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## Examining characteristics associated with quitting smoking during pregnancy and relapse postpartum

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### Abstract

**Introduction**—Smoking during pregnancy is a significant public health concern that can cause adverse health outcomes for both the mother and fetus. Studies have shown only 40% of women quit smoking during pregnancy, with more than half relapsing within 6 months, and up to 90% relapsing within one year. This study investigates differences in demographics and smoking-related symptomatology between pregnant smokers and pregnant quitters, as well as factors associated with postpartum relapse.

**Methods**—Data on pregnant smokers and pregnant quitters were obtained from two separate parent studies. Data on smoking demographics and smoking-related symptomatology were collected at screening visits.

**Results**—Compared to pregnant smokers, pregnant quitters had more favorable smoking characteristics (e.g., smoked fewer cigarettes per day, reported higher motivation for abstinence and less dependency). They also had more favorable relationship characteristics (e.g., were more

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### CONTRIBUTIONS

Sharon Allen designed the studies and wrote the protocols. Farnaaz Kia conducted literature searches, provided summaries of previous research studies and wrote the first draft of the manuscript. Samantha Carlson conducted the statistical analysis. Nicole Tosun managed all subject recruitment, data collection, data entry and cleaning. All authors have contributed to and approved the final manuscript.

### CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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likely to be married, less likely to have a significant other who smokes) and had less reproductive liability (e.g., fewer pregnancies, fewer children). In terms of symptomatology, pregnant quitters reported more positive affect, negative affect, physical symptoms and withdrawal but less craving. Predictors of postpartum relapse included increased maternal age, having a significant other who smokes and an increased likelihood of returning to smoking after pregnancy (self-reported prior to delivery).

**Conclusions**—Several demographics and smoking-related symptomatology were significantly different between pregnant quitters and pregnant smokers. In addition, multiple factors predicting postpartum relapse were identified. This information can inform personalized interventions for high risk pregnant smokers and pregnant quitters at risk for postpartum relapse.

## 1.0 INTRODUCTION

Smoking during pregnancy is a major public health concern with about 1 in 10 women reporting smoking in the three months prior to pregnancy. While 55% of these women quit smoking sometime during pregnancy, about 40% start smoking again within 6 months after delivery and up to 90% relapse within one year (P D Mullen, Richardson, Quinn, & Ershoff, n.d.; Patricia Dolan Mullen, 2004; “Trends in Smoking Before, During, and After Pregnancy --- Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 Sites, 2000--2005,” n.d.). The adverse health outcomes of smoking during pregnancy affect not only the mother, with increased risk for ectopic pregnancy, premature rupture of membranes, placental abruption, placenta previa, spontaneous abortion, stillbirth, stroke and peripheral vascular disease (Augood, Duckitt, & Templeton, 1998; Rogers, 2008; US Department of Health and Human Services, 2014; Waylen, Metwally, Jones, Wilkinson, & Ledger, 2008); but also affect the infant, with increased risk for premature birth, lower birth weight, sudden infant death syndrome and other congenital conditions (Augood et al., 1998; Hackshaw, Rodeck, & Boniface, 2011; Rogers, 2008; US Department of Health and Human Services, 2014; Waylen et al., 2008; Zhang & Wang, 2013). Effective pre and postpartum interventions for cessation are lacking (Fang et al., n.d.; Hajek et al., 2013; Levine, Cheng, Marcus, Kalarchian, & Emery, 2016). Understanding potential differences in demographics and smoking-related symptomatology (i.e., craving, withdrawal and mood) between pregnant smokers and pregnant quitters can provide valuable insight informing more effective interventions.

The current literature sheds some light on factors related to a woman’s inability to quit smoking during pregnancy. Passmore et al found that teenage mothers and women with three or more previous pregnancies are less likely to quit during pregnancy (Passmore, McGuire, Correll, & Bentley, 2015). A study of new mothers in fifteen European countries found women without a spouse, with a lower education level, who worked in the home, had previous children and/or had an unplanned pregnancy were more likely to continue smoking during pregnancy (Smedberg, Lupattelli, Mårdby, & Nordeng, 2014). Furthermore, a US study using data obtained from birth certificates found that smoking rates during pregnancy were highest among women who had less than a high school education, had Medicaid health insurance and were receiving benefits from the Special Supplemental Nutrition program for Women, Infants and Children (Curtin & Mathews, 2016). In contrast to the Passmore et al

study results, pregnant teenagers had the highest rate of smoking cessation among any age group. Additionally, those with the highest rates of cessation during pregnancy were non-Hispanic Asians and Hispanic women, women with a bachelor's degree or higher, with private insurance and those who had smoked fewer cigarettes per day prior to cessation (Curtin & Mathews, 2016).

Existing studies have identified some smoking-related symptomatology in pregnant smokers, but most have not found significant differences between pregnant smokers and pregnant quitters. Ludman et al found that women who quit early in pregnancy had lower levels of stress and depressive symptoms in comparison to those who continued to smoke. However, after dependence level and other demographics were adjusted for, no significant differences were noted (Ludman et al., 2000). Another study compared differences between pregnant women attempting to quit (those who quit, but not for longer than 6 months before the study), pregnant quitters (those who quit more than 6 months but less than one year before the study), and pregnant relapsers (those who quit before or during pregnancy, but reported they were smoking again) (Devries & Backbier, 1994). It showed pregnant women attempting to quit had more positive social influences for quitting and pregnant quitters had greater self-efficacy, while those who relapsed had the lowest self-efficacy. Those attempting to quit and pregnant quitters were more confident in their attempt to quit during pregnancy and ability to remain abstinent after pregnancy, while relapsers were significantly less confident. It is important to investigate pregnant women who have quit and stayed quit compared to women who continue to smoke during the pregnancy.

Previous studies have also touched on factors associated with postpartum smoking relapse. Harmer et al found that women who lived in urban areas and who had three or more children were more likely to relapse postpartum (Harmer & Memon, 2013). Other studies found that the highest rate of postpartum relapse was amongst women with other smokers in the household, those who smoked more than 10 cigarettes per day prior to quitting ("Trends in Smoking Before, During, and After Pregnancy --- Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 Sites, 2000--2005," n.d.), were not college educated ("Trends in Smoking Before, During, and After Pregnancy --- Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 Sites, 2000--2005," n.d.) and had Medicaid coverage (Tong, Jones, Dietz, D'Angelo, & Bombard, 2009). Conversely, those who were exclusively breastfeeding were much less likely to relapse (Harmer & Memon, 2013).

Given that smoking in pregnancy and relapsing postpartum is a major public health concern, it is important to have a clear understanding of the characteristics that differ between pregnant smokers and pregnant quitters, as well as what makes a woman at high risk for relapse. This study is unique relative to most of the current literature in that it aims to directly compare pregnant smokers to pregnant quitters in a clinical setting (as opposed to using survey data) in terms of demographics and smoking-related symptomatology, as well as specifically identify factors related to postpartum relapse. We hypothesized that there would be significant differences in demographics (i.e., age, race, ethnicity, smoking behavior, relationship and reproductive status) and smoking-related symptomatology (i.e., withdrawal, craving, affect, physical symptoms) between pregnant smokers and pregnant

quitters, and that demographics and smoking-related symptomatology measures would be associated with postpartum smoking relapse. Further investigation of these associations can inform effective and personalized interventions for women who smoke during pregnancy and who are at high risk for relapsing postpartum.

## 2.0 METHODS

Data on pregnant smokers (study 1) and pregnant quitters (study 2) were obtained from two separate parent studies described below. Inclusion/exclusion criteria were the same for both groups (with the exception of current smoking status) and all recruitment was completed during the same time period and at the same location. All participants were recruited from the Minneapolis/St. Paul metro area in Minnesota, USA using social media, internet newspapers, mass media (i.e., TV and radio) and flyers posted in local businesses and clinics. All procedures were approved by the University of Minnesota Institutional Review Board. In order to be eligible, all participants (from both studies) had to be a healthy woman between the ages of 18-35 with an uncomplicated, single-gestation pregnancy (no gestational diabetes, hypertension, history of more than 2 miscarriages, etc.). Participants were excluded if they were taking psychotropic medications, using illicit drugs or any other types of tobacco or nicotine replacement therapy.

### 2.1 Study 1: Pregnant Smokers: A Human Lab Study

Pregnant women who currently smoked at least 5 cigarettes per day were invited to participate in a nicotine lab study. This was a moderate-size study (n=99) with the goal of assessing acute nicotine response following overnight smoking abstinence. Participants were recruited in either their second or third trimesters and completed an 8-day testing week. Results of this parent study are forthcoming.

### 2.2 Study 2: Pregnant Quitters: A Feasibility Trial

Pregnant women who quit smoking during their pregnancy were invited to participate in a postpartum relapse prevention study. This was a small feasibility trial (n=46) with the goal of determining whether delivering exogenous progesterone (200mg twice per day) postpartum would help prevent smoking relapse. Participants were recruited in their third trimester, independently quit at least four weeks prior to enrollment and completed a 12-week follow-up postpartum. See Allen et al, 2016 for details (Allen, Allen, Lunos, & Tosun, 2016).

### 2.3 Measures

Demographics and smoking-related symptomatology were collected at screening visits: 32-35 weeks gestation for the pregnant quitters and either 12-22 weeks or 32-37 weeks for the pregnant smokers. Smoking relapse data (pregnant quitters only) were collected during the 12-week follow-up period. Relapse was defined as not maintaining continuous abstinence. Taking a puff or more from a lit cigarette was considered a relapse. This was assessed using the TimeLine FollowBack procedure (Brown et al., 1998).

**Demographics (all participants)**—The following demographic variables were assessed on the intake surveys at the screening visit: age, race, education, marital status, cigarettes smoked per day before pregnancy or before quitting, motivation to quit or stay quit, age of became a regular smoker, quit attempts, partner smoking status, number of pregnancies and number of living children. Nicotine dependence was also assessed using the Fagerstrom Nicotine Dependence Scale for the pregnant smokers only (Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

**Smoking-related symptomatology (all participants)**—The Subjective State Scale (SSS) was assessed at screening visit. The scale contained 24 items that yielded five different subscales using a seven-point Likert-type scale. Positive affect was defined as an average of feeling cheerful, content, calm, in control and interested. Negative affect was defined as an average of feeling anxious, irritable, impatient and restless. Craving was defined as a desire to smoke. Physical symptoms were defined as an average of feeling a headache, tremor, cough, stomach problems, sweating, tiredness and drowsiness. Lastly, withdrawal was defined as an average of feeling irritable, angry, anxious, having difficulty concentrating, restlessness, sadness and hunger (al'Absi, Hatsukami, Davis, & Wittmers, 2004; al'Absi, Wittmers, Erickson, Hatsukami, & Crouse, 2003).

**Other factors related to postpartum relapse (pregnant quitters only)**—The Reasons for Quitting Questionnaire was assessed at screening visit. Fifteen of the 20 items matched the validated questionnaire by Curry et al and were broken down into two subscales using a five-point Likert-type scale. Intrinsic motivation was organized into health concerns and self-control. Extrinsic motivation was outlined by immediate reinforcement and social Influence (Curry, Grothaus, & McBride, n.d.). The Smoking Abstinence Self-Efficacy Scale was also assessed at screening visit. This scale contained 17 items that assessed confidence in abstaining from smoking in high-risk situations using a five-point Likert-type scale (Velicer, Diclemente, Rossi, & Prochaska, 1990). The Smoking Cessation Process of Change Scale was the final scale assessed at screen. This 20-item questionnaire measured ten primary factors using a five-point Likert-type scale representing the processes of change including: consciousness raising, dramatic relief, environmental reevaluation, social liberation, self-reevaluation, helping relationships, stimulus control, counter conditioning, reinforcement management and self-liberation (Hoepfner et al., 2006). Lastly, the month of pregnancy when they quit smoking was examined as a potential predictor of relapse.

## 2.4 Analysis

Demographics were summarized for the pregnant smokers and pregnant quitters using means and standard errors, or frequencies and proportions. Demographics were compared between groups using t-tests and chi-square tests, adjusting for covariates as necessary in ANCOVA models. Additionally, smoking-related symptomatology was compared between the pregnant quitters in the third trimester, pregnant smokers in the second trimester and pregnant smokers in third trimester using ANCOVA models and pairwise comparisons, adjusting for multiple comparisons using the Tukey-Kramer method.

Demographics, smoking-related symptomatology and other factors related to smoking were summarized for the pregnant quitters who relapsed and the pregnant quitters who did not relapse, using means and standard errors, or frequencies and proportions. Relative risk regression was conducted to test for associations between demographics and the likelihood of relapsing. Each predictor was assessed in its own model and adjusted for treatment randomization from the parent study (progesterone or placebo). Models examining the number of living children and number of pregnancies as predictors were also adjusted for age as a potential confounder. Given the small sample size (n=46), the high potential for model-fit issues and a lack of association between several predictors and relapse, parsimonious relative risk regression models were prioritized. Results are reported as adjusted relative risks (RRs) and 95% confidence intervals (CI). P-values <0.05 were considered statistically significant. Given the small sample size and pilot-nature of the study, p-values in relative risk regression models were not adjusted for multiple tests. SAS Software v.9.4 (SAS Institute Inc., Cary, NC) was used for analyses. SAS Software v.9.4 (SAS Institute Inc., Cary, NC) was used for analyses.

### 3.0 RESULTS

#### 3.1 Sample

There were n=99 participants included from Study 1 (pregnant smokers). About half (53%, 52/99) were in the second trimester of pregnancy at the screening visit, and the other half (47%, 47/99) were in the third trimester of pregnancy at the screening visit. There were n=46 participants included from Study 2 (pregnant quitters). Of these 46, 50% (n=23/46) relapsed during the 12 weeks of follow-up postpartum. All of these women were in the third trimester of pregnancy at the screening visit. Study retention in Study 2 (pregnant quitters) after randomization was 87% (40/46) at 12 weeks postpartum. Of the six incomplete participants, three relapsed prior to dropout and three did not.

#### 3.2 Comparing pregnant smokers to pregnant quitters

Pregnant smokers (n=99) compared to pregnant quitters (n=46) were found to be less educated (p=0.0015), less likely to be married (8% vs. 20%, p=0.0185), smoked more cigarettes per day before pregnancy or quitting (16.4 vs. 10.1, p<0.0001), were less motivated to stay quit after delivery on a ten-point Likert-type scale (7.1 vs. 9.4, p<0.0001), started smoking at a younger age (15.8 vs. 17.4, p=0.0252), made fewer quit attempts (2.8 vs. 4.3, p=0.0011) and were more likely to have a partner who was a smoker (76% vs. 42%, p=0.0002). After adjusting for age, pregnant smokers had more pregnancies (3.1 vs. 2.1, p=0.0001) and more children (1.5 vs. 0.7, p=0.0001) compared to pregnant quitters. No statistically significant differences were found in age or race between pregnant smokers and pregnant quitters (Table 1).

There were no statistically significant differences between pregnant smokers in the second trimester (n=52) and pregnant smokers in the third trimester (n=47) in smoking-related symptomatology ( $\beta \pm se$ , positive affect 2.7  $\pm$  0.2 vs. 3.2  $\pm$  0.2, p=0.31; negative affect 1.3  $\pm$  0.2 vs. 1.3  $\pm$  0.2, p=1.00; craving 3.1  $\pm$  0.2 vs. 3.6  $\pm$  0.2, p=0.25; physical symptoms 0.6  $\pm$  0.1 vs. 0.5  $\pm$  0.1 p=0.96; withdrawal 1.1  $\pm$  0.2 vs. 1.1  $\pm$  0.2, p=0.98). Thus, pregnant smokers in both

trimesters were combined for further analysis. When comparing pregnant smokers and pregnant quitters (Table 2), pregnant smokers reported significantly lower positive ( $p<0.0001$ ) and negative affect ( $p=0.0038$ ), higher craving ( $p<0.0001$ ), lower physical symptoms ( $p=0.0450$ ), and less withdrawal ( $p=0.0051$ ) in comparison to pregnant quitters, after adjusting for education level and pregnancy trimester.

### 3.3 Factors related to postpartum relapse (pregnant quitters only)

Analysis revealed that as maternal age at screening increased one year, the risk of postpartum relapse decreased by 6% ( $p=0.0211$ ; 95% CI: 1%-12%). Participants who had a significant other who smoked were 2.07 times more likely to relapse postpartum than participants who did not have a significant other that smoked ( $p=0.0307$ ; 95% CI: 1.07-4.00). Lastly, as participants reported a decreased likelihood of returning to smoking after pregnancy, the risk of relapse decreased by 25% (RR: 0.75, 95% CI: 0.57-0.99). No other statistically significant associations were found between factors and postpartum relapse (Table 3).

## 4.0 DISCUSSION

In summary, our comparison of pregnant smokers to pregnant quitters confirmed our hypotheses. We found several significant differences in demographics and smoking-related symptomatology between groups, as well as identified specific risk factors associated with postpartum smoking relapse.

This study has expanded upon the previous literature by directly comparing smoking-related symptomatology between pregnant smokers and pregnant quitters in a clinical setting (as opposed to using survey data), which to our knowledge, has not been done before. Also unique to our study is the analysis of smoking related symptomatology between groups. Our results indicate that pregnant smokers report less positive affect, less negative affect, less withdrawal and more craving than pregnant quitters. It is not completely understood if the discrepancy in opposing moods (lower positive affect and negative affect) and lower withdrawal reported by pregnant smokers is due to smoking itself or other multifactorial conditions of pregnancy. A double-blind, placebo-controlled study done by File et al showed that nicotine blocked mood changes like anxiety, aggression and discontent when females were exposed to a moderately stressful task (File, Fluck, & Leahy, 2001). Since pregnant quitters are not exposed to nicotine, they may be more likely to experience such mood changes, explaining the increased rate of positive and negative affect, as well as withdrawal (which encompasses items such as irritability, anger, and sadness). It is also possible, that some women in the pregnant quitter group were still, in fact, experiencing classic nicotine withdrawal. Studies have shown that withdrawal symptoms usually peak within 2 to 3 days after cessation, however they can last up to 1-3 months. The final two symptoms to resolve are usually irritability and low energy (Kenford et al., 1994).

It seems counterintuitive that pregnant quitters are less likely to crave cigarettes in comparison to pregnant smokers. However, this finding may be related to how the construct was assessed (Sayette et al., 2000) or to other demographic differences found in our study. For instance, pregnant quitters were smoking fewer cigarettes per day prior to quitting, had

more previous quit attempts and were less likely to have a significant other who smokes. Given high levels of craving are also associated with nicotine dependence (Fagerstrom & Schneider, 1989) and relapse (Killen & Fortmann, 1997), these demographics help explain why some groups are at a higher risk for continued smoking during pregnancy and postpartum relapse.

Our results also serve to reinforce previous literature, suggesting increased relapse rates postpartum among younger women (Harmer & Memon, 2013) and those less confident (McKay, 1999). In our study, pregnant quitters who were less likely to relapse postpartum were older and tended to report a decreased likelihood of returning to smoking after pregnancy. McBride et al in a study assessing the influence of smoking partners on relapse rates in pregnancy, showed that women with nonsmoking partners were more likely to establish smoking cessation during pregnancy, but did not show an association between relapse rates later in pregnancy and partner smoking status (McBride et al., 1998). In contrast, our study observed that pregnant quitters with a significant other who smokes were more likely to relapse postpartum.

Another noteworthy finding is that we did not see a significant difference in relapse by maternal race among pregnant quitters. These findings are interesting due to several studies showing variation of nicotine metabolism rate by demographic subgroups (BENOWITZ, LESSOVSCHLAGGAR, SWAN, & JACOBIII, 2006; N L Benowitz et al., 1999; Neal L Benowitz, Hukkanen, Jacob, & III, 2009; Neal L Benowitz, Pérez-Stable, Herrera, & Jacob, 2002; Dempsey, Jacob, & Benowitz, 2002; Pérez-Stable, Herrera, Jacob, & Benowitz, 1998). A study by Dennis et al showed African Americans are less likely to report long-term quitting in comparison to non-Hispanic Whites and other racial/ethnic minorities (Asian Americans/Pacific Islanders, Hispanics/Latinos) (Trinidad, Pérez-Stable, White, Emery, & Messer, 2011). Studies have shown that pregnancy significantly increases nicotine and cotinine clearance, by 60% and 140% respectively (Dempsey et al., 2002), and the rate of nicotine and cotinine clearance is higher in women than in men (a 13% higher rate of nicotine clearance and 24% higher rate of cotinine clearance) (BENOWITZ et al., 2006). Given the varying rates of nicotine metabolism among different demographic subgroups (BENOWITZ et al., 2006; N L Benowitz et al., 1999; Neal L Benowitz et al., 2009, 2002; Dempsey et al., 2002; Pérez-Stable et al., 1998) and that African Americans are less likely to report quitting (Trinidad et al., 2011), one would still expect to see a difference between race and smoking relapse. On the other hand, our lack of findings could be attributed to type II error, given the small sample size and likely low statistical power to detect associations in subgroups (i.e. n=17 minority pregnant quitters). Further investigation should be done in this area to determine if there is a direct association between race and smoking relapse rates among this particular population of women.

Limitations of our study include a smaller sample size and selection bias. Participants were selected from a convenience sample. Thus, it is likely the women that participated in our study were more motivated and health-conscious than the general pregnant-smoking population. Since the follow-up was only 12-weeks long, it is possible that some women relapsed after our follow-up period ended, limiting generalizability. Additionally, due to the small number of pregnant quitters, we were unable to run complex regression models



accounting for potential confounding variables. Given this is a post-hoc, secondary analysis, the risk for type I error due to the multiple testing (17 tests in Tables 1 and 2; 17 tests in Table 3) should be considered in the interpretation of the results. Finally, smoking behavior pre-pregnancy and pregnant quitter's cessation date was self-report and subject to recall bias.

Despite these limitations, our study explored several novel associations that can be expanded upon in future research. It would be beneficial to replicate this study using a larger, more generalizable sample. Future studies could be designed to evaluate specific interventions for pregnant smokers based on the demographics, smoking-related symptomatology and other risk factors reported in this paper. Such studies could inform the development of effective interventions for smoking cessation in pregnancy and the prevention of postpartum relapse.

In conclusion, this study has expanded on the previous knowledge surrounding differences in women who are able to quit during pregnancy, women who continue to smoke during pregnancy and factors associated with postpartum relapse. Several demographics and smoking-related symptomatology were significantly different between pregnant smokers and pregnant quitters. Factors associated with postpartum relapse were also identified. These findings could help inform the development of effective interventions for smoking cessation in pregnancy and the prevention of postpartum relapse.

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**HIGHLIGHTS**

- Nicotine dependency may play a role in who is able to quit smoking during pregnancy.
- Pregnant quitters may experience larger mood changes than pregnant smokers.
- Predictors of postpartum relapse include age, having a significant other who smokes and self-efficacy.

**Table 1**

Demographics and Sample Characteristics – Comparing Pregnant Smokers to Pregnant Quitters

	Pregnant Smokers	Pregnant Quitters	t-test p-value
N	99	46	
Age, mean (SE)	26.6 (0.4)	26.5 (0.8)	0.8446
CPD <sup>1</sup> , mean (SE)	16.4 (0.7)	10.1 (0.7)	<0.0001
Fagerstrom Nicotine Dependence Score, mean (SE)	4.9 (0.2)	---- <sup>3</sup>	----
Motivation to stay quit after baby is born, or motivation to quit, mean (SE) on a scale from 1-10	7.1 (0.2)	9.4 (0.1)	<0.0001
Age regular smoker, mean (SE)	15.8 (0.3)	17.4 (0.4)	0.0252
Quit attempts, mean (SE)	2.8 (0.3)	4.3 (0.7)	0.0011
# of Pregnancies, mean (SE) <sup>2</sup>	3.1 (0.1)	2.1 (0.2)	0.0003
# of Living children, mean (SE) <sup>2</sup>	1.5 (0.1)	0.7 (0.2)	0.0001
			$\chi^2$ p-value
Non-Hispanic, n (%)	96 (97%)	42 (91%)	0.1385
Race, n (%)			
White	53 (54%)	28 (62%)	0.6009
Asian	1 (1%)	0 (0%)	
Black or African American	24 (24%)	12 (27%)	
Native American or Alaskan Native	7 (7%)	2 (4%)	
More than One Race	14 (14%)	3 (7%)	
Education, n (%)			
Graduate/professional degree	2 (2%)	1 (2%)	0.0015
College graduate/ 4-year degree	2 (2%)	7 (15%)	
Some college / 2-year degree	49 (49%)	30 (65%)	
High school (or equivalent)	30 (30%)	6 (13%)	
Some High School	16 (16%)	2 (4%)	
Marital status, n (%)			
Never married	84 (85%)	30 (65%)	0.0185
Married	8 (8%)	9 (20%)	
Separated	3 (3%)	0 (0%)	
Divorced	3 (3%)	6 (13%)	
Remarried	1 (2%)	1 (2%)	
Partner Smoking Status, n (% Smoker) <sup>4</sup>	62 (76%)	18 (42%)	0.0002
Trimester of pregnancy, n (%)			
Second	52 (52%)	46 (100%)	----
Third	47 (47%)	0 (0%)	

<sup>1</sup>CPD: Cigarettes per day from prior to quitting for pregnant quitters and prior to pregnancy for pregnant smokers;

<sup>2</sup>Adjusted for age in linear regression model;

<sup>3</sup>Fagerstrom Nicotine Dependence Scale is not a valid tool for participants who are not smoking;

<sup>4</sup>missing n=20

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**Table 2**

Smoking-related Symptomatology – Comparing Pregnant Smokers to Pregnant Quitters

	Pregnant Smokers	Pregnant Quitters	p-value <sup>I</sup>
N	99	46	
Subjective State Scale (SSS), mean (SE)			
Positive Affect	3.00 (0.15)	4.38 (0.24)	<0.0001
Negative Affect	1.29 (0.15)	2.19 (0.24)	0.0038
Craving	3.44 (0.16)	0.26 (0.25)	<0.0001
Physical Symptoms	0.54 (0.08)	0.87 (0.13)	0.0450
Withdrawal	1.07 (0.12)	1.75 (0.19)	0.0051

<sup>I</sup> p-values from linear regression adjusted for education level and trimester

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**Table 3**

Association between Demographics Factors Related to Postpartum Relapse on Actual Relapse Postpartum (Pregnant Quitters Only; n=46)

	Relapse in Postpartum Unadjusted Mean (SE) or n (%)		RR of Relapse (95% CI)	p-value
	No	Yes		
N	23 (50%)	23 (50%)		
Age	28.13 (1.00)	24.78 (1.08)	0.94 (0.88 - 0.99)	0.0211
Race, white race vs all others	14 (64%)	14 (61%)	0.94 (0.53 - 1.69)	0.8473
Education, at least 4yr college degree vs. < 4yr college degree	6 (26%)	2 (9%)	0.44 (0.13 - 1.53)	0.1985
Average CPD in 3 months prior to pregnancy	10.26 (0.86)	10.72 (1.08)	1.01 (0.95 - 1.09)	0.7022
Month of pregnancy quit smoking	3.57 (0.50)	3.70 (0.49)	1.01 (0.90 - 1.14)	0.8510
Number of minutes before 1st cigarette in morning, Risk of relapse for each 30 min increment	62.26 (16.15)	58.67 (18.45)	0.99 (0.87 - 1.12)	0.8702
Likelihood of returning to smoking after pregnancy, 1-5 with 5 as not at all likely to smoke	4.09 (0.18)	3.57 (0.15)	0.75 (0.57 - 0.99)	0.0421
Partner smoking status, smoker vs. nonsmoker	6 (26%)	12 (60%)	2.07 (1.07 - 4.00)	0.0307
Number of pregnancies <sup>1</sup>	2.39 (0.31)	1.83 (0.21)	0.99 (0.73 - 1.35)	0.9562
Number of living children <sup>1</sup>	1.00 (0.22)	0.35 (0.12)	0.58 (0.33 - 1.00)	0.0519
Intention to breastfeed (yes vs. no)	13 (57%)	18 (78%)	1.74 (0.80 - 3.79)	0.1605
Smoking Abstinence Self-Efficacy Scale – Overall	4.02 (0.15)	3.71 (0.17)	0.76 (0.53 - 1.09)	0.1390
SCPS Smoking Cessation Process of Change Scale (SCPS) – Overall	2.59 (0.15)	2.72 (0.13)	1.14 (0.76 - 1.69)	0.5300
SCPS Experiential Process	2.50 (0.15)	2.67 (0.13)	1.20 (0.78 - 1.86)	0.3981
SCPS Behavioral Process	2.68 (0.16)	2.77 (0.14)	1.08 (0.75 - 1.56)	0.6826
Reasons for Quitting, Intrinsic Motivation	6.17 (0.34)	6.00 (0.47)	0.96 (0.79 - 1.17)	0.6862
Reasons for Quitting, Extrinsic Motivation	3.70 (0.32)	3.78 (0.31)	1.02 (0.84 - 1.23)	0.8400

p-values are from relative risk regression models adjusted for treatment randomization; each row is its own model; RR is risk of relapse in first 12 weeks postpartum;

<sup>1</sup>Also adjusted for age