseling and skills-based interventions, it is important to consider other factors that could exacerbate risks for IPV and poor pregnancy outcomes.

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