ORIGINAL INVESTIGATION

Prepartum and Postpartum Predictors of Smoking

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ABSTRACT

Introduction: Reduction of smoking during pregnancy and in the postpartum period remains a public health priority. This study tested whether variables (demographic, pregnancy related, emotional, and smoking related) assessed in abstinent women during their pregnancy predicted resumed smoking at 1 month and 1 year postpartum. Additionally, pregnancy-related and smoking-related variables obtained in the immediate postpartum period were examined as predictors of smoking at 1 year postpartum.

Methods: Participants were pregnant women in their second and third trimester ($N = 504$) who enrolled in a randomized controlled trial of a smoking relapse-prevention intervention. Multivariate regression analyses were conducted with baseline data collected during pregnancy and follow-up assessments completed at 1 month and 12 months postpartum.

Results: Independent predictors of smoking at 1 month postpartum included not intending to remain abstinent, lower quitting confidence, the presence of other household smokers, and not planning to breast feed. Smoking at 12 months postpartum was predicted by only not intending to remain abstinent and having a partner who maintained his or her smoking rate. In contrast, when assessed at 1 month postpartum, smoking at 12 months was predicted by current smoking status and lower quitting confidence.

Conclusions: Baseline variables measured during pregnancy differentially predicted early versus late smoking status. After delivery, the best predictor of later smoking status was current smoking status, reinforcing the need to focus on preventing early postpartum relapse. The importance of quitting confidence, or self-efficacy, was also reinforced. Findings may be useful for screening women at risk of relapse and targeting interventions to key variables.

INTRODUCTION

The reduction of smoking during pregnancy and in the postpartum period remains a public health priority and objective of the Department of Health and Human Services Healthy People 2020 (U.S. Department of Health and Human Services, 2011). Maternal smoking results in myriad adverse health outcomes not only for the mother, but also for her fetus. For instance, smoking during pregnancy is associated with increased risk of premature birth, low birth weight, and stillbirth (U.S. Department of Health and Human Services, 2004). Additional, possibly greater, risks stem from exposure to tobacco smoke during infancy and childhood. Examples of potential negative outcomes include heightened risk of sudden infant death syndrome, increased rates of ear infections, and greater chance of developing asthma and behavioral problems (U.S. Department of Health and Human Services, 2006).

Despite the decrease in smoking prevalence rates during pregnancy, smoking relapse in the postpartum period occurs at alarmingly high rates (Mullen, 2004; Su & Buttenheim, 2013).

The majority of research related to smoking during pregnancy has focused on cessation and the efficacy of cessation interventions during pregnancy (Lumley et al., 2009). Research on the maintenance of smoking abstinence has received far less attention. Moreover, most previous interventions designed to reduce smoking relapse have shown limited efficacy (Agboola, McNeill, Coleman, & Leonardi Bee, 2010).

In an effort to reduce smoking relapse among the general population of smokers, our research team previously developed an efficacious and a cost-effective self-help intervention entitled, *Forever Free* (Brandon, Collins, Julian, & Laze, 2000). Based on this prior work and the critical need to address postpartum smoking relapse, we adapted the *Forever Free* booklets for pregnant/postpartum women in a series entitled, *Forever Free for Baby and Me* (FFB). Information regarding the development and content of these booklets can be found in a prior publication (Quinn et al., 2006). We recently completed a randomized clinical trial (RCT) to test the efficacy of the FFB intervention for reducing postpartum relapse (Brandon et al., 2012). Pregnant women ($N = 504$) were randomized to receive either

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the series of 10 FFB booklets distributed through 8 months postpartum or to usual care control (UCC) comprising existing materials from the National Cancer Institute (National Cancer Institute, 2003) and the American Cancer Society (American Cancer Society, 2002). Results indicated that the FFB booklets produced higher abstinence rates than UCC at 8 months postpartum (69.6% vs. 58.5%, $p < .05$); however, the significant intervention effect was not observed at 12 months postpartum. Several key demographic (e.g., age, income, education), smoking-related (e.g., years smoked, household and partner smoking), emotional (e.g., depression), and pregnancy-related variables (e.g., nausea, breast-feeding intentions) were examined as moderators of intervention outcomes. Results revealed that the intervention effects were moderated by household income and age. Among women with annual household incomes below \$30,000 the FFB intervention condition produced significantly higher abstinence rates at both 8 (72% vs. 54%) and 12 months (72% vs. 51%) postpartum. In contrast, no effect was found for higher income women. With regard to age, higher abstinence rates were observed for younger women receiving the FFB intervention.

Because the FFB intervention represents one of the few successful attempts at reducing relapse among pregnant women, more research is needed to understand the predictors of postpartum smoking relapse to better target and design interventions for this important and at-risk group. Previous research has identified psychosocial and socioeconomic factors related to postpartum smoking relapse such as depression and anxiety (Park et al., 2009); friends, partners, and family members who smoke (Solomon et al., 2007; Kahn, Certain, & Whitaker, 2002; Harmer & Memon, 2013); youth (Colman & Joyce, 2003), education and income (Tong et al., 2009); weight concerns (Levine, Marcus, Kalarchian, Houck, & Cheng, 2010); and lower overall motivation (Heppner et al., 2011). Furthermore, breast feeding has been associated with decreased risk of smoking relapse (Harmer & Memon, 2013; Kendzor et al., 2010). As noted, our prior study examined several of these aforementioned variables as moderators of treatment outcomes and revealed few significant interactions (i.e., only the highly correlated variables of age and income were related to treatment effects).

The goal of the present study was to use the large sample of prospective data collected during our previously completed RCT to further explore demographic, pregnancy-related, emotional, and smoking-related variables (collected during the second and third trimester) as predictors of relapse at 1 month and 1 year postpartum. In addition, we sought to examine pregnancy-related and smoking-related measures obtained approximately 1 month postpartum as predictors of smoking relapse at 1 year postpartum. We are unaware of previous studies that have used data collected in the immediate postpartum period (i.e., 1 month after due date) to predict postpartum relapse at a later time point. Because motivational, emotional, and situational factors change during and after pregnancy, it is plausible that the relative importance of individual relapse risk factors would vary depending on pregnancy stage (i.e., prepartum vs. postpartum). Thus, learning this information would allow us to better target and tailor our interventions. Moreover, the immediate postpartum period coincides with a time during which women have contact with health care providers, either via an obstetrical/gynecological postpartum visit or a pediatric appointment. As such, women could be screened for relapse risk factors at a point when their smoking abstinence

is typically less emphasized. Importantly, our study builds on prior research by including both short- and long-term follow-up and assessing both prepartum and postpartum predictors of smoking relapse.

METHODS

Participants

Participants were recruited for a large RCT designed to test the efficacy of a minimal, self-help intervention for reducing postpartum relapse (see Brandon et al., 2012 for results of this parent study). Telephone numbers were purchased from a direct marketing company for 41,377 purportedly pregnant women. Using a proactive recruitment strategy, we made three attempts for each telephone number. Women ($n = 7,943$) were screened for the following eligibility criteria: at least 18 years of age; able to speak and read English; currently in months 4–8 of pregnancy; previously smoked at least 10 cigarettes/day for at least 1 year prior to pregnancy; quit smoking either in anticipation of, or during pregnancy; and had abstained for the past week. Women meeting inclusion criteria ($n = 731$) were invited to join the study in which they would receive information about maintaining tobacco abstinence and be asked to complete questionnaires by mail. We had a high acceptance rate of 96% ($n = 705$). We obtained verbal informed consent and HIPAA (Health Insurance Portability and Accountability Act) authorization from the women.

Procedures

Participants were randomly assigned to our FFB intervention condition or UCC comprised of a booklet from the National Cancer Institute entitled, *Clearing the Air* (National Cancer Institute, 2003) and a pamphlet from the American Cancer Society entitled, *Living Smoke-free for You and Your Baby* (American Cancer Society, 2002). The FFB intervention consisted of 10 booklets, distributed through 8 months postpartum, covering topics such as *Smoking, Stress, and Mood*; *Smoking and Weight*; *Life Without Cigarettes*; and a *Partner Support* booklet designed to be shared with the partner. Additional details describing the development and content of the FFB booklets can be found in a separate publication (Quinn et al., 2006).

Participants were mailed a baseline assessment at the time of enrollment and follow-up assessments at 1, 8, and 12 months post expected due date. Participants were compensated \$20 for completing the baseline, and \$25, \$30, and \$35 for the follow-up assessments, respectively.

Measures

Demographic and Smoking Variables

Participants provided demographic (e.g., age, household income, race, ethnicity, education, number of people, and children in the home) and smoking information (e.g., number of years smoked prior to pregnancy, average cigarettes per day, number of cigarettes smoked in past week). Smoking status at baseline was classified using 7-day point prevalence criteria (i.e., no smoking in previous 7 days was recorded as abstinent). We also included an item measuring quitting confidence and

the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991), reworded to reflect prequit level of dependence. Prior research has indicated that pregnant women may have intentions to suspend their smoking behavior solely during the pregnancy (Stotts, DiClemente, Carbonari, & Mullen, 1996), thus we also assessed intentions to remain quit postpregnancy. In addition, participants reported their partners' smoking status before and after the pregnancy, including changes in their partners' smoking rate due to the pregnancy (i.e., whether they cut down, stopped, or continued to smoke the same amount).

Pregnancy-Related Variables

We assessed several pregnancy-related variables at baseline including number of prior pregnancies, history of miscarriage, self-reported overall health during pregnancy, nausea severity, importance of postpartum weight loss, plans to return to work, and intentions to breast feed.

Mood and Partner Support

We assessed depressive symptomatology with the Center for Epidemiologic Studies—Depression (CES-D; Radloff, 1977) scale as well as an additional item to assess depression vulnerability (“Are you the type of person who easily becomes very depressed, sad, blue, or down in the dumps?”) using a 7-point Likert scale. The Partner Interaction Questionnaire (PIQ) was used to assess perceived partner support for quitting smoking. The PIQ is a 20-item measure comprised of two scales assessing positive and negative partner behaviors related to smoking cessation (Cohen & Lichtenstein, 1990).

Follow-Up Assessments

Participants were mailed three follow-up assessments that corresponded to 1, 8, and 12 months postpartum. We present only the 1 month and 12 months data in this article as they are representative of short- and long-term follow-up points (and early and late relapse). At each follow-up, we assessed smoking status using 7-day point prevalence criteria. We also collected biosamples (breath carbon monoxide and saliva) on a small subsample ($n = 22$) of women living within 100 miles of the laboratory. Of the 22 women tested, 21 provided biosamples consistent with their self-reported abstinence (see Brandon et al., 2012, for additional details). In addition, we included a measure of depressive symptomatology (CES-D), a single item assessing partner support, partner's smoking status, an item measuring self-efficacy to be abstinent in the next 6 months, and breast-feeding status.

Data Analyses

Baseline variables were tested as univariate relative risk factors of smoking at 1 month and 12 months postpartum. Because of the prospective orientation of the study, relative risk was assessed rather than odds ratio using a modified Poisson regression approach (Zou, 2004). Predictors were assessed with treatment group as a covariate. The interaction between each predictor variable and treatment was assessed. Significant interactions were explored by testing the predictor within each treatment group. A backward stepwise regression approach was employed using a significance level of $p < .10$ to be included in the multivariate model. A similar analysis was conducted

using data collected at the 1-month follow-up to predict smoking relapse at 12 months.

Multiple imputation procedures were used for missing data at baseline and the follow-ups (~10%). We applied a Markov Chain Monte Carlo method (e.g., Schafer, 1997) to impute 10 datasets using PROC MI in SAS/STAT® software version 9.1 (same as for Brandon et al., 2012). The multiple imputations incorporated 46 variables: (a) smoking status at each follow-up, (b) all baseline and follow-up measures assessed as prospective predictors of 1 month and 12 months smoking status, and (c) several auxiliary variables that were related to smoking status.

RESULTS

Participant Characteristics

We received baseline assessments from 594 (84%) of the 705 women who consented to join the study. Of these, 504 (85%) remained eligible based on inclusion criteria, and they constituted the final sample. Return rates for the 1 month and 12 month assessments were 88% and 79%, respectively. Most participants were Caucasian (92.3%) and married (69.6%). Participants were on average 25.8 years old and prior to quitting had smoked an average of 15.2 cigarettes per day for 8.6 years. Table 1 presents additional descriptive characteristics as reported at the baseline assessment.

Smoking Status

All participants in the current study self-reported abstinence when the baseline questionnaire was completed. Smoking rates at 1, 8, and 12 months were 27.2%, 37.1%, and 39.9%, respectively. Figure 1 displays movement and change in smoking rates from baseline to the 1- and 12-month follow-up periods, our primary timepoints of interest. As illustrated, among women who were abstinent at 1 month, approximately one third were smoking at 12 months.

Predictor Outcomes

Baseline Variables Associated With Resumption of Smoking at 1 Month and 12 Months Postpartum

Baseline demographic, pregnancy-related, and smoking-related variables were examined as predictors of resuming smoking approximately 1 month after delivery. There were no significant interactions of a predictor with treatment. Significant univariate predictors ($p < .10$), after controlling for treatment, are shown in Table 2. The eight significant relative risk factors, along with treatment condition, were then entered into a multivariate model and tested using a backward stepwise regression method. The final model demonstrated that increased risk of resuming smoking was related to several baseline smoking variables including not planning to quit for good ($RR = 2.15$, $CI = 1.51$ – 3.05 , $p < .001$), lower confidence in the ability to maintain abstinence ($RR = 1.14$, $CI = 1.02$ – 1.27 , $p = .02$), and having another smoker in the house ($RR = 1.45$, $CI = 1.01$ – 2.06 , $p = .04$). Fewer total years of smoking ($RR = 1.03$, $CI = 1.00$ – 1.07 , $p = .06$) and having a partner who maintained their smoking rate during the pregnancy ($RR = 1.29$, $CI = 0.98$ – 1.71 , $p = .07$) were marginally significant. Among pregnancy-related variables, no intention to

Table 1. Descriptive Statistics for Demographic and Other Baseline Variables (Responders Only)

	<i>M (SD), %, or Md</i>	<i>N</i>
Demographic variables		
Age	25.8 (5.6)	504
Race		
White/Caucasian	92.3%	504
Black/African American	4.4%	
Other	3.3%	
Hispanic ethnicity	5.8%	504
Education		
Less than high school diploma	9.1%	504
High school diploma	35.1%	
College or technical school	55.8%	
Married	69.6%	504
Employed	41.5%	504
Household income (category)	\$30–40,000	501
Pregnancy-related variables		
Number of pregnancies	2.2 (1.4)	503
Healthy pregnancy rating (1–5)	4.3 (0.8)	504
Nausea rating (1–5)	2.8 (1.5)	504
Had prior miscarriage(s)	26.2%	493
Planning to breast feed	77.6%	499
Smoking variables		
Abstinent	100.0%	504
Years of smoking	8.6 (4.8)	504
Number of cigarettes per day	15.2 (6.6)	503
Fagerström Test for Nicotine Dependence (FTND) score (before quitting; 0–10)	3.7 (2.2)	504
Quit smoking in first trimester or earlier	86.7%	
Other smoker(s) in house	53.6%	504
Plan to quit for good: %	69.0%	503
Confidence rating (abstinent in future; 1–5)	3.7 (1.1)	504
Partner currently smokes	54.6%	498
Partner smoked as much as before pregnancy	31.5%	498
Mood and partner support variables		
PIQ—positive (0–40)	18.8 (10.5)	498
PIQ—negative (0–40)	11.3 (9.3)	498
Partner is husband/boyfriend	92.3%	504
Lives with partner	83.0%	501
Hours (waking) with partner (category)	3–5 hours	501
Important to lose weight eating (1–5)	4.3 (1.1)	504
CES-D (0–60)	16.7 (10.4)	504
Depression proneness (1–7)	3.5 (1.8)	504

Note. PIQ = Partner Interaction Questionnaire; CES-D = Center for Epidemiologic Studies—Depression.

breast feed ($RR = 1.41$, $CI = 1.06$ – 1.88 , $p = .02$) was the sole variable significantly related to resuming smoking.

Baseline variables were also examined as predictors of relapse at 12 months postpartum. There were no significant interactions of a predictor with treatment. Table 2 displays predictor variables with p values less than .10, with treatment condition as a covariate. The final model demonstrated that increased risk of resuming smoking at 12 months was related to two baseline smoking variables: participants who had no intention to quit for good ($RR = 1.46$, $CI = 1.16$ – 1.85 , $p = .002$) and women who reported having a partner who smoked as much during pregnancy as before pregnancy ($RR = 1.37$, $CI = 1.09$ – 1.70 , $p = .006$).

Variables at 1 Month Follow-Up Related to Smoking Relapse at 12 Months Postpartum

Figure 1 displays the transition in smoking status from the 1 month follow-up to the final 12 months follow-up. Variables

Figure 1. Change in smoking status over time. Values based on the first of 10 datasets created by multiple imputations.

collected at the 1 month follow-up were used to predict smoking status at the 12 months follow-up. Predictor variables included smoking status, confidence, partner smoking status, level of partner support, breast-feeding status, and depressive

Table 2. Individual Baseline Measures as Relative Risk Factors for Smoking at 1-Month and 12 Months Postpartum

Relative risk factor	As a single factor		As a factor in final model	
	<i>p</i>	<i>RR</i> (95% CI)	<i>p</i>	<i>RR</i> (95% CI)
Smoking at 1 month				
Not planning to quit for good	<.0001	2.87 (2.10, 3.90)	<.001	2.15 (1.51, 3.05)
Less confident of not smoking 6 months postpartum (1–5)	<.0001	1.35 (1.21, 1.51)	.02	1.14 (1.02, 1.27)
Another smoker in household	.0002	1.91 (1.54, 3.72)	.04	1.45 (1.01, 2.06)
Partner smoked as much as before pregnancy	.0010	1.63 (1.22, 2.19)	—	—
Not planning to breast feed	.0035	1.63 (1.18, 2.26)	.02	1.41 (1.06, 1.88)
Less education than diploma/GED	.0121	1.64 (1.11, 2.42)	—	—
Lower partner positive support style (0–40)	.0492	1.01 (1.00, 1.03)	—	—
Fewer total years of smoking (1–25)	.0557	1.04 (1.00, 1.07)	—	—
Smoking at 12 months				
Not planning to quit for good	.0005	1.52 (1.20, 1.92)	.002	1.46 (1.16, 1.85)
Less confident of not smoking 6 months postpartum (1–5)	.0025	1.54 (1.13, 2.10)	—	—
Partner smoked as much as before pregnancy	.0024	1.41 (1.13, 1.76)	.006	1.37 (1.09, 1.70)
Another smoker in household	.0245	1.32 (1.04, 1.68)	—	—

Note. All variables were assessed with treatment condition as a covariate (1 month, *p* values > .78; 12 months, .097 < *p* values < .142). Variables retained in the final model following backward stepwise regression are in bold.

Table 3. Measures at 1 Month Postpartum as Relative Risk Factors for Smoking at 12 Months

Relative risk factor	As a single factor		As a factor in final model	
	<i>p</i>	<i>RR</i> (95% CI)	<i>p</i>	<i>RR</i> (95% CI)
Smoking at 12 months				
Smoking at 1 month	<.0001	2.42 (1.96, 3.00)	.002	1.70 (1.21, 2.38)
Less confident of not smoking in 6 months (1–5)	<.0001	1.33 (1.25, 1.42)	.002	1.17 (1.06, 1.29)
Lower partner support rating (1–5)	.0027	1.50 (1.16, 1.94)	—	—
Partner currently smokes	.0123	1.36 (1.07, 1.73)	—	—

Note. All variables were assessed with treatment condition as a covariate (*p* values > .12). Variables retained in the final model following backward stepwise regression are in bold.

symptomatology. Table 3 shows relative risk factors with *p* values less than .10.

In the regression model, smoking at 1 month (*RR* = 1.70, *CI* = 1.21–2.38, *p* = .002) and lower confidence about not smoking in the next 6 months (*RR* = 1.17, *CI* = 1.06–1.29, *p* = .002) remained significant risk factors for smoking at 12 months. To further understand confidence as a risk factor, additional analyses were performed for those abstinent and for those smoking at 1 month. Results revealed that confidence was a significant predictor for both groups: abstinent (*RR* = 1.32, *CI* = 1.12–1.56, *p* = .001) and smoking (*RR* = 1.13, *CI* = 1.02–1.25, *p* = .019).

DISCUSSION

Given high postpartum smoking rates, and limited success in developing effective relapse-prevention interventions, we sought to identify variables that could be of use to both researchers and clinicians for distinguishing women both during and after pregnancy who remain at risk for smoking relapse. Our study revealed several variables that can be targeted in future

relapse-prevention interventions or used to identify high-risk subpopulations of pregnant smokers.

Consistent with prior research (Harmer & Memon, 2013; Levine et al., 2010), women who had other smokers in their household were more likely to be smoking at 1 month postpartum. These results are also similar to studies with the general smoking population, indicating that household smoking is a significant risk factor for smoking relapse (Zhou et al., 2009). In addition to the presence of other smokers in the household, women reported more specifically on whether their pregnancy status caused a change in their partners' smoking behavior. Women with partners who did not alter their smoking behavior were more likely to be smoking at 12 months postpartum. Together, these findings imply the need to include effective intervention strategies for reducing the impact/risk of being around other smokers. Examples of such interventions include implementing household smoking bans (e.g., Ashford, Hahn, Hall, Rayens, & Noland, 2009; Sockrider, Hudmon, Addy, & Dolan Mullen, 2003) and learning how to avoid smokers or how to cope with urges to smoke around other smokers. Indeed, there has been a growing recognition of the need to address smoking among partners and other family members

and to include other smokers in the interventions themselves (Mullen, 2004; Borland, Babayan, Irfan, & Schwartz, 2013). Efforts to enhance recognition and routine assessment of this risk factor by health care providers may also help to identify women who will likely require more intensive cessation and relapse-prevention strategies.

Pregnancy represents a unique time with regards to quitting motivation. Prior research had shown that for some pregnant women, their quitting motivation is best characterized as a suspension of smoking rather than an attempt at lifelong abstinence (Stotts, DiClemente, Carbonari, & Mullen, 2000). That is, among some women the motivational factors to remain abstinent during the pregnancy, such as for the health of the fetus and social stigma, may not extend to the postpartum period. Our findings are consistent with this research and indicate that a sizeable group of women in our study did not intend to quit permanently. We also found a relationship between quitting intentions and a woman's postpartum smoking status. Specifically, although the majority of women (69%) planned to quit for good, women who were unsure or planned to resume smoking after pregnancy were more likely to be smoking at both follow-up timepoints. Based on this finding and prior research demonstrating the predictive utility of prepartum motivation measures (Heppner et al., 2011), it is recommended that women be asked about their intentions to remain smoke free after childbirth. Women who do not report intentions to maintain their smoking abstinence postpregnancy should be identified as a high-risk group. Future research is needed develop targeted interventions for this sizeable subgroup of unmotivated pregnant smokers.

A variable often related to quitting motivation—self-reported confidence in quitting—was also measured. Lower quitting confidence reported at the baseline assessment significantly predicted resumed smoking at the 1 month follow-up, but not at the 12 months follow-up. Lower quitting confidence at 1 month was associated with smoking at the 12 months follow-up. Additional analyses demonstrated that this relationship existed regardless of smoking status at 1 month. The identification of confidence as a relapse risk factor measured both before and after delivery underscores the importance of maintaining high levels of self-efficacy. More research is needed to determine effective strategies to maintain and boost self-efficacy throughout pregnancy and beyond. These results also support the potential utility of conducting brief assessments of confidence in quitting postdelivery to target smoking relapse-prevention efforts.

The relationship between breast feeding and postpartum smoking has been examined in various ways. For instance, studies have explored the role of breast-feeding initiation (Kendzor et al., 2010), duration, and patterns (i.e., exclusive vs. partial breast feeding) on smoking. In the current study, we assessed plans to breast feed prior to delivery and breast-feeding status reported after delivery. Although the majority of women in the current study intended to breast feed (78%), women who did not have an intention to breast feed after childbirth were more likely to be smoking shortly after giving birth. These findings reinforce the importance of assessing intentions to breast feed. Fifty percent of women in our study reported breast feeding at the 1-month follow-up. In contrast to a prior study (Kendzor et al., 2010), we did not find a relationship between breast feeding shortly after birth and smoking status at a later follow-up point. Additional research is needed to understand the complex relationship between breast feeding and smoking

relapse, with attention to the measurement of confounding factors (e.g., age, socioeconomic status [SES]).

Not surprisingly, we also found that women smoking 1 month postpartum were more likely to be smoking 11 months later. Consistent with Clinical Practice Guidelines (Fiore et al., 2008), efforts should be directed toward implementing repeated assessment of smoking status to assess the need to initiate or reintroduce cessation interventions after delivery. In addition, future research should investigate the optimal timing for interventions to be delivered, including how long to extend smoking relapse interventions into the postpartum period.

Whereas most studies have included a final follow-up at 6 months, we were able to examine predelivery and immediate postpartum variables associated with smoking 12 months postpartum. Our study findings suggest that baseline variables may differentially predict short- and/or long-term smoking behavior, supporting the inclusion of multiple follow-up points in future studies. Future research may also consider more frequent measurements over longer follow-up periods to better examine the role of time-varying factors in influencing relapse.

The current study had several methodological strengths to contribute to this body of research including: women proactively contacted, measurement of several modifiable relapse risk variables; short- and long-term follow-up points; and variables collected shortly after delivery to be examined in relation to smoking status at 12 months. There are some limitations of this study that should be noted. First, participants were recruited from direct marketing lists, thus the sample is less diverse than the general population of pregnant ex-smokers. Second, all women in the study received a self-help intervention and although the interventions were quite minimal, it did have effects (Brandon et al., 2012). As such, it is possible that prediction of relapse risk factors may be somewhat different for women not receiving treatment. Third, because the study was conducted by mail with participants from across the United States and we were only able to collect in-person biosamples from a small subsample, we must acknowledge the possibility of misclassifying smoking status. Fourth, to maximize assessment adherence and minimize participant burden, assessments were relatively brief, and as a result some predictor variables may have been missed. Future studies may also consider the addition of population-specific measures of predictors. For example, the Edinburgh Postnatal Depression Inventory (Cox, Holden, & Sagovsky, 1987) may be better suited for measuring depression in this population because it lacks the somatic symptom items typically included within standard measures of depression (i.e., CES-D). Finally, it is important to note that we identified risk factors or markers, not necessarily causes of relapse. Some predictors have potential as modifiable causes of smoking relapse (e.g., confidence, partner smoking, intentions), whereas others (e.g., breast feeding) are most likely markers for more general third variables such as SES.

Results from the current study suggest important areas for relapse risk assessment such as measurement of quitting intentions for the postpartum period, intention to breast feed during pregnancy, and quitting confidence assessed both before and after delivery. Of note, a greater number of baseline predictor variables were revealed for the short-term (1 month) versus the long-term (12 months) follow-up. This finding may be explained by the fact that many other environmental and life factors may intervene prior to the long-term follow-up. However, the best predictor of long-term smoking status using

short-term follow-data was smoking. Notably, confidence at 1 month postpartum continued to predict relapse. These findings reinforce the importance of promoting abstinence during and immediately after pregnancy, and to instill confidence about a women's ability to maintain abstinence.

Many of the identified predictors are amenable for targeting in future interventions (e.g., enhancing self-efficacy and motivation to remain quit). Researchers have called for routine smoking cessation intervention during prenatal care (Orleans, Barker, Kaufman, & Marx, 2000); however, given the high smoking relapse rates, attention should also be paid to integrating and extending smoking relapse interventions in the postnatal period using a continuing care approach (Coleman-Cowger, 2012). Fortunately, multiple opportunities exist for conducting brief assessments and interventions given the postnatal obstetric and gynecological appointment and multiple pediatric appointments for the infant. Future research should continue to explore the implementation and efficacy of interventions delivered or disseminated in these settings.

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DECLARATION OF INTERESTS

None declared.

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