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Postpartum Smoking Relapse After Quitting During Pregnancy: Pregnancy Risk Assessment Monitoring System, 2000–2011

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Abstract

Background: Relapsing to smoking postpartum jeopardizes a woman's health and her infant's health. Our study estimated the proportion and identified characteristics associated with postpartum relapse using a large population-based sample.

Materials and Methods: We analyzed Pregnancy Risk Assessment Monitoring System data among women with live births. Relapse was defined as smoking at survey completion among those who quit by the last 3 months of pregnancy. We assessed linear trends for relapse during 2000–2011 in 40 sites overall and individually using logistic regression. Adjusted prevalence ratios (aPRs) were calculated to assess characteristics associated with relapse during 2009–2011 (n = 13,076).

Results: During 2000–2011, the proportion of women who relapsed postpartum remained unchanged overall (p = 0.84) and by site ($p \geq 0.05$ for each), ranging in 2011 from 30.8% to 52.2% (Wyoming-Arkansas). Characteristics associated with relapse compared with reference groups were prepregnancy daily smoking (aPR = 1.80; 95% confidence interval (CI): 1.59–2.04); age <20 years (aPR = 1.51; 1.24–1.84), 20–24 years (aPR = 1.39; 1.17–1.65), or 25–34 years (aPR = 1.26; 1.07–1.48); not initiating breastfeeding (aPR = 1.34; 1.24–1.44); not having a complete home smoking ban (aPR = 1.27; 1.14–1.42); being black non-Hispanic (aPR = 1.25; 1.14–1.38); being multiparous (aPR = 1.20; 1.11–1.28); experiencing 3–5 stressors during pregnancy (aPR = 1.12; 1.01–1.24); having an unintended pregnancy (aPR = 1.11; 1.03–1.19); and having 12 years of education (aPR = 1.09; 1.01–1.17).

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Conclusions: There was no change in the proportion of women relapsing postpartum during 2000–2011. In 2011, nearly half (42%) of women relapsed after quitting smoking during pregnancy. Disparities exist by site and by maternal characteristics. A comprehensive approach maximizing tobacco control efforts and developing effective clinical interventions delivered across sectors is necessary for long-term tobacco abstinence among women.

Introduction

Postpartum smoking relapse after successfully quitting during pregnancy can adversely affect a woman's lifetime health, her interconception health, and her infant's health. The 2014 Surgeon General's Report, the *Health* Consequen*ces of Smoking—50 Years of Progress*, reported that women are as likely as men to die from smoking-related diseases.[1] For example, women's risk of lung cancer and cardiovascular disease equals the risk for men, and the absolute number of women dying from chronic obstructive pulmonary disease exceeds that of men. Since 1959, the risk of lung cancer among female smokers has risen 10-fold, while the risk for male smokers has only doubled.[1] In addition to a woman's personal lifetime health risk, smoking tobacco during the interconception period, between pregnancies, can delay conception and cause infertility.[2] Maternal smoking can also cause some birth defects such as cleft palate and/or cleftlip. [2]Smoking after delivery can expose infants to secondhand smoke, putting them at increased risk for lower respiratory disease, ear infections, and sudden infant death syndrome.[3] Thus, preventing postpartum relapse can help to improve a woman's long-term and interconception health, as well as her infants' health.

Given that half of pregnant smokers report quitting by the third trimester, the postpartum period provides an important opportunity to maintain this positive behavior change and promote lifelong cessation.[4] In recognition of the importance of maintaining abstinence after delivery, a new objective was added to *Healthy People 2020* with the goal of reducing postpartum smoking relapse among women who quit smoking during pregnancy to 38.2% (Objective No. MICH-18).[5] Progress toward meeting this objective can be measured using data from the Pregnancy Risk Assessment Monitoring System (PRAMS), a population-based surveillance system of maternal behaviors and attitudes administered postpartum.[6]

A PRAMS report using 2000–2005 data found no change in the proportion of postpartum women who relapsed to smoking over time, but more recent trends have not been examined.[7] Many legislative changes and tobacco control efforts have also been implemented in recent years, which have affected tobacco use.[8] PRAMS can provide information on the characteristics associated with postpartum relapse among a large, diverse population-based sample of women.

The objectives of this study were to extend previous findings using the most recent PRAMS data available, 2000–2011, to monitor annual postpartum smoking relapse estimates and assess trends over time and to describe the maternal characteristics associated with postpartum smoking relapse in women who quit during pregnancy. This information can be used to inform state tobacco control efforts and research to prevent relapse.

Materials and Methods

This analysis utilized data from PRAMS, a surveillance system administered by the Centers for Disease Control and Prevention in collaboration with state health departments using standardized data collection methodology. Detailed PRAMS methodology is described elsewhere.[6] In brief, women who have recently delivered a live birth are sampled from the state birth certificate records and are sent a mail survey 2–6 months postpartum about their behaviors, attitudes, healthcare use, and maternal morbidities that occurred before, during, and after pregnancy. Women who do not respond to the first mailing receive up to two more paper surveys, and then a follow-up telephone interview. The PRAMS survey responses are linked to the selected information from the infant's birth certificate.

Data from all 40 sites (38 states, 1 city, and 1 special tribal project area; Table 1) that participated in PRAMS during 2000–2011 were included and spanned three PRAMS questionnaire cycles: Phase 4 (2000–2003), Phase 5(2004–2008), and Phase 6 (2009–2011). To minimize nonresponse bias, only sites meeting response rate thresholds were included in the analysis. The response rate threshold was ≥70% for 2000–2006 and ≥65% for 2007–2011. PRAMS survey data are weighted to account for sampling design, nonresponse, and noncoverage. This sample represents 20,789,093 live births occurring in the included sites, ~42% of all U.S. births from 2000 to 2011.

Variables

The PRAMS questionnaire captures maternal self-reported smoking behaviors surrounding pregnancy using four questions. First, all women are asked a filter question about tobacco use in the previous 2 years before becoming pregnant. Women who answered yes to the filter question were asked three follow-up questions related to timing. Specifically, women were asked how many cigarettes they smoked on average in a day during the 3 months before pregnancy, in last 3 months of pregnancy, and after delivery (assessed at the time of survey administration). Categorical responses were none (0 cigarettes), less than 1, 1–5, 6–10, 11–20, 21–40, or 41, or more. Women who answered no to the filter question were categorized as nonsmokers for all three time periods. Quitters were defined as women who reported any smoking in the 3 months before pregnancy and no smoking during the last 3 months of pregnancy. Postpartum smoking relapse was defined as women who reported any smoking after delivery at the time of survey administration and who had quit smoking during pregnancy.

The maternal demographic characteristics included maternal age, race/ethnicity, education level, and marital status. The other pregnancy-related characteristics explored were based on literature review. Women who smoked before pregnancy were categorized as nondaily (<1 cigarette per day) and daily smokers (≥1 cigarette(s) per day). Stressful life events included family member illness/death, moving, divorce, homelessness, job loss, financial troubles, jail time, and physical abuse. Women were categorized according to the cumulative number of stressful life events they reported in the 12 months before delivery consistent with classifications given by PRAMS. Poor infant outcome at birth was defined as having a preterm (≤37 weeks gestational age) or a low birth weight (<2500 g) infant. Maternal race, marital status, education level, and poor infant outcome were derived from the

birth certificate, while maternal age; pregnancy intention; parity; enrollment in the Special Supplemental Nutritional Program for Women, Infants, and Children (WIC); breastfeeding initiation; prepregnancy smoking status; number of stressors experienced; and smoking ban status in the home (complete ban vs. partial or none) were based on self-report from the PRAMS questionnaire.

Data analysis

Annual site-specific postpartum relapse proportion estimates and 95% confidence intervals (CIs) were calculated for 2000–2011. We assessed linear trends in relapse over the entire study period for sites with 3 or more years of data individually (35 sites), for the 40 total sites overall, and for a subset of nine states that had data for all 11 years of the study period (Arkansas, Colorado, Hawaii, Maine, Nebraska, Oklahoma, Utah, Washington, and West Virginia). Logistic regression was used to model postpartum relapse as the outcome variable and infant's birth year as a continuous independent variable. A categorical variable was included in the model to adjust for an artifact of changing the PRAMS filter question in 2009. The Phase 6 filter question (Have you smoked any cigarettes in the past 2 years?) had a significant effect on the prevalence estimates of smoking before pregnancy compared with when the Phase 4 and 5 filter question (Have you smoked at least 100 cigarettes in the past 2 years?) was being used.[4] In addition, site was included in the model for the overall trend among the 40 sites to account for site-specific differences in proportions. Linear trends evaluated the average change in the proportions of postpartum relapse over the entire study period, 2000–2011; significant changes in relapse were determined by linear trend with $p \leq 0.05$. A subanalysis was conducted to assess linear trends from 2003 to 2011. All logistic regression models used predicted marginal risks described by Bieler *et al.*[9]

To assess characteristics associated with postpartum relapse, we aggregated data from the most recent PRAMS Phase 6 (2009–2011) where only 32 sites with adequate response rates participated. Proportions and 95% CIs for postpartum smoking relapse by levels of selected characteristics were calculated, and differences were assessed using chi-square tests. Multivariable logistic regression was used to calculate adjusted prevalence ratios (aPRs) for relapse, controlling for site, year of birth, and all characteristics examined. About 8.5% of total records had missing information on one or more covariates and were excluded from the multivariate analyses. Missing data ranged from 0.01% for maternal age to 3.5% for breastfeeding initiation. The proportions of relapse did not differ between included and excluded women; however, excluded women were more likely to be black non-Hispanic, American Indian/Alaska Native, unmarried, and have a preterm and/or low birth weight infant compared with included women ($p < 0.05$). Our final adjusted model included all variables and only women with no missing covariate information ($n = 13,076$).

The analysis was conducted using SAS version 9.3 and SUDAAN version 11 (Research Triangle) to account for the complex survey design of PRAMS. The significance level for statistical tests was set at $p < 0.05$.

Results

There was no significant change overall in the trend for annual proportions of postpartum relapse from 2000 to 2011 across the 40 sites (trend $p = 0.84$) after controlling for the change in the filter question and site (Table 1). Likewise, none of the individual 35 sites with 3 or more years of data showed a significant change in postpartum relapse over time ($p \geq 0.05$ for each) (Table 1). Postpartum relapse proportions peaked around 2003 at 53.3% and then declined to 42.8% in 2011, which was a significant decrease (trend $p = 0.02$) even after controlling for the filter change. This pattern was consistent among the subgroup of the nine states with data for all 11 years (trend $p = 0.04$). It should be noted that some sites had individual years, which had prevalence estimates with nonoverlapping CIs. For the most recent estimates, the proportion of relapse across sites varied, ranging in 2011 from 30.8% in Wyoming to 52.2% in Arkansas.

For the 32-site aggregated data from 2009 to 2011, 24% of all women smoked before pregnancy, 11% smoked in the last 3 months of pregnancy, and 16% smoked after delivery. Around half (54%) of all women who smoked before pregnancy quit by the last 3 months of pregnancy. Among quitters, 44% had relapsed to smoking at the time of survey completion, with surveys being completed, on average, 4 months (mean = 124 days, standard deviation = 36 days) after delivery.

In unadjusted analyses, the demographic subgroups with the highest proportion of postpartum relapse were black non-Hispanics (65%), <20 years of age (55%), <12 years of education (55%), and not married (50%) (Table 2). Other groups that had notably high relapse estimates were those who never initiated breastfeeding (61%), had a partial or no smoking ban in the home (61%), experienced 3–5 (49%) or ≥6 stressors (50%) during the 12 months before the infant's birth, and had a poor infant outcome (50%) (Table 2).

Based on the multivariable analysis, the demographic characteristics independently associated with postpartum relapse to smoking were age <20 years (aPR = 1.51; 95% CI: 1.24–1.84), 20–24 years (aPR = 1.39; 1.17–1.65), or 25–34 years (aPR = 1.26; 1.07–1.48) compared with age ≥35 years; being black non-Hispanic (aPR = 1.25; 1.14–1.38) compared with being white non-Hispanic; and having 12 years of education (aPR = 1.09; 1.01–1.17) compared with >12 years (Table 2). Other characteristics independently associated with postpartum relapse were prepregnancy daily smoking (aPR = 1.80; 1.59–2.04) versus nondaily smoking; never (aPR = 1.34; 1.24–1.44) versus ever initiating breastfeeding; having no home smoking ban or a partial ban (aPR = 1.27; 1.14–1.42) versus a complete home smoking ban; being multiparous (aPR = 1.20; 1.11–1.28); experiencing 3–5 stressors in the 12 months before the infant's birth (aPR = 1.12; 1.01–1.24) versus none; and having an unintended pregnancy (aPR = 1.11; 1.03–1.19) (Table 2).

Discussion

From 2000 to 2011, the overall proportion of women who quit smoking during pregnancy and relapsed to smoking after delivery did not change, which is consistent with trends from 2000 to 2005.[7] However, we did find a significant decrease in the proportion of postpartum

relapse prevalence in the later years during 2003–2011. During a similar time period, the proportion of smoking before pregnancy had not changed, although there were increases in the proportion of smoking cessation during pregnancy.[4] Our sample represents an estimated 89,500 women annually who quit smoking during pregnancy and relapsed postpartum across the study sites. Our findings suggest that efforts to reduce the proportion of quitters who relapse after delivery have not been sufficient in all study sites to meet the *Healthy People 2020* goal of reducing relapse.

In our study, an estimated 44% of women who quit smoking during pregnancy relapsed after delivery during 2009–2011, but the proportions varied by site with a high of 52% in Arkansas and a low of 31% in Wyoming in 2011. In 2011, only five of the 25 study sites had met the *Healthy People 2020* goal of reducing postpartum relapse to 38.2%. Our findings can be used to help sites evaluate their progress toward achieving the *Healthy People 2020* objective of reducing postpartum relapse and inform tobacco control efforts. Population-based tobacco control strategies that have been shown to reduce the prevalence of tobacco use among adults and young people also have effects on women of reproductive age.[10] In a 2000–2005 PRAMS analysis, a $1.00 increase in tobacco tax increased postpartum smoking abstinence by 4.2%.[11] Additionally, state policies such as smoke-free air laws, access to healthcare coverage, and Medicaid cessation treatment coverage have been shown to reduce perinatal smoking.[3,12,13] These population-based strategies can help reduce the prevalence of smoking before, during, and after pregnancy.

In addition, our study was able to examine a diverse population-based sample and identify groups of women at high risk for postpartum smoking relapse. Women who did not report a complete smoking ban in the home had a 27% higher likelihood of relapse. Women who are exposed to other smokers are more likely to smoke postpartum and during subsequent pregnancies.[14–17] There is high awareness of recommendations to eliminate infant secondhand smoke exposure as an analysis of 2010 PRAMS data suggests, with 94% of newly postpartum women reported as having complete smoke-free home rules.[18] Implementation of smoke-free home rules has been shown to reduce secondhand smoke exposure in infants.[3,19] Maintaining these rules has also been shown to increase cessation and reduce the risk of relapse among all household members.[3,19] Nonsmokers living in multiunit housing complexes lacking complete smoke-free policies are vulnerable to secondhand smoke exposure from neighboring units, even when smoke-free home rules are in place.[20] Therefore, efforts to institute smoke-free home bans, including multiunit housing communities, may help to curb infant secondhand smoke exposure and reduce smoking triggers, benefiting both the mother and her children. As recommended by the American Academy of Pediatrics (AAP), providers and ancillary staff should encourage continued adoption of 100% smoke-free home bans at delivery and postpartum.[21]

Daily smoking before pregnancy (vs. nondaily smoking) had the strongest association with postpartum relapse, as shown elsewhere.[22] Women who were daily smokers before pregnancy had 80% higher prevalence of relapse than nondaily smokers. In our study, stress, not initiating breastfeeding, and higher parity were also associated with relapse, consistent with other studies.[23–28] A study using 2010 PRAMS data showed that 70% of women reported at least one stressor in the 12 months before pregnancy, with financial stressors

being the most common type.[29] There is some evidence that females may respond more strongly to stress by smoking.[30] While there is conflicting literature about the significance of the association between low socioeconomic status (SES) and relapse, we found that one SES indicator, marital status, was not associated with relapse, whereas other SES indicators, such as education level, race/ethnicity, and maternal age, were associated with increased relapse after controlling for other potential confounders.[15,26,31] Based on our diverse population-based sample, age and race/ethnicity may be more strongly associated with relapse than other SES indicators, showing increased prevalence of postpartum relapse for women ≤34 years of age and black non-Hispanic women after controlling for other potential confounders. Even though all women with a smoking history should receive continued tobacco cessation support postpartum, these high-risk groups could be a target group for relapse prevention services.

Clinical interventions, with providers and staff interacting with individual women to prevent postpartum relapse, are suggested as part of a comprehensive approach to smoking cessation surrounding pregnancy. Recent reviews reported that thus far no intervention strategies have been proven to reduce relapse greater than 1 year postpartum, although there have been promising and effective short-term interventions lasting up to 6 months after delivery.[32,33] For example, incentive programs, such as monetary rewards for maintaining quit status, showed promise with the highest rates of women remaining abstinent, and psychosocial tobacco cessation interventions, such as counseling, also showed significant decreases in relapse rates.[32,33] Telephone counseling, partner support, self-help materials, and pharmacological interventions have not been effective in reducing postpartum relapse, even at 6 months.[32,33]

The strength of this study is that a large population-based sample with 11 years of data was used to monitor the *Healthy People 2020* objective of reducing postpartum smoking relapse. Previous studies that have examined characteristics of postpartum relapse are based on small samples sizes or are among intervention cohorts.[33] Additionally, PRAMS allowed us to assess several important characteristics potentially associated with postpartum smoking relapse. However, this study has several limitations. First, smoking status was based on maternal self-report obtained after delivery. Women tend to under-report smoking and over-report quitting, which may result in underestimations of the true proportion of women who relapsed to smoking postpartum.[4] Although biochemical verification would be preferred, PRAMS is a confidential survey and identifies more smokers compared with other self-reported data sources.[34] Second, because PRAMS is a cross-sectional survey, which woman complete between 2 and 9 months after delivery, we were only able to assess associations with relapse in the early months of the postpartum period. Third, as part of the survey questionnaire design across the consecutive phases of PRAMS, the filter question to identify smokers changed in 2009, ascertaining more smokers before pregnancy. This resulted in an overall decrease of 7% points in the proportion of postpartum relapse in 2009–2011 compared with 2000–2008. However, this filter change was controlled for when assessing all linear trends. Last, these results may not be generalizable to women whose pregnancy did not result in a live birth or women who delivered a live birth outside of the sites included in the study.

To reduce postpartum relapse and reach the *Healthy People 2020* goal, states should implement a comprehensive tobacco control strategy that includes increasing the unit price of tobacco products, high-impact antitobacco mass media campaigns, comprehensive smoke-free laws, and enhanced access to help quitting in combination with effective clinical interventions to prevent relapse. Pregnancy is a major motivator for women to quit smoking, and the postpartum period is a window of opportunity to reinforce cessation among women who have successfully sustained a quit status during pregnancy.[35] Studies have reported that postpartum relapse rates increase over time and may be as high as 80% at 1 year postpartum.[24,27] Therefore, providers need to continually target women throughout the postpartum period. An estimated 88% of women receive a postpartum checkup, in which a provider is typically serving a woman within 4–6 weeks after delivery.[36] During the year following birth, women regularly see pediatricians for baby well and sick visits. The AAP recommends the pediatrician's interaction with parents begins at the child's first visit.[37] This involvement should include talking to the parents about tobacco use and secondhand smoke exposure in the child's environment and providing relapse prevention for women and other family members who quit during pregnancy. It is also important that healthcare workers from multiple sectors (*e.g.*, OB/GYNs, pediatricians, ancillary staff, healthy start programs, WIC programs, home visitation programs) work together to provide services and deliver repetitive messaging about the harms of smoking and the effects of secondhand smoke to prevent postpartum smoking relapse.

Conclusions

Although from 2000 to 2011 the proportion of women who relapsed to smoking after delivery has not significantly improved, there were promising declines during 2003–2011. Postpartum relapse estimates vary by state and by maternal characteristics. Annually, we estimate that 89,500 women who quit smoking during pregnancy relapsed postpartum among our study sites. Clinicians should follow AAP and the American College of Obstetricians and Gynecologists guidelines to provide tobacco cessation and relapse services to all women of reproductive age.[21,37] Preventing postpartum relapse may lead to long-term tobacco abstinence and reduction in secondhand smoke exposure, thereby reducing the risk of smoking-related disease among women and their children. Understanding the characteristics associated with postpartum relapse may inform the development of novel and more effective clinical interventions to assist women who quit smoking during pregnancy remain in quit status. Comprehensive tobacco control efforts in combination with clinical interventions may assist women in maintaining long-term abstinence from tobacco.

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Table 1.

Proportion of Women Who Relapsed to Smoking Following Delivery After Having Quit Smoking During Pregnancy by Site and Year—PRAMS, United States, 40 Sites, 2000–2011

	Year, % (95%CI)									Filter change[a]				
	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010	2011	P [b]
Number of PRAMS sites with available data	19	22	27	27	27	26	24	31	29		29	27	25	
Total sites[c]	51.4 (48.4–54.4)	50.9 (48.1–53.7)	46.8 (44.2–49.4)	53.3 (50.7–55.8)	52.5 (50.0–54.9)	53.0 (50.4–55.6)	50.3 (47.8–52.9)	50.6 (48.1–53.2)	50.4 (47.9–52.8)		44.4 (42.0–46.9)	43.5 (40.9–46.1)	42.8 (40.5–45.2)	0.84
9 PRAMS sites[d]	47.0 (43.1–50.9)	47.4 (43.6–51.2)	44.2 (40.4–48.0)	49.6 (45.7–53.5)	50.6 (46.7–54.6)	49.9 (46.1–53.7)	47.1 (43.3–50.9)	48.9 (45.1–52.7)	44.4 (40.5–48.4)		37.7 (34.4–41.0)	42.1 (38.7–45.5)	41.7 (38.1–45.4)	0.86
Alabama	54.0 (43.4–64.2)	54.9 (45.3–64.3)	52.1 (42.3–61.8)	42.4 (32.2–53.3)	__[e]	—	—	—	—		—	—	—	0.12
Alaska	52.0 (43.9–60.0)	42.4 (34.7–50.5)	47.3 (40.1–54.7)	41.8 (34.7–49.3)	47.6 (39.0–56.3)	44.8 (36.2–53.7)	42.5 (34.4–51.1)	48.1 (39.0–57.3)	52 2 (42.6–61.8)		38.5 (30.9—46.6)	46.4 (37.6–55.4)	—	0.64
Arkansas	43.1 (32.2–54.7)	43.0 (34.3–52.1)	45.3 (35.7–55.2)	56.6 (47.4–65.3)	50.4 (41.9–58.9)	62.0 (53.8–69.5)	57.0 (48.3–65.3)	57.0 (48.4–65.2)	40.4 (29.9–51.8)		48.7 (38.1–59.3)	45.5 (37.0–54.3)	52.2 (40.9–63.2)	0.06
Colorado	45.5 (36.9–54.3)	45.6 (37.1–54.3)	39.3 (31.2–48.1)	43.1 (34.2–52.4)	45.2 (35.8–55.0)	48.8 (38.7–58.9)	51.9 (42.0–61.6)	47.8 (38.4–57.3)	34.6 (26.3–44.0)		30.6 (23.9–38.2)	38.4 (30.5–47.1)	40.4 (32.5–48.9)	0.92
Delaware[f]	—	—	—	—	—	—	—	57.0 (43.0–69.9)	54.0 (45.5–62.3)		51.4 (43.0–59.8)	41.4 (33.1–50.1)	—	0.14
Florida[f]	59.1 (46.5–70.7)	45.8 (35.4–56.6)	43.3 (32.8–54.5)	54.4 (43.4–64.9)	53.8 (44.1–63.2)	55.0 (45.2–64.5)	—	—	—		—	—	—	0.56
Georgia[f]	—	—	—	—	52.3 (40.0–64.4)	59.5 (47.2–70.7)	59.0 (47.6–69.5)	55.7 (37.5–72.5)	48.8 (34.0–63.8)		65.4 (50.7–77.6)	56.0 (41.8–69.4)	49.8 (35.8–63.8)	0.45
Hawaii	46.6 (40.5–52.9)	46.6 (40.3–52.9)	42.4 (34.8–50.4)	47.7 (40.1–55.5)	44.6 (38.4–51.0)	43.3 (36.8–50.2)	45.4 (38.2–52.7)	44.6 (37.7–51.8)	39.1 (32.0–46.7)		38.5 (30.4–47.2)	40.7 (32.7–49.3)	31.6 (24.3–40.0)	0.25
Illinois	45.8 (37.7–54.3)	51.1 (43.2–58.9)	50.1 (42.5–57.6)	53.5 (44.7–62.2)	49.8 (42.2–57.4)	50.0 (41.0–58.9)	52.4 (44.2–60.6)	50.5 (42.2–58.8)	48.7 (40.4–57.2)		45.1 (37.4–53.0)	—	—	0.76

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	Year, % (95%CI)									Filter change[a]				P [b]
	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010	2011	
Louisiana[f]	65.9 (57.8–73.3)	63.3 (55.4–70.5)	62.3 (53.8–70.1)	68.4 (59.7–76.0)	57.3 (48.5–65.6)	—	—	—	—		—	—	—	0.33
Maine	42 2 (33.4–51.5)	41.2 (32.3–50.8)	39.8 (31.2—49.1)	42.3 (33.1–52.0)	42.9 (33.3–53.1)	43.7 (35.1–52.7)	35.1 (26.7–44.6)	36.4 (27.1–46.9)	52.4 (42.9–61.7)		33.3 (25.4–42.2)	40.8 (32.1–50.1)	38.9 (30.3–48.4)	0.53
Maryland[f]	—	46.4 (33.7–59.6)	40.5 (28.4–53.9)	54.5 (41.3–67.2)	64.1 (51.5–75.1)	49.0 (34.5–63.8)	56.7 (42.7–69.7)	47.7 (34.7–61.0)	44.8 (32.5–57.8)		52.0 (39.0–64.6)	46.3 (33.4–59.6)	41.0 (29.7–53.4)	0.89
Massachusetts	—	—	—	—	—	—	—	44.2 (30.4–59.0)	42 2 (30.9–54.5)		35.1 (25.4–46.3)	35.1 (24.9–46.9)	36.5 (26.9–47.3)	0.89
Michigan[f]	—	46.0 (34.3–58.1)	51.4 (42.8–59.9)	59.6 (51.1–67.5)	55.6 (46.4–64.4)	54.6 (46.0–63.0)	60.2 (50.7–69.0)	56.4 (48.0–64.4)	64.0 (54.8–72.2)		45.8 (38.4–53.3)	44.0 (36.4–52.0)	40.0 (32.9–47.6)	0.05
Minnesota[f]	—	—	40.1 (30.3–50.8)	43.7 (34.1–53.8)	48.8 (39.4–58.3)	54.5 (45.1–63.7)	48.6 (41.5–55.7)	48.4 (40.0–56.9)	43.2 (34.8–52.0)		41.3 (33.7–49.3)	39.8 (31.8–48.3)	38.6 (31.3–46.5)	0.63
Mississippi[f]	—	—	—	63.6 (51.9–73.9)	57.6 (45.7–68.7)	—	61.8 (49.8–72.5)	—	69.7 (59.4–78.3)		47.2 (38.6–56.1)	—	—	0.24
Missouri	—	—	—	—	—	—	—	54.8 (45.7–63.6)	—		45.0 (36.7–53.5)	53.5 (45.8–61.0)	50.5 (42.3–58.7)	0.15
Montana	—	—	36.9 (29.3–45.2)	—	—	—	—	—	—		—	—	—	*g*
Nebraska	48.0 (39.7–56.6)	50.0 (43.0–57.0)	41.9 (34.1–50.1)	46.3 (38.6–54.2)	59.5 (50.5–67.9)	52.0 (43.4–60.5)	41.0 (32.5–50.1)	46.8 (38.0–55.8)	54.0 (43.4–64.3)		43.0 (36.1–50.3)	37.3 (30.1–45.0)	50.6 (43.2–57.9)	0.79
New Jersey[f]	—	—	43.9 (31.3–57.4)	50.8 (42.2–59.3)	45.2 (37.6–53.0)	53.0 (45.0–60.8)	50.5 (42.5–58.4)	46.0 (36.9–55.2)	53.3 (44.0–62.3)		45.2 (37.6–53.0)	36.5 (28.9–44.7)	38.3 (30.6–46.7)	0.62
New Mexico[f]	54.8 (47.2–62.2)	40.4 (33.0–48.2)	43.8 (36.1–51.9)	42.7 (34.8–51.0)	46.5 (38.5–54.8)	51.7 (41.5–61.7)	—	—	—		—	—	42.3 (36.1–48.7)	0.79
New York[f,h]	56.1 (44.4–67.2)	49.7 (39.0–60.4)	52.5 (40.6–64.2)	40.9 (30.8–51.9)	54.1 (43.7–64.2)	50.8 (39.5–62.1)	52.1 (36.2–67.5)	49.7 (37.7–61.8)	51.0 (39.2–62.6)		—	47.5 (37.0–58.2)	49.6 (38.3–61.0)	0.81
New York City[f]	—	—	—	—	72.8 (55.2–85.3)	54.9 (40.5–68.5)	43.8 (31.7–56.6)	65.7 (53.0–76.5)	—		—	30.7 (20.6–43.0)	48.8 (37.8–59.9)	0.71

	Year, % (95%CI)									Filter change[a]				P [b]
	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010	2011	
North Carolina[f]	47.8 (38.5–57.2)	51.9 (41.5–62.1)	47.9 (38.7–57.3)	60.5 (50.1–70.1)	50.9 (41.8–60.0)	44.3 (32.3–57.0)	—	46.5 (36.4–56.8)	53.4 (43.7–62.8)		—	—	—	0.98
North Dakota	—	—	50.8 (41.4–60.3)	—	—	—	—	—	—		—	—	—	*g*
Ohio	52.3 (42.0–62.3)	61.2 (50.2–71.3)	46.8 (35.6–58.3)	62.5 (52.0–71.9)	—	61.5 (50.1–71.7)	45.6 (36.6–55.0)	53.2 (41.9–64.1)	52.7 (43.0–62.1)		45.5 (36.4–55.0)	40.0 (30.8–49.9)	—	0.39
Oklahoma	60.2 (49.8–69.7)	57 8 (47.2–67.8)	56.9 (46.2–66.9)	59.7 (49.2–69.4)	64.3 (53.4–73.9)	54.8 (44.8–64.5)	54.5 (43.7–64.9)	56.2 (46.7–65.2)	47.9 (38.4–57.6)		51.1 (41.9–60.3)	51.1 (41.2–61.0)	41.0 (30.9–51.9)	0.09
Oregon	—	—	—	42.7 (29.4–57.2)	39.2 (27.9–51.8)	36.4 (24.9–49.6)	48.0 (36.3–59.9)	35.4 (24.5–48.0)	31.9 (20.2–46.4)		38.7 (28.7–49.7)	42.3 (33.8–51.3)	32.4 (23.6–42.6)	0.41
Pennsylvania[f]	—	—	—	—	—	—	—	59.6 (44.4–73.3)	51.2 (42.1–60.2)		47.7 (38.5–57.1)	50.2 (40.6–59.7)	41.8 (33.2–51.1)	0.73
Rhode Island	—	—	34.7 (25.1–45.9)	38.4 (29.6–48.1)	47.8 (38.3–57.5)	46.1 (36.4–56.1)	50.1 (40.1–60.1)	46.7 (36.9–56.8)	42.9 (33.7–52.6)		43.5 (34.7–52.8)	44.5 (35.5–53.8)	39.6 (31.1—48.8)	0.15
South Carolina[f]	50.0 (37.7–62.3)	70.2 (57.1–80.7)	40.1 (27.2–54.5)	61.5 (48.6–72.9)	55.3 (42.5–67.5)	60.8 (48.2–72.1)	44.0 (29.6–59.6)	41.7 (29.4–55.2)	—		—	—	—	0.15
South Dakota Tribal[f,i]	—	—	—	—	—	—	—	68.6 (63.1–73.5)	—		—	—	—	*g*
Tennessee	—	—	—	—	—	—	—	—	61.3 (46.7–74.2)		45.8 (32.9–59.2)	—	—	*g*
Texas[f]	—	—	—	—	—	—	—	—	—		46.2 (37.8–54.8)	41.1 (33.0–49.6)	—	*g*
Utah	38.9 (27.3–51.9)	39.5 (29.2–50.8)	35.6 (24.0–49.1)	52.0 (39.8–63.9)	45.9 (36.8–55.3)	41.4 (31.7–51.8)	44.4 (35.0–54.2)	48.8 (38.0–59.7)	39.6 (29.8–50.4)		34.7 (26.0–44.6)	33.4 (24.5–43.7)	40.6 (30.4–51.7)	0.42
Vermont[f]	—	34.7 (28.1–42.0)	37.2 (28.8–46.3)	33.9 (26.0–42.8)	47.4 (38.5–56.4)	44.0 (34.8–53.6)	32.4 (24.1—41.9)	39.8 (31.5—48.6)	37.7 (29.1—47.1)		30.9 (24.1–38.8)	30.2 (23.1–38.5)	42.3 (33.6–51.5)	0.57
Washington	41.6 (30.9–53.2)	46.2 (35.0–57.9)	38.9 (28.2–50.9)	46.3 (35.1–57.9)	48.4 (36.6–60.3)	43.9 (32.5–56.0)	38.5 (27.7–50.6)	40.5 (29.8–52.2)	42.5 (31.5–54.3)		26.3 (18.6–35.7)	39.9 (30.3–50.3)	35.8 (26.3–46.5)	0.84

	Year, % (95%CI)									Filter change[a]				P [b]
	2000	2001	2002	2003	2004	2005	2006	2007	2008		2009	2010	2011	
West Virginia[f]	51.0 (41.4–60.4)	53.5 (43.9–62.8)	65.4 (56.0–73.8)	52.1 (42.2–61.8)	46.2 (32.8–60.2)	58.9 (49.5–67.6)	49.4 (39.9–58.8)	56.5 (46.2–66.4)	62.0 (52.7–70.4)		48.4 (40.5–56.4)	46.5 (38.4–54.7)	46.9 (39.2–54.8)	0.49
Wisconsin	—	—	—	—	—	—	—	39.5 (29.7–50.2)	51.9 (40.0–63.6)		30.0 (21.4–40.2)	—	47.1 (36.1–58.4)	0.13
Wyoming	—	—	—	—	—	—	—	50.0 (40.1–59.8)	52.7 (41.9–63.3)		39.2 (29.2–50.2)	39.4 (30.4–49.1)	30.8 (21.6—41.8)	0.79

[a] Year 2000–2008 Phase 4 and 5 filter question (Have you smoked at least 100 cigarettes in the past 2 years?) changed in 2009–2011 to Phase 6 filter question (Have you smoked any cigarettes in the past 2 years?). Estimates in 2009–2011 are 7% points artificially lower than 2000–2008 due to the change in the filter question.

[b] Linear trends were assessed using logistic regression model for sites with at least 3 years of data, adjusted for Phase 6 filter question change over the entire study period ($p \leq 0.05$).

[c] Overall proportion for total sites with data for each given year. The linear trend was assessed using logistic regression adjusted for the Phase 6 filter question change and site.

[d] Data aggregated for nine PRAMS sites (Arkansas, Colorado, Hawaii, Maine, Nebraska, Oklahoma, Utah, Washington, and West Virginia) with data available for all years.

[e] Data not available.

[f] Sites include partial year of births because of data availability for a given year.

[g] Insufficient data (*i.e.*, ≤3 years) to assess linear trends.

[h] New York City births reported separately.

[i] South Dakota Tribal PRAMS data are representative of women in South Dakota and Sioux County, North Dakota, who gave birth to an American Indian infant and are not representative of all live births in the state of South Dakota.

PRAMS, Pregnancy Risk Assessment Monitoring System; CI, confidence interval.

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Table 2.

Demographic and Pregnancy-Related Characteristics of Women Who Relapsed to Smoking Following Delivery After Quitting Smoking During Pregnancy—PRAMS, United States, 32 Sites, 2009–2011

Maternal characteristics	Relapsed to smoking after delivery[a] % (95% CI)	p[b]	Relapsed to smoking after delivery[a] aPR[d] (95% CI)	p[c]
Total	43.7 (42.2–45.1)			
Maternal age group (years)		<0.001		<0.001
<20	54.8 (50.4–59.1)		1.51 (1.24–1.84)	
20–24	48.9 (46.3–51.6)		1.39 (1.17–1.65)	
25–34	39.5 (37.6–41.5)		1.26 (1.07–1.48)	
≥35	29.5 (25.1–34.2)		1.00	
Maternal race/ethnicity		<0.001		<0.001
White, non-Hispanic	41.1 (39.4–42.8)		1.00	
Black, non-Hispanic	64.7 (60.9–68.3)		1.25 (1.14–1.38)	
Hispanic	39.1 (34.3–44.0)		0.90 (0.79–1.03)	
American Indian/Alaska Native	53.6 (46.4–60.6)		1.16 (0.96–1.39)	
Asian/Pacific Islander	30.8 (24.6–37.8)		0.88 (0.68–1.13)	
Other	46.0 (38.1–54.1)		1.02 (0.84–1.23)	
Maternal education (years)		<0.001		0.067
<12	55.1 (51.2–58.9)		1.10 (0.99–1.22)	
12	49.8 (47.2–52.4)		1.09 (1.01–1.17)	
>12	36.2 (34.4–38.1)		1.00	
Marital status		<0.001		0.387
Not married	50.1 (48.1–52.2)		1.04 (0.96–1.12)	
Married	36.0 (34.0–38.0)		1.00	
Pregnancy intention		<0.001		0.004
Intended	37.8 (35.8–39.8)		1.00	
Unintended	48.8 (46.7–50.8)		1.11 (1.03–1.19)	
Parity		<0.001		<0.001
First birth	40.6 (38.6–42.6)		1.00	
Second or later birth	46.8 (44.7–48.9)		1.20 (1.11–1.28)	

Maternal characteristics	Relapsed to smoking after delivery[a] % (95% CI)	p[b]	Relapsed to smoking after delivery[a] aPR[d] (95% CI)	p[c]
WIC enrollment during pregnancy[e]		<0.001		0.254
Yes	50.6 (48.5–52.6)		1.04 (0.97–1.13)	
No	35.6 (33.7–37.6)		1.00	
Breastfeeding initiation		<0.001		<0.001
Never breastfed	60.7 (57.5–63.7)		1.34 (1.24–1.44)	
Ever breastfed	38.8 (37.2–40.4)		1.00	
Prepregnancy smoking status[f]		<0.001		<0.001
Nondaily smoker	22.2 (19.5–25.1)		1.00	
Daily smoker	48.6 (47.0–50.2)		1.80 (1.59–2.04)	
Number of stressors experienced in 12 months before infant's birth[g]		<0.001		0.111
None	37.9 (34.7–41.2)			
1–2	40.3 (38.1–42.6)		1.05 (0.96–1.16)	
3–5	49.4 (46.8–52.0)		1.12 (1.01–1.24)	
≥6	49.7 (44.9–54.5)		1.03 (0.89–1.19)	
Smoking ban in home		<0.001		<0.001
Complete Ban	42.2 (40.7–43.7)		1.00	
Partial Ban or None	60.6 (55.3–65.7)		1.27 (1.14–1.42)	
Preterm/low birth weight infant		<0.001		0.108
Yes	49.5 (46.8–52.2)		1.06 (0.99–1.14)	
No	41.7 (40.0–43.4)		1.00	

Data aggregated for 32 PRAMS sites (Alaska, Arkansas, Colorado, Delaware, Georgia, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, New York City, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming) with data available for 2009–2011.

[a]Relapsed to smoking after delivery = smoking after delivery among women who quit smoking by the last 3 months of pregnancy on the basis of the PRAMS survey. Average = 124 days, Range = 64–269 days. Quit smoking = no smoking during the last 3 months of pregnancy among women who smoked 3 months before pregnancy on the basis of the PRAMS survey.

[b]Chi-square test.

[c]Wald test.

[d] aPRs were calculated using logistic regression, adjusting for site, infant year of birth, maternal age, maternal race/ethnicity, maternal education, marital status, pregnancy intention, parity, WIC enrollment during pregnancy, breastfeeding duration, prepregnancy daily number of cigarettes, number of stressors experienced during pregnancy, smoking ban in home, and preterm/low birth weight infant (n = 13,076).

[e] Special Supplemental Nutrition Program for WIC.

[f] Nondaily smokers were women who reported smoking <1 cigarette/day; daily smokers were woman who reported smoking ≥1 cigarette/ day in the 3 months before pregnancy

[g] Stressors included family member illness/death, moving, divorce, homelessness, job loss, financial troubles, jail time, and physical abuse.

PRAMS, Pregnancy Risk Assessment Monitoring System; CI, confidence interval; aPR, adjusted prevalence ratio; WlC, Women, Infants, and Children.