Tobacco Smoke Use and Exposure Are Linked with Breastfeeding Psychosocial Factors and Behaviors

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Abstract: *Background and Objective;* To describe the intersection of tobacco smoke exposure with breastfeeding psychosocial predictors and practice.

Methods; This is a **s**econdary analysis of the Baby's Breath study data among a free-living people from southeastern New England**.** Participants were 843 pregnant people who use (38%), recently quit (23%) or are exposed to (39%) tobacco smoke, who intended (77%) to breastfeed, and who were 55% married, 53% primiparous, 56% unemployed, 41% non-Hispanic White, 27% Hispanic, 13% non-Hispanic Black, and 28% <21, 39% 21-25 or 33%>25 years old. Main outcome measures were self-reported breastfeeding intentions and predictors at 16- and 32-weeks gestation, breastfeeding initiation and continuation at 3 and 6 months postpartum, and tobacco use and exposure at all timepoints. Chi-square and regression models assessed breastfeeding and smoking status and associations between psychosocial scores with breastfeeding intention and smoking status.

Results; Breastfeeding variables differed by smoking exposure. Psychosocial scores were associated with breastfeeding intention. Knowledge, self-efficacy, and social support scores were associated with tobacco smoke exposure during pregnancy.

Conclusions; Breastfeeding intention, practice, and associated knowledge, self-efficacy, and social support are associated with tobacco use and exposure. Tobacco smoke avoidance messaging and breastfeeding support addressing common antecedents will likely lead to less smoke-exposed, more successfully breastfed babies with better health outcomes.

Article Summary: Breastfeeding factors are assessed among smoke exposed people early pregnancy to postpartum. Breastfeeding intention, practice, knowledge, self-efficacy, and social support are associated with tobacco exposure.

Keywords: Tobacco, Smoke, ETS, Exposure, Breastfeeding.

INTRODUCTION

The benefits of breast milk are well established [1]; however, breastfeeding in the U.S. is lower than the CDC targets, especially for exclusive breastfeeding, which is breastfeeding without any supplementation with other foods or beverages [2]. The decision to breastfeed often occurs early in pregnancy [3]. Many factors influence breastfeeding decisions including tobacco smoke exposures. People who intend to breastfeed are more likely to be older, non-Black, non-smokers, have lower weight, and higher incomes and educational attainment [4]. Those with lower education levels, socioeconomic status, full-time employment, cesarean deliveries and/or maternal smoke exposure during pregnancy tend to stop breastfeeding at or before six months [5]. Exclusive breastfeeding is recommended for six months, then continued breastfeeding while introducing complimentary foods until about twelve months [6].

Tobacco smoke use and exposure are repeatedly identified as determinants of breastfeeding. Pregnant people who smoke are less likely to intend to breastfeed [7-9], initiate breastfeeding [10-18], and stop breastfeeding earlier [15, 17, 19, 20] than non-smokers. Also quitting smoking during pregnancy is associated with subsequent higher likelihood of successful breastfeeding initiation [21, 22]. Conversely, breastfeeding is associated with less smoking, and increased smoking cessation [23], and abstinence postpartum [24]. Even during pregnancy, people who intended to breastfeed have been found to smoke less [23], be twice as likely to quit smoking [21-23]; or stay quit after pregnancy [24]. Quitting smoking during pregnancy was associated with subsequent higher likelihood of successful breastfeeding initiation [21, 22].

Psychosocial factors also influence breastfeeding. Self-efficacy [25-30], knowledge [27, 31-33], and social

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support [27, 29, 34-38], are strong predictors of breastfeeding. Considerable prior work has examined breastfeeding determinants in cross-sectional, short term longitudinal and intervention studies, though none to our knowledge have been conducted longitudinally in the context of tobacco smoke using or exposed women beginning in early pregnancy.

Examination of breastfeeding in the context of smoke use or exposure is important given their similar, but opposite influences on mortality and disease risk. Approximately 2% of pregnant people globally smoke tobacco during pregnancy, with Europe (8%) [39] and the US (6%) having higher prevalence [40]. Parental smoking during and after pregnancy is associated with increased risk of perinatal mortality [41], asthma, [42, 43] cardiovascular disease risk [44-50] and some child [51-58] and adult cancers [59, 60]. In contrast, breastfeeding directly decreases the risk for a myriad of conditions [61, 62], specifically infant morbidity and mortality, but also later metabolic and other chronic diseases, childhood cancers [63].

Smoking during lactation results in transmission of nicotine through breast milk [64, 65], as well as alterations in macronutrient, antioxidant and immune factor composition [66, 67], and may also be associated with lower breast milk volume and negatively influence infants' response to breastfeeding and breast milk [68]. Due to the high risk of health complications for smoke-exposed infants, the American Academy of Pediatrics [2] and the American College of Obstetrics and Gynecology [69] encourage mothers to quit smoking and avoid exposing their children to smoke; however, also recommend to breastfeed as the many health and nutritional benefits of breast milk outweigh and may even help reduce the many risks of smoke exposure.

Though tobacco smokes exposures and breastfeeding intentions and behaviors are interrelated, no studies to our knowledge have examined the relationship between psychosocial determinants of breastfeeding with tobacco smoke exposure or use status. Therefore, the purpose of this study is to describe the relationship between tobacco smoke use or exposure with breastfeeding intention, initiation, and duration among a sample of smoke-exposed pregnant and postpartum people, and to examine the relationship of psychosocial predictors with breastfeeding and tobacco smoke exposure or use status during and after pregnancy.

MATERIALS AND METHODS

Study Design

Data for this analysis is drawn from Baby's Breath, a randomized controlled trial of a tailored video intervention. Complete details regarding the Baby's Breath study, which aimed to reduce tobacco smoke exposure among pregnant women and their infants, are available elsewhere [70, 71]. We recruited people who spoke English, were at least 18 years of age, smoke-exposed, not pregnant with multiple babies, and not more than 16 weeks pregnant. The Institutional Review Board (IRB) for Brown University and the IRBs of recruitment sites approved of this project. Written consent was obtained from every pregnant participant on behalf of themselves and their infants.

Analytic Sample

Of the 6,187 people approached, those found to be eligible and enrolled were assigned intervention (n=360) or comparison (n=378) groups. The intervention provided three videos prenatally and two postpartum tailored to the participant's smoking or smoke exposure status, readiness to quit or avoid environmental tobacco smoke (ETS) and the supportive or resistant nature of close family while no videos were provided to the comparison group. The videos contained minimal content regarding breastfeeding that comprised less than one minute of a ~20-minute video and was identical for all participants. Both groups received paper newsletters during pregnancy and after delivery with smoking cessation and smoke avoidance content only in the intervention versions with the same infant feeding or breastfeeding content for all. Participants from both experimental groups were included in the present analysis. Excluded from the final analytical sample were those who did not report their infant's feeding method at each time point.

Measures

Telephone surveys were used to collect data at all timepoints. Demographic characteristics collected at enrollment, included age, race/ethnicity, income, education, parity and marital status. Age was asked as a continuous variable, then categorized as less than 21 years old, 21-25 years old, and older than 25 years old. Race/ethnicity responses were collapsed to non-Hispanic white, non-Hispanic Black, Hispanic, and other which included multiracial and Asian. Employment was categorized as employed full-time, employed part-time, and not employed. Annual household income was categorized as less than $10,000, between $10,000-30,000, and more than

$30,00. Income. Education responses included as less than a high school diploma, high school diploma or GED, and some college, technical school or more education. Marital status was defined as married or cohabiting versus not married or cohabiting. Parity was determined from hospital chart abstraction and coded as primiparous v. multiparous.

Participants were asked about their intention to breastfeed at baseline and 32 weeks gestation with response options including intend to breastfeed only, breastfeed and formula feed, formula feed only or undecided. For this analysis these were collapsed to "Likely Breastfeeding" indicated they planned to breastfeed exclusively, breastfeed with formula or were undecided; "Planning Formula Feeding" indicated that they only planned to feed formula. Undecided was included in the "Likely Breastfeeding" group as 57% of the undecided group went on to initiate breastfeeding [3].

Breastfeeding was assessed shortly after birth via brief calls, and full surveys at 12 weeks and 6 months postpartum. Breastfeeding initiation was defined as breastfed for at least 1 day and initiated formula or another type of supplementation later. At later follow-up, women reported if they were exclusively breastfeeding, mixed feeding (breastfeeding and formula feeding) or formula feeding. Breastfeeding status was then categorized as formula only (no breastfeeding) versus any breastfeeding (mixed feeding or exclusively breastfeeding).

Prenatal breastfeeding attitudes, knowledge, and self-efficacy were assessed using the Mitra index of breastfeeding psychosocial factors [72], which is comprised of eighteen items among five subscales identified as 'Knowledge Barriers', 'Self-efficacy', 'Embarrassment Barriers', Social and Time Barriers' and 'Social Support Barriers'. We broadened the responses to the original scale from the original 'true/false' response option to a five-point Likert scale with responses of 'agree a lot,' 'agree a little,' 'neither agree nor disagree', 'disagree a little,' and 'disagree a lot.' Responses were assigned scores from -2 to +2 where ± 2 represented a strong response, ± 1 indicated a mild response, both scored in the direction of breastfeeding support based on the original index, and 0 indicated the neutral response. A score of +2 or +1 represented a strong or mild response supporting breastfeeding.

Self-reported smoking status categorized each participant as a 'Smoker', 'Non-smoker/ETS Exposed', 'Quitter', and 'Pauser' [70, 71]. For the current analyses, 'Smoker" reflects those who reported they were currently smoking cigarettes or smoked, even a puff, in the last seven days; 'Quitter," participants reported that they do not currently smoke cigarettes, but smoked over 100 cigarettes in their lifetime, and stopped smoking during or less than three months before pregnancy; 'Non-Smoker/ETS Exposed,' participants reported not smoking cigarettes and not smoking over 100 cigarettes in their lifetime, but daily were exposed to ETS.

Statistical Analysis

Descriptive statistics were calculated for demographic characteristics. We used chi-square tests to examine associations between demographic characteristics and baseline smoking status as well as breastfeeding initiation. To identify potential confounding variables for subsequent analyses, chi-square analyses examined the relationship between each demographic variable with dependent variables (smoking and breastfeeding) at each time point. The models described below included a demographic or other characteristic if it was associated with both the dependent and independent variable using $p<0.10$ as a conservative cut-off.

The relationship between baseline smoking status (independent variable) was assessed with breastfeeding intention, initiation or active breastfeeding (dependent variables) for each time period. Crude and adjusted logistic regression models were created at each timepoint with pairwise comparisons identified between each category of the smoke variable. To assess differences between the smoking groups pairwise comparisons were calculated for each breastfeeding variable. Data were analyzed using the statistical software package STATA and statistical significance was measured at the .05 level.

Mitra overall and sub-scores at baseline and 32-weeks' gestation were examined in separate generalized linear models with concurrent breastfeeding and smoking status. Adjusted models then included demographic variables associated with both the dependent and independent variables and utilized the Tukey adjustment for multiple comparisons.

RESULTS

Participants in this analysis represented a diverse group of 843 pregnant people who average 24 years of age (Table **1**). The largest group self-identified as

Table 1: Demographic Characteristics Compared to Baseline Tobacco Smoking Status or Exposure and Breastfeeding Intention

Demographics	Overall	Smoking	Recently Quit Smoking	Non-smoker ETS Exposed	P-Value	Intended Breastfeeding	Did not Intend to Breastfeed	P-value
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Sample Size	843	152 (38)	92 (23)	154 (39)		645 (77)	198 (23)	
Age					<0.001*			<0.001*
<21	238 (28)	72 (21)	45 (21)	121 (42)		201 (31)	37 (19)	
21-25	331 (39)	142 (41)	92 (43)	97 (34)		254 (39)	77 (38)	
>25	274 (33)	130 (38)	75 (35)	69 (24)		190 (29)	84 (42)	
Race/Ethnicity								
Non-Hispanic White	351 (41)	174(51)[c]	97 (46)[c]	80 (28) [ab]	<0.001*	255 (40)	96 (48)	02*
Non-Hispanic Black	107 (13)	38 (11)	21 (10)	48 (17)		80 (12)	27 (14)	
Hispanic	226 (27)	63 (18)	60 (28)	103 (36)		189 (29)	37 (19)	
Other**	158 (19)	68 (20)	34 (16)	56 (20)		120 (19)	38 (19)	
Missing n=1								
Nativity								
Born in the US	724 (86)	315 (92)[bc]	178 (84)[a]	231 (80)[a]	<0.001*	539 (84)	185 (93)	<0.001*
Born outside of the US	119 (14)	29 (8)	34 (16)	56 (20)		106 (16)	13 (7)	
Marital status								
Never Married	373 (45)	161 (47)	90 (42)	122 (43)		270 (42)	103 (52)	
Married/cohabitating	465 (55)	179 (53)	122 (58)	164 (57)	.39	371 (58)	94 (48)	0.01*
Missing n=5								
Multiparous								
No	415 (53)	151 (47)[c]	107 (53)	157 (59)[a]		341 (57)	74 (40)	
Yes	373 (47)	171 (53)	95 (47)	107 (41)	0.01*	262 (43)	111 (60)	<0.001
Missing n=55								
Employment status								
Not Working	367 (56)	163 (61)	85 (52)	119 (53)		272 (54)	95 (61)	
Full or Part Time	288 (44)	104 (39)	79 (48)	105 (47)	.10	228 (26)	60 (39)	.13
Missing n=188								
Highest level of education								
< high school diploma	292 (35)	152 (44)[bc]	60 (29)[a]	80 (28)[a]		202 (32)	90 (45)	
High school diploma/GED	331 (40)	125 (37)	77 (37)	129 (46)	<0.001*	247 (39)	84 (42)	<.01*
Some college/tech. School	211 (25)	65 (19)	73 (35)	73 (26)		187 (29)	24 (12)	
Missing n=9								
Annual household income								
<$10,000	335 (40)	153 (45)[bc]	68 (33)[a]	114 (40)[a]		259 (41)	76 (39)	
$10,000-30,000	269 (32)	112 (33)	70 (34)	87 (30)	0.01*	205 (32)	64 (33)	0.98
>$30,000	121 (15)	37 (11)	44 (21)	40 (14)		92 (14)	29 (15)	
Missing n=118								

*: *p* value is <.05; numbers may not add to the total sample size due to missing values; NH: non-Hispanic; GED: general education degree; **: includes those identifying as multiracial. Different from: a= smoking at baseline; b=recently quit at baseline; c=non-smoker/ETS exposed at baseline.

Table 2: Breastfeeding Intention, Initiation and Later Behaviors by Baseline and Concurrent Smoking Status

Concurrent Smoking Status						
Infant Feeding Intention or Status	**Total Sample**	**Smoking**	**Recently Quit Smoking/ Still Quit**	**Non-smoker ETS Exposed**	**Crude P-value**	**Adjusted P-value**
		n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Baseline Intention	n=843	344 (40)	212 (25)	287 (34)		
Breastfeeding or Unsure	645 (77%)	234 (68)	171 (81)	240 (84)	<.001*	<.01*
Formula Only	198 (23%)	110 (32)	41 (19)	47 (16)		
32 weeks gestation Intention	n=691	238 (34)	208 (30)	235 (35)		
Breastfeeding or Unsure	452 (65)	80 (59)[b]	91 (83)[a]	130 (86)	<.001*	<.001*
Formula Only	95 (35)	55 (41)	19 (17)	21 (14)		
At Birth	n=495	150 (30)	161 (33)	184 (37)		
Initiated Breastfeeding	319 (64)	40 (39)[b]	56 (65)[a]	71 (70)	<.001*	<.001*
No Breastfeeding	176 (36)	63 (61)	30 (35)	30 (30)		
3 Months Postpartum	n=473	201 (42)	100 (21)	172 (36)		
Any Breastfeeding n=82 (25%)	113 (24)	31 (15)[b]	39 (39)[a,c]	43 (25)[b]	<.001*	<.001*
Formula Only n=242 (75%)	360 (76)	170 (85)	61 (61)	129 (75)		
6 Months Postpartum	n=493	247 (50)	76 (15)	179 (34)		
Any Breastfeeding n=33 (10%)	48 (10)	17 (7)[b]	14 (18)[a,c]	17 (10)[b]	.02*	.01*
Formula Only n=308 (90%)	445 (90)	230 (93)	62 (82)	153 (90)		

*: *p* value is <.05; Pairwise nomenclature indicates significant difference in crude analysis from: a= smoking; b=quit/pause; c=non-smoker ETS exposed. Baseline and 32 weeks analyses are adjusted for race/ethnicity, age, parity and income. Breastfeeding initiation and breastfeeding status at 3 and 6 months are adjusted for race, age, parity and education.

non-Hispanic white (41%), but the sample also included non-Hispanic Black (13%), Hispanic (27%), and others (19%) who did not self-identify into one of those groups. Of the full sample, 45% identified as being married/cohabiting and the majority (56%) were not employed. More than one-third (35%) achieved less than high school education and another slightly more than a third finished high school (40%), and one quarter attended at least some college or technical school. The largest group (40%) reported <$10,000 household income, 32% reported $10,000-$30,000, and the smallest group (15%) reported>$30,000. Smokers represented 38% of the total sample, while 23% had recently quit, and 39% were non-smokers who were regularly exposed to tobacco smoke. Early in pregnancy 77% of participants intended to breastfeed, and formula, 23% intended to not breastfeed at all. Over half (64%) initiated breastfeeding and 25% were still breastfeeding at 12 weeks and 10% at 6 months (Table **2**).

Participants' smoke exposure status varied by several demographic characteristics. Baseline smokers and quitters were less likely to be non-Hispanic White (50 and 46% respectively) compared with non-smokers (28%) (p <.01). Smokers were more likely to be born in

the US (92%) compared with quitters (84%) and non-smokers (80%, p<0.01). Smokers were less likely to be multiiparous (47%) than non-smokers (59%, p=0.01). Smokers were also more likely to be in the lowest educational group (44%) and income group (45%) compared with quitters (29% and 33%, respectively) and non-smokers (28% and 40%, respectively, p <0.01 for all pairwise comparisons).

Breastfeeding intention was associated with several demographic characteristics. Participants who intended to breastfeed were more likely to be younger (p<0.01), non-White (p=0.02), born outside of the US (<0.01), primiparous (p<0.01), and of higher education (p<0.01) than those who did not initiate breastfeeding.

Breastfeeding intention, initiation, and status differed significantly by smoking status at each time point in crude analyses (Table **2**, p<0.05 for each). In adjusted models, relationships between smoke exposure and breastfeeding intention or status were maintained at all time points (p<0.01). Participants who smoked at baseline were less likely to intend to breastfeed (68%) compared to non-smoker/ETS exposed (86%, p<0.01). At 32 weeks, smokers were also less likely to intend to breastfeed (59%) compared to those who recently quit (83%, p<0.05). Smokers were also less likely to initiate breastfeeding (39%) compared to recent quitters (65%, p<0.01). Also, quitters were more likely to still be breastfeeding at 3 and 6 months (39% and 18%) compared to those still smoking (15% and 7% respectively, p<0.01 for both) and smoke-exposed non-smokers (25% and 10% respectively, p<0.05).

The psychosocial variables associated with breastfeeding (Mitra scores) were all found to be associated with concurrent breastfeeding intention and most with concurrent smoking status (Table **3**). The Overall Mitra score and all sub-scores were higher with breastfeeding intention, initiation and continuation at every time point (p<0.01) in both crude and adjusted

Table 3: Mean Mitra overall and Adjusted Sub-scores by Concurrent Infant Feeding Intention and Smoking/Smoke Exposure Status at Baseline and 32 Weeks Gestation

		Overall Mean (Std. Dev) (n)	Any Breastfeeding or Unsure Mean (SD) (n)	No Breastfeeding Mean (SD) (n)	P-value (2 sided)	Overall Mean (SD) (n)	Smoke Mean (SD) (n)	Quit or Pause Mean (SD) (n)	Non Smoke ETS Exposed Mean (SD) (n)	P-value (2 sided)
Mitra Overall	Baseline	0.43 (0.54)(543)	0.84 (0.56)(412)	0.03 (0.51)(131)	<0.001*	0.66 (0.65)(501)	0.52 (0.67)(205)[b,c]	0.76 (0.68)(121)[a]	0.69 (0.59)(175)[a]	0.02*
	32 weeks	0.59 (0.55)(419)	0.97 (0.55)(317)	0.21 (0.55)(102)	<0.001*	0.79 (0.63)(418)	0.63 (0.69)(145)[b,c]	0.90 (0.59)(123)[a]	0.84 (0.60)(150)[a]	<0.001*
Knowledge	Baseline	0.57 (0.77)(547)	0.96 (0.77)(416)	0.18 (0.78)(131)	<0.001*	0.79 (0.84)(541)	0.69 (0.88)(220)	0.86 (0.85)(126)	0.82 (0.78)(195)	0.19
	32 weeks	0.72 (0.77)(451)	1.13 (0.73)(341)	0.32 (0.82)(110)	<0.001*	0.93 (0.81)(449)	0.78 (0.91)(155)[b]	0.99 (0.77)(129)[a]	1.03 (0.77)(165)	0.02*
Self-Efficacy	Baseline	0.50 (0.91)(543)	1.13 (0.85)(412)	-0.13 (0.97)(131)	<0.001*	0.85 (1.02)(501)	0.61 (1.11)(205)[b,c]	0.97 (1.04)(121)[a]	0.96 (0.91)(175)[a]	0.02*
	32 weeks	0.56 (0.94)(422)	1.21 (0.82)(320)	-0.08 (1.05)(102)	<0.001*	0.89 (1.02)(418)	0.64 (1.17)(145)[b,c]	0.98 (0.97)(123)[a]	1.07 (0.92)(150)[a]	0.02*
Embarrassment Barriers	Baseline	-0.27 (1.10)(543)	0.00 (1.11)(412)	-0.54 (1.09)(131)	<0.001*	-0.11 (1.14)(501)	-0.18 (1.14)(205)	0.06 (1.20)(121)	-0.21 (1.07)(175)	0.17
	32 weeks	-0.09 (1.14)(450)	0.19 (1.17)(340)	-0.37 (1.11)(110)	<0.001*	0.06 (1.17)(418)	-0.07 (1.27)(145)	0.21 (1.15)(123)	0.04 (1.11)(150)	0.27
Time and Social Barriers	Baseline	0.75 (0.80)(504)	1.10 (0.75)(383)	0.40 (0.86)(121)	<0.001*	0.95 (0.83)(501)	0.84 (0.85)(205)	0.99 (0.82)(121)	1.01 (0.83)(175)	0.33
	32 weeks	0.91 (0.81)(423)	1.25 (0.69)(321)	0.57 (0.94)(102)	<0.001*	1.08 (0.80)(418)	0.97 (0.86)(145)	1.16 (0.74)(123)	1.12 (0.81)(150)	0.27
Social Support Barriers	Baseline	0.66 (0.82)(547)	1.10 (0.76)(416)	0.23 (0.87)(131)	<0.001*	0.91 (0.86)(501)	0.72 (0.88)(205)[b,c]	1.01 (0.80)(121)[a]	1.00 (0.90)(175)[a]	0.01*
	32 weeks	0.86 (0.84)(454)	1.18 (0.81)(344)	0.55 (0.86)(110)	<0.001*	1.04 (0.84)(418)	0.84 (0.86)(145)[b]	1.20 (0.76)(123)[a]	1.07 (0.88)(150)	0.02*

*: *p* value is <.05. Adjusted baseline breastfeeding models included the following covariates at baseline: Mitra overall: Race and education; Knowledge: none; Self-Efficacy: age, race, education, parity; Embarrassment: Education; Time Barriers: Parity, Social Support: race; and at 32 weeks: Mitra overall: Race and education; Knowledge: education; Self-Efficacy: age, education, paritiy; Embarrassment: race, education; Time Barriers: parity, Social Support: race. Adjustment for baseline tobacco smoke use and exposure models included at baseline and 32 weeks: Mitra overall: race, education, parity; Self-Efficacy, Embarrassment, Time and Social Barriers and Social Support: Age; Embarrassment: education; and Knowledge at baseline: income, Knowledge at 32 weeks: education.

models. At each time point, participants planning to breastfeed or undecided averaged higher overall and Mitra sub-scores compared with participants planning to only formula feed.

Overall Mitra score at baseline and at 32 weeks were associated with concurrent smoking status in both crude and adjusted models ($p \leq 0.01$ for both models at both time points). Smokers had lower Overall Mitra scores (0.52 baseline and 0.65 at 32 weeks) compared with recent quitters (0.76 and 0.85 respectively) and ETS-exposed non-smokers (0.73 baseline and 0.86 at 32 weeks, $p=0.02$ and $p<0.01$ respectively).

Knowledge barriers scores differed by smoke status in both crude and adjusted models at 32 weeks gestation ($p<0.05$), but not at baseline. At 32 weeks, smokers (0.77) averaged lower than quitters (0.99, $p<0.05$).

Self-efficacy and social support barriers to breastfeeding also differed by smoking status at both baseline and 32-weeks. Self-efficacy scores differed by smoking status at both prenatal time points. Smokers averaged lower self-efficacy at baseline and 32 weeks (0.61 and 0.64 respectively) compared to quitters (0.97 and 0.98, respectively) and non-smoker/ETS exposed (0.96 and 1.07, respectively, $p<0.05$). Social support barriers also differed by smoking status at both prenatal time points in both crude and adjusted models. Smokers scored lower on social support barrier scores (higher barriers) at both baseline and 32 weeks (0.72 and 0.84, respectively compared with quitters (1.01 and 1.20, respectively) and ETS-exposed non-smokers at baseline (1.00 v. 1.07, respectively, $p<0.05$ for each). Neither Embarrassment Barrier or Time and Social Barrier differed by smoking status in crude or adjusted models at both time points.

DISCUSSION

This paper establishes a clear relationship between tobacco smoke exposures with breastfeeding early and late pregnancy intention, initiation, and breastfeeding continuation. Moreover, psychosocial factors associated with breastfeeding are also associated with smoking or smoke exposure early in pregnancy, which might account for some of the observed associations with breastfeeding. To our knowledge, this is the first study to examine the relationship between early pregnancy smoking status or ETS exposure with breastfeeding psychosocial factors associated.

Tobacco smoke exposures of pregnant people in the Baby's Breath study are associated with breastfeeding intention, initiation, and continued breastfeeding at 3 months post-partum with trends for differences also at 6 months postpartum. Our findings confirm the small prior literature showing that smokers are less likely to intend to breastfeed during pregnancy [7, 8], initiate breastfeeding, [10-13, 18] and breastfeed for a shorter period of time [19, 20]. Also, ETS exposed pregnant people are also less likely to intend to or initiate breastfeeding [11] and to stop breastfeeding earlier than non-exposed women [73]. Ours is one of few studies to determine these associations in a single, prospective study.

Our study is also the first to prospectively link psychosocial determinants to both breastfeeding and tobacco smoke exposure status. Associations between tobacco smoke exposure and breastfeeding can be partially explained by attitudes of women who smoke [74]. Previous studies of somewhat vaguely identified "attitudes" might fit well with the Mitra psychosocial predictors we measured. For example, smokers are much less likely to believe smokers should breastfeed according to our own Baby's Breath data,(data not shown) and others [74, 75]. Worry about exposing their children to smoke toxicants has been identified as a disincentive to breastfeed in qualitative studies [76-78], which may decrease breastfeeding among those who then believe that their own breast milk is toxic or dangerous to their infants [5].

This belief among smokers that it is not appropriate to breastfeed may indicate a lower level of knowledge and could certainly decrease a pregnant person's confidence in breastfeeding, which are two of the strongest constructs we found to be associated with smoking. Lower confidence in breastfeeding has been shown among women who smoke or recently quit compared with non-smokers [79]. We also found lower educational attainment to be associated with lower breastfeeding intention and higher likelihood of smoking as well as lower breastfeeding self-efficacy at baseline and breastfeeding knowledge at 32 weeks. Younger age is also associated with breastfeeding self-efficacy and smoking status throughout pregnancy as well as breastfeeding intention at 32 weeks, as others have found [80]. Importantly, the relationship between breastfeeding knowledge and self-efficacy with outcomes in the current study was sustained after adjustment for potential confounders, which included age and education as appropriate.

Social support is also associated with smoking status in our findings. Support from healthcare providers, their partner, family, including key female

relatives, and the workplace are all identified as important predictors of breastfeeding initiation [81, 82] and continuation [83-86]. Family and partners constitute an interpersonal sphere of support based on the socioecological model [27, 87]. Though many interventions include outreach to this interpersonal level, people's emotional experiences with breastfeeding may include guilt, feelings of failure, and isolation if their breastfeeding was unsuccessful [88]. It makes sense that the family and partner who's support is needed for breastfeeding might also have a significant influence on smoking behaviors and exposures for pregnant people and new mothers [89, 90].

As we consider these findings, we also acknowledge the study limitations. The sample size is somewhat small and geographically limited to draw expansive conclusions. Also, as these findings are based in a tobacco smoke using or exposed sample, we are not able to make comparisons to non-smoke exposed women of similar SES. However, these findings are based on analysis of a moderate sized sample followed prospectively.

In conclusion, this study strengthens the literature demonstrating the relationship between breastfeeding intention, initiation and continuation with tobacco smoke exposures and further demonstrates that breastfeeding knowledge, self-efficacy and social support also serve as predictors of tobacco smoke status, which may indicate shared antecedents of these important behaviors. Future research must focus attention on inclusion of both smoking cessation and avoidance with breastfeeding support in all prenatal health programs and messaging. Child health has the potential to be enormously enhanced by identifying the most successful methods of encouraging and supporting tobacco smoke avoidance and successful breastfeeding.

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DECLARATION OF CONFLICT OF INTEREST

The Authors declares that there are no relevant financial or non-financial competing interests to report.

AUTHOR CONTRIBUTIONS

Dr. Patricia Markham Risica conceptualized and designed the study, and critically reviewed and revised the manuscript.

Anna Alikhani carried out the initial analyses, drafted the initial manuscript, and coordinated and supervised author feedback, and critically reviewed and revised the manuscript.

Melanie Morales, Samantha Buyungo, Paola Solano, and Selena Evora critically reviewed and revised the manuscript.

Dr. Tayla von Ash participated in conceptualization of the manuscript, critically reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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DATA SHARING

Deidentified individual participant data (including data dictionaries) will be made available. The data will be made available upon publication to researchers who provide a methodologically sound proposal for use in achieving the goals of the approved proposal. Proposals should be submitted to patricia_risica@brown.edu.

ABBREVIATIONS

ETS = Environmental Tobacco Smoke

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