Estimates of Smoking Before and During Pregnancy, and Smoking Cessation During Pregnancy: Comparing Two Population-Based Data Sources

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ABSTRACT

Objectives. We compared three measures of maternal smoking status—prepregnancy, during pregnancy, and smoking cessation during pregnancy—between the Pregnancy Risk Assessment Monitoring System (PRAMS) questionnaire and the 2003 revised birth certificate (BC).

Methods. We analyzed data from 10,485 women with live births in eight states from the 2008 PRAMS survey, a confidential, anonymous survey administered in the postpartum period that is linked to select BC variables. We calculated self-reported prepregnancy and prenatal smoking (last trimester only) prevalence based on the BC, the PRAMS survey, and the two data sources combined, and the percentage of smoking cessation during pregnancy based on the BC and PRAMS survey. We used two-sided t-tests to compare BC and PRAMS estimates.

Results. Prepregnancy smoking prevalence estimates were 17.3% from the BC, 24.4% from PRAMS, and 25.4% on one or both data sources. Prenatal smoking prevalence estimates were 11.3% from the BC, 14.0% from PRAMS, and 15.2% on one or both data sources. The percentages of prepregnancy smokers who indicated that they quit smoking by the last trimester were 35.1% from the BC and 42.6% from PRAMS. The PRAMS estimates of prepregnancy and prenatal smoking, and smoking cessation during pregnancy were statistically higher than the corresponding BC estimates (t-tests, $p < 0.05$).

Conclusions. PRAMS captured more women who smoked before and during the last trimester than the revised BC. States implementing PRAMS and the revised BC should consider information from both sources when developing population-based estimates of smoking before pregnancy and during the last trimester of pregnancy.

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Prenatal smoking remains one of the most common preventable causes of infant morbidity and mortality. Smoking may cause reduced fertility and delayed conception among women and is associated with an increased risk of cleft lip and palate.^{1,2} Smoking during pregnancy causes placental abruption, placenta previa, preterm delivery, low birthweight, Sudden Infant Death Syndrome (SIDS), and preterm-related death.² In the United States, an estimated 5%–8% of preterm deliveries, 13%–19% of full-term low birthweight deliveries, 23%–34% of SIDS deaths, and 5%–7% of preterm-related deaths could be averted if prenatal smoking was eliminated.³

Healthy People 2020 goals include reducing the smoking prevalence before and during pregnancy and increasing smoking cessation during pregnancy.⁴ Most states can measure progress in achieving these goals by using two population-based data sources, the Pregnancy Risk Assessment Monitoring System (PRAMS) and the revised 2003 birth certificate (BC). PRAMS surveys women with live births and collects information on smoking in the three months before pregnancy, during the last three months of pregnancy, and approximately four months after delivery. PRAMS data are linked to each infant's BC. As of 2011, 40 states and New York City were implementing PRAMS, representing 75% of U.S. live births.⁵ Unlike the 1989 version of the BC, which ascertains whether a woman smoked during pregnancy without specifying in which trimester, the 2003 revised BC collects data on smoking status during the three months before pregnancy and during the first, second, and third trimesters. As of 2011, 38 states had implemented the revised BC, representing 86% of U.S. live births (Personal communication, Joyce Martin, National Center for Health Statistics, October 2011).

Two previous studies compared the BC and PRAMS in ascertaining self-reported smoking during pregnancy only and found that using PRAMS resulted in higher estimates of prenatal smoking than using the BC.^{6,7} In the Allen et al. study,⁶ only two of the 24 states had implemented the revised BC in 2004. To our knowledge, no studies have compared BC and PRAMS estimates of smoking in the three months before pregnancy and the percentage of women who quit smoking during pregnancy. Thus, our study is an update and expansion of findings from previous work.

The purpose of this study was to compare estimates of prepregnancy and prenatal smoking using PRAMS, the BC, and both sources combined, and to compare the percentage of smokers who quit by the last trimester of pregnancy estimated using PRAMS with the percentage estimated using the BC. A secondary goal was to assess whether smokers identified by only one data

source had similar or different demographic characteristics than smokers identified by both data sources.

METHODS

PRAMS is an ongoing, population-based surveillance system of maternal behaviors and experiences before, during, and after pregnancy. All health departments participating in PRAMS use a standardized data collection methodology developed by the Centers for Disease Control and Prevention (CDC).⁵ In each state, a monthly stratified sample of 100–300 new mothers is selected systematically from recent BCs. PRAMS staff mail a self-administered questionnaire to selected women two to three months after the delivery of a live infant, and nonresponders are contacted by telephone. Survey data are linked to selected BC variables. Smoking data from the BC are only for those respondents who completed the PRAMS survey, and the data were available from the states as part of the sampling process for PRAMS. The data are weighted for sample design, nonresponse, and noncoverage to represent all live births delivered in each state. Among 38 states that participated in PRAMS in 2008, our analysis was restricted to eight states that implemented the 2003 revised BC and achieved a $\geq 65\%$ response rate: Colorado, Delaware, New York (excluding New York City), Ohio, Oregon, Tennessee, Washington State, and Wyoming. Response rates ranged from 65% in Oregon to 80% in Delaware.

Variables

In the 2003 revised BC, smoking status is determined from the question about the average number of cigarettes or packs of cigarettes smoked per day for the three months before pregnancy and during each trimester of pregnancy. Prepregnancy smokers and prenatal smokers were defined as smoking >0 cigarettes or packs of cigarettes per day for the three months before pregnancy and during the third trimester of pregnancy, respectively. The BC does not contain a mechanism for indicating smoking amounts of <1 cigarette per day. The CDC National Center for Health Statistics published estimates of smoking during any trimester of pregnancy using the revised BC for 24 states (Florida, Georgia, and Michigan were excluded, as they did not report smoking in a compatible format).⁸ For our study, we report only smoking during the last trimester, as this is the measure collected by PRAMS and can be used to calculate estimates of smoking cessation during pregnancy.

In PRAMS, women were first asked if they smoked at least 100 cigarettes in the past two years; if they

responded yes, they were asked how many cigarettes they smoked per day on average during the three months before pregnancy and during the last three months of pregnancy (the only measure collected during pregnancy). Categorical responses included 0, <1, 1–5, 6–10, 11–20, 21–40, or ≥ 41 cigarettes. Prepregnancy smokers and prenatal smokers were defined as smoking >0 cigarettes per day during the three months before pregnancy and during the last three months of pregnancy, respectively.

For both data sources, we calculated the proportion of women who quit smoking (i.e., smoking cessation) by the last trimester of pregnancy by dividing the number of women who reported both prepregnancy smoking and not smoking any cigarettes during the last trimester by the number reporting prepregnancy smoking.

We calculated combined prevalence estimates of prepregnancy and prenatal smoking using smoking status indicated from the BC, PRAMS, or both sources. Smoking cessation was dependent on indication of prepregnancy smoking status; thus, we did not calculate a combined estimate for smoking cessation. Women were considered nonsmokers before and during pregnancy when neither source indicated prepregnancy or prenatal smoking.

To assess potential bias by reporting source of smoking, the source indicating a woman was a smoker (BC, PRAMS, or both) was explored by maternal characteristics (age, education, race/ethnicity, marital status, trimester of entry into prenatal care [PNC], parity, insurance coverage during PNC, and participation in the Special Supplemental Nutrition Program for Women, Infants, and Children [WIC]) and infant birthweight.

Statistical analysis

We used kappa (k) statistics to compare the agreement between the BC and the PRAMS questionnaire in ascertaining prepregnancy and prenatal smoking, and we assessed cut-points for agreement at <0.21 (poor), 0.21–0.40 (fair), 0.41–0.60 (moderate), 0.61–0.80 (good), and 0.81–1.00 (very good). Using each data source separately, we calculated prevalence and 95% confidence intervals (CIs) of prepregnancy smoking, prenatal smoking, and smoking cessation for the total (all states combined) and for each state. We calculated combined prevalence estimates of prepregnancy and prenatal smoking using data from both sources. We conducted two-way t -tests to evaluate differences in the prevalence estimates between data sources. Relative proportion differences were calculated by subtracting the BC estimate from the PRAMS estimate and then dividing by the BC estimate. We calculated adjusted

prevalence ratios (APRs) and 95% CIs using logistic regression, as described by Bieler et al.,⁹ to examine whether maternal characteristics associated with smoking status differed by data source. We used Chi-square tests to examine differences in characteristics and the average number of cigarettes smoked per day among women with smoking indicated on one data source only (BC only or PRAMS only) compared with women who indicated smoking on both sources. All analyses were conducted using SAS® version 9.2 and SUDAAN® version 10.0 to account for the complex survey design of PRAMS.^{10,11} The data were weighted to represent women who delivered live births in each state.

A total of 10,797 records were available for analysis. Women were excluded if data were missing in either data source for prepregnancy smoking status (PRAMS: $n=195$, 1.8%; and BC: $n=97$, 0.6%) or prenatal smoking status (PRAMS: $n=192$, 1.8%; and BC: $n=98$, 0.6%). The final analytic sample included 10,485 women (97.1%). At the time of PRAMS questionnaire completion, the average infant's age was 3.8 months.

RESULTS

Prepregnancy smoking

There was “good” agreement between the two data sources for prepregnancy smoking status ($k=0.68$) (Table 1). Of the 10,485 women in the sample, 2,577 women (25.4%, 95% CI 24.1, 26.8) had prepregnancy smoking indicated on one or both data sources (i.e., BC and/or PRAMS). Of the 2,577 prepregnancy smokers, 1,524 (64%) had smoking indicated on both data sources, 117 (4%) had smoking indicated on the BC only, and 936 (32%) had smoking indicated on PRAMS only (data not shown).

Prepregnancy smoking prevalence was 17.3% from the BC and 24.4% from PRAMS (Table 2). The total PRAMS estimate was 41% higher than the BC estimate, based on the relative proportion difference. Overall and by state, the PRAMS prepregnancy smoking estimates were statistically higher than the BC estimates (t -tests, $p<0.05$). The state-specific combined estimates of prepregnancy smoking ranged from 18.2% in Colorado to 32.6% in Ohio.

The PRAMS estimates of prepregnancy smoking were statistically higher than the BC estimates for all sociodemographic subgroups (Table 3). The two data sources identified the same subgroups of women with the highest prepregnancy smoking prevalence: those who were aged <20 years and 20–24 years, of non-Hispanic white race/ethnicity, unmarried, Medicaid-enrolled, WIC participants, educated 12 years, and with either late or no PNC. In the adjusted analysis,

Table 1. Prepregnancy and prenatal smoking by U.S. women as reported on the revised 2003 birth certificate and PRAMS questionnaire, 2008^a

	PRAMS			
Smoking status	Smoker N (percent) ^b	Nonsmoker N (percent) ^b	Total N (percent) ^b	Kappa (95% CI)
Prepregnancy smoking ^c				
Birth certificate				0.68 (0.67, 0.70)
Smoker	1,524 (16.3)	117 (1.0)	1,641 (17.3)	
Nonsmoker	936 (8.1)	7,908 (74.6)	8,844 (82.7)	
Total ^d	2,460 (24.4)	8,025 (75.6)	10,485 (100.0)	
Prenatal smoking ^e				
Birth certificate				0.75 (0.73, 0.77)
Smoker	964 (10.1)	109 (1.2)	1,073 (11.3)	
Nonsmoker	444 (3.9)	8,968 (84.8)	9,412 (88.7)	
Total ^f	1,408 (14.0)	9,077 (86.0)	10,485 (100.0)	

^aData include eight states that have implemented PRAMS and the 2003 revised birth certificate (Colorado, Delaware, New York State [excludes New York City], Ohio, Oregon, Tennessee, Washington, and Wyoming).

^bThe percentages were weighted to adjust for survey design, noncoverage, and nonresponse. Unweighted numbers are provided.

^cPrepregnancy smoking is defined as any smoking during the three months before pregnancy.

^dThe total sample included 10,485 women, of which 2,577 women reported prepregnancy smoking on one or both data sources (i.e., birth certificate and/or PRAMS).

^ePrenatal smoking is defined as any smoking during the last trimester of pregnancy.

^fThe total sample included 10,485 women, of which 1,517 women reported prenatal smoking on one or both data sources (i.e., birth certificate and/or PRAMS).

PRAMS = Pregnancy Risk Assessment Monitoring System

CI = confidence interval

although there were some changes of high-risk groups from the bivariate analysis, prepregnancy smoking was independently associated with similar characteristics in both data sources: 25–29 years of age, having ≤ 12 years of education, being of non-Hispanic white race/ethnicity, being unmarried, being enrolled in Medicaid or uninsured, and participating in WIC.

Women who were non-Hispanic black or Hispanic and women who smoked ≤ 5 cigarettes per day pre-pregnancy were more often identified as prepregnancy smokers in only one data source compared with women who were white or smoked > 5 cigarettes per day who were more likely to be identified as prepregnancy smokers in both data sources (data not shown). In PRAMS, a higher proportion of women reported smoking ≤ 5 cigarettes per day pre-pregnancy compared with the BC. Additionally, women who had > 12 years of education, were married, were privately insured, and were not enrolled in WIC were more likely to report being pre-pregnancy smokers on PRAMS only (data not shown).

Prenatal smoking

There was “good” agreement between the two data sources for prenatal smoking status ($k=0.75$) (Table 1). Of 10,485 women, 1,517 women (15.2%, 95% CI

14.1, 16.4) had prenatal smoking indicated on one or both data sources. Of the 1,517 prenatal smokers, 964 (66.5%) had smoking indicated on both data sources, 109 (7.8%) had smoking indicated on the BC only, and 444 (24.7%) had smoking indicated on PRAMS only (data not shown).

The total prenatal smoking prevalence was 11.3% from the BC and 14.0% from PRAMS (Table 2). Overall and by state, the PRAMS estimate was statistically higher than the BC estimate. Based on the relative proportion difference, the overall PRAMS estimate of prenatal smoking prevalence was 24% higher than the BC estimate. The combined state-specific estimates ranged from 8.9% in Colorado to 21.5% in Tennessee.

The PRAMS estimates of prenatal smoking were statistically higher than the BC estimates for all sociodemographic subgroups except for non-Hispanic black race/ethnicity (Table 4). The two data sources identified the same subgroups of women with the highest prenatal smoking prevalence: those who were aged 20–24 years, of non-Hispanic white race/ethnicity, unmarried, Medicaid-enrolled, participating in WIC, with 12 years of education, and with late or no PNC. Similar to prepregnancy smoking, there were some changes of high-risk groups from the bivariate to

Table 2. Smoking status by state and data source among U.S. women who have delivered a live birth: revised 2003 birth certificate and PRAMS, 2008^a

State	Data source	Prepregnancy smoking ^b Percent (95% CI) ^c	Prenatal smoking ^b Percent (95% CI) ^c	Smoking cessation ^{b,d} Percent (95% CI) ^c
Total ^{e,f,g}	Birth certificate	17.3 (16.1, 18.6)	11.3 (10.3, 12.4)	35.1 (31.5, 39.0)
	PRAMS	24.4 (23.1, 25.8)	14.0 (12.9, 15.2)	42.6 (39.4, 45.9)
	Combined estimate	25.4 (24.1, 26.8)	15.2 (14.1, 16.4)	NC
Colorado ^{e,f}	Birth certificate	9.4 (7.8, 11.3)	5.7 (4.5, 7.2)	39.6 (30.3, 49.7)
	PRAMS	17.0 (14.8, 19.3)	8.2 (6.6, 10.0)	51.9 (44.6, 59.1)
	Combined estimate	18.2 (16.0, 20.7)	8.9 (7.4, 10.8)	NC
Delaware ^{e,f}	Birth certificate	15.1 (13.2, 17.2)	10.0 (8.5, 11.9)	34.0 (27.5, 41.2)
	PRAMS	24.3 (21.9, 26.8)	13.0 (11.2, 15.1)	46.3 (40.6, 52.1)
	Combined estimate	25.3 (23.0, 27.9)	13.5 (11.7, 15.6)	NC
New York ^{e,f}	Birth certificate	14.4 (12.0, 17.3)	9.7 (7.7, 12.2)	32.9 (24.3, 42.8)
	PRAMS	21.2 (18.4, 24.4)	11.9 (9.7, 14.6)	43.9 (36.2, 52.0)
	Combined estimate	22.0 (19.1, 25.3)	13.3 (11.0, 16.1)	NC
Ohio ^{e,f,g}	Birth certificate	25.5 (22.6, 28.8)	15.7 (13.2, 18.5)	38.7 (32.2, 45.7)
	PRAMS	31.4 (28.3, 34.8)	18.3 (15.7, 21.3)	41.8 (35.6, 48.2)
	Combined estimate	32.6 (29.4, 36.0)	19.4 (16.8, 22.5)	NC
Oregon ^{e,f}	Birth certificate	8.5 (6.3, 11.3)	6.1 (4.2, 8.7)	28.4 (17.0, 43.4)
	PRAMS	19.9 (16.7, 23.5)	11.2 (8.7, 14.3)	43.9 (34.4, 53.8)
	Combined estimate	20.3 (17.1, 24.0)	11.3 (8.8, 14.4)	NC
Tennessee ^{e,f}	Birth certificate	23.9 (20.2, 28.2)	16.2 (13.0, 19.9)	33.5 (25.1, 43.1)
	PRAMS	30.6 (26.5, 35.1)	19.7 (16.3, 23.7)	35.6 (27.9, 44.2)
	Combined estimate	31.5 (27.4, 36.1)	21.5 (17.9, 25.6)	NC
Washington ^{e,f}	Birth certificate	12.8 (10.6, 15.4)	9.2 (7.3, 11.5)	28.3 (20.2, 38.2)
	PRAMS	19.7 (17.1, 22.6)	10.8 (8.8, 13.2)	45.5 (37.6, 53.5)
	Combined estimate	20.9 (18.2, 23.9)	12.2 (10.1, 14.7)	NC
Wyoming ^{e,f}	Birth certificate	23.3 (20.1, 26.9)	12.8 (10.4, 15.7)	45.6 (37.4, 54.1)
	PRAMS	28.9 (25.5, 32.6)	16.4 (13.7, 19.6)	43.3 (36.1, 50.9)
	Combined estimate	30.3 (26.8, 34.0)	17.3 (14.5, 20.5)	NC

^aData include eight states that have implemented PRAMS and the 2003 revised birth certificate (Colorado, Delaware, New York State [excludes New York City], Ohio, Oregon, Tennessee, Washington, and Wyoming).

^bPrepregnancy smoking is defined as any smoking during the three months before pregnancy. Prenatal smoking is defined as any smoking during the last trimester of pregnancy. Smoking cessation is defined as the proportion of women who reported both prepregnancy smoking and not smoking any cigarettes during the last trimester divided by the number reporting prepregnancy smoking.

^cWeighted percentages and 95% CIs

^dThe estimate of smoking cessation was determined from women who reported prepregnancy smoking: for birth certificate ($n=1,641$) and PRAMS ($n=2,460$).

^eThe difference in prepregnancy smoking between birth certificates and the PRAMS questionnaire, as assessed by a t-test, $p<0.05$

^fThe difference in prenatal smoking between birth certificates and the PRAMS questionnaire, as assessed by a t-test, $p<0.05$

^gThe difference in smoking cessation between birth certificates and the PRAMS questionnaire, as assessed by a t-test, $p<0.05$

PRAMS = Pregnancy Risk Assessment Monitoring System

CI = confidence interval

NC = not calculated

the adjusted analysis; however, prenatal smoking was independently associated with similar characteristics in both data sources (except for parity and entry into PNC): aged 25–29 years, having ≤ 12 years of education, being of non-Hispanic white race/ethnicity, being unmarried, being enrolled in Medicaid or uninsured, and participating in WIC.

Women who smoked ≤ 5 cigarettes per day during

pregnancy were more likely to be identified as prenatal smokers in only one data source compared with women who smoked >5 cigarettes per day, who were more likely to be identified as prenatal smokers in both data sources (data not shown). Additionally, women who were <20 years of age, privately insured, and not enrolled in WIC were more likely to be indicated as prenatal smokers on PRAMS only (data not shown).

Smoking cessation by last trimester of pregnancy

Among prepregnancy smokers identified using the BC only ($n=1,641$), 35.1% of women (95% CI 31.5, 39.0) quit smoking by the last trimester (Table 2). State-specific estimates ranged from 28.3% in Washington State to 45.6% in Wyoming. Among those who quit smoking and remained that way until the end of pregnancy, 58% quit before the first trimester, 31%

quit before the second trimester, and 11% quit before the third trimester (data not shown).

Among prepregnancy smokers identified using PRAMS only ($n=2,460$), 42.6% (95% CI 39.4, 45.9) quit smoking by the last trimester (Table 2). State-specific estimates ranged from 35.6% in Tennessee to 51.9% in Colorado. The overall PRAMS estimate of smoking cessation was statistically higher than the BC estimate;

Table 3. Prevalence and APR of prepregnancy smoking in U.S. women by sociodemographic characteristics and data source, 2008^a

Characteristic	Birth certificate		PRAMS		Combined	
	Prevalence (percent)	APR (95% CI) ^b	Prevalence (percent)	APR (95% CI) ^b	Prevalence (percent)	APR (95% CI) ^b
Age (in years)						
<20 ^c	23.8	0.78 (0.57, 1.07)	34.2	0.86 (0.67, 1.11)	36.7	0.90 (0.71, 1.14)
20–24 ^c	25.5	1.06 (0.86, 1.31)	35.6	1.13 (0.96, 1.33)	36.7	1.12 (0.96, 1.32)
25–29 ^c	18.2	1.26 (1.05, 1.51)	24.9	1.21 (1.05, 1.39)	26.0	1.22 (1.06, 1.39)
>29 ^c	10.1	Ref.	14.9	Ref.	15.4	Ref.
Education (in years)						
<12 ^c	22.9	1.60 (1.26, 2.03)	29.5	1.39 (1.14, 1.70)	31.2	1.41 (1.16, 1.71)
12 ^c	29.3	1.73 (1.43, 2.09)	40.7	1.69 (1.46, 1.97)	41.9	1.67 (1.44, 1.93)
>12 ^c	10.7	Ref.	16.1	Ref.	16.8	Ref.
Race/ethnicity						
Non-Hispanic white ^c	20.3	1.66 (1.22, 2.25)	28.3	1.44 (1.15, 1.81)	29.2	1.40 (1.14, 1.73)
Non-Hispanic black	16.9	0.72 (0.49, 1.06)	22.0	0.61 (0.46, 0.83)	24.0	0.63 (0.48, 0.84)
Hispanic ^c	5.9	0.27 (0.17, 0.43)	10.4	0.33 (0.23, 0.46)	11.3	0.33 (0.24, 0.46)
Other ^c	11.1	Ref.	18.2	Ref.	19.3	Ref.
Marital status						
Not married ^c	30.4	2.10 (1.73, 2.55)	40.7	2.01 (1.74, 2.33)	42.3	1.99 (1.72, 2.29)
Married ^c	10.1	Ref.	15.5	Ref.	16.2	Ref.
PNC						
First trimester ^c	15.5	Ref.	22.2	Ref.	23.3	Ref.
Second trimester ^c	23.1	1.15 (0.95, 1.38)	31.3	1.11 (0.96, 1.29)	32.4	1.08 (0.94, 1.25)
Third trimester/no PNC ^c	24.8	1.22 (0.92, 1.62)	35.2	1.23 (0.98, 1.54)	36.1	1.20 (0.96, 1.50)
Insurance during PNC						
Medicaid ^c	28.5	1.53 (1.22, 1.90)	37.8	1.41 (1.19, 1.67)	39.6	1.43 (1.22, 1.68)
Uninsured ^c	22.6	1.55 (1.21, 1.98)	29.6	1.35 (1.12, 1.64)	30.2	1.32 (1.10, 1.60)
Other ^c	9.7	Ref.	15.4	Ref.	16.0	Ref.
WIC						
Participant ^c	28.6	1.61 (1.32, 1.96)	36.6	1.40 (1.20, 1.64)	38.1	1.40 (1.20, 1.62)
Not a participant ^c	10.3	Ref.	16.6	Ref.	17.2	Ref.
Parity						
0 ^c	17.3	0.96 (0.82, 1.12)	25.7	1.00 (0.89, 1.14)	26.7	0.99 (0.88, 1.12)
≥1 ^c	17.5	Ref.	23.7	Ref.	24.7	Ref.

^aData include eight states that have implemented PRAMS and the 2003 revised birth certificate (Colorado, Delaware, New York State [excludes New York City], Ohio, Oregon, Tennessee, Washington, and Wyoming).

^bAdjusted for age, education, race/ethnicity, marital status, PNC, insurance, WIC, and parity

^cStatistically significant difference in prepregnancy smoking estimates between the 2003 revised birth certificate and the PRAMS questionnaire by subgroup, as assessed by t-tests, $p<0.05$

APR = adjusted prevalence ratio

PRAMS = Pregnancy Risk Assessment Monitoring System

CI = confidence interval

Ref. = reference group

PNC = prenatal care

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Table 4. Prevalence and APR of prenatal smoking in U.S. women by sociodemographic characteristics and data source, 2008^a

Characteristic	Birth certificate		PRAMS		Combined	
	Prevalence (percent)	APR (95% CI) ^b	Prevalence (percent)	APR (95% CI) ^b	Prevalence (percent)	APR (95% CI) ^b
Age (in years)						
<20 ^c	13.7	0.55 (0.36, 0.83)	20.3	0.81 (0.57, 1.16)	22.6	0.86 (0.62, 1.20)
20–24 ^c	16.7	0.91 (0.70, 1.19)	20.4	1.10 (0.86, 1.40)	22.5	1.13 (0.89, 1.42)
25–29 ^c	13.2	1.36 (1.08, 1.71)	15.5	1.39 (1.13, 1.72)	16.7	1.42 (1.16, 1.74)
>29 ^c	6.0	Ref.	7.5	Ref.	7.8	Ref.
Education (in years)						
<12 ^c	18.5	2.24 (1.65, 3.02)	22.8	2.01 (1.52, 2.66)	24.4	1.96 (1.51, 2.54)
12 ^c	20.2	2.05 (1.59, 2.66)	23.7	1.89 (1.51, 2.38)	26.0	1.85 (1.49, 2.30)
>12 ^c	5.4	Ref.	7.3	Ref.	7.9	Ref.
Race/ethnicity						
Non-Hispanic white ^c	13.5	1.63 (1.11, 2.37)	16.5	1.50 (1.06, 2.12)	17.7	1.46 (1.07, 1.99)
Non-Hispanic black	10.9	0.63 (0.39, 1.01)	12.5	0.56 (0.36, 0.86)	15.1	0.60 (0.40, 0.90)
Hispanic ^c	2.8	0.14 (0.08, 0.26)	4.6	0.21 (0.12, 0.35)	4.9	0.19 (0.12, 0.32)
Other ^c	8.0	Ref.	10.9	Ref.	11.9	Ref.
Marital status						
Not married ^c	21.2	2.08 (1.62, 2.67)	25.5	2.12 (1.71, 2.64)	28.0	2.13 (1.73, 2.62)
Married ^c	5.9	Ref.	7.7	Ref.	8.2	Ref.
PNC						
First trimester ^c	9.6	Ref.	12.1	Ref.	13.2	Ref.
Second trimester ^c	17.5	1.32 (1.06, 1.65)	20.5	1.27 (1.04, 1.55)	22.0	1.22 (1.01, 1.47)
Third trimester/no PNC ^c	19.0	1.35 (0.97, 1.88)	25.9	1.52 (1.13, 2.05)	26.6	1.39 (1.04, 1.85)
Insurance during PNC						
Medicaid ^c	20.8	1.95 (1.43, 2.66)	23.9	1.47 (1.14, 1.89)	26.5	1.57 (1.24, 1.99)
Uninsured ^c	16.9	2.06 (1.46, 2.90)	19.5	1.58 (1.18, 2.12)	21.3	1.65 (1.25, 2.17)
Other ^c	4.5	Ref.	6.9	Ref.	7.1	Ref.
WIC						
Participant ^c	21.0	2.02 (1.54, 2.64)	24.3	1.78 (1.41, 2.25)	26.6	1.76 (1.42, 2.19)
Not a participant ^c	5.0	Ref.	7.4	Ref.	7.8	Ref.
Parity						
0 ^c	9.8	0.91 (0.74, 1.12)	12.5	0.80 (0.66, 0.96)	13.6	0.79 (0.66, 0.94)
≥1 ^c	12.4	Ref.	15.2	Ref.	16.5	Ref.
Infant birthweight (in grams)						
<1,500	16.6	1.48 (1.08, 2.02)	18.9	1.35 (1.01, 1.82)	21.5	1.39 (1.07, 1.81)
1,500–2,500 ^c	19.7	1.50 (1.27, 1.77)	22.9	1.47 (1.27, 1.69)	24.6	1.42 (1.24, 1.63)
>2,500 ^c	10.7	Ref.	13.4	Ref.	14.5	Ref.

^aData include eight states that have implemented PRAMS and the 2003 revised birth certificate (Colorado, Delaware, New York State [excludes New York City], Ohio, Oregon, Tennessee, Washington, and Wyoming). Prenatal smoking is defined as any smoking during the last trimester of pregnancy.

^bAdjusted for age, education, race/ethnicity, marital status, PNC, insurance, WIC, parity, and infant birthweight

^cThe difference in prenatal smoking between birth certificates and the PRAMS questionnaire, as assessed by a t-test, $p < 0.05$

APR = adjusted prevalence ratio

PRAMS = Pregnancy Risk Assessment Monitoring System

CI = confidence interval

Ref. = reference group

PNC = prenatal care

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

however, this difference was statistically significant in only one state (Ohio). Based on relative proportion difference, the total PRAMS estimate of quitting was 21% higher than the BC estimate.

With the exception of age, the two data sources identified similar groups of women with the highest proportion of smoking cessation (those with >12 years of education, of Hispanic race/ethnicity, married, privately insured, not participating in WIC, and nulliparous) (Table 5). For these demographic groups, the PRAMS estimate of smoking cessation was higher than the BC estimate, although not all reached statistical significance. On the BC, smokers who were <20 years of age had the highest proportion of smoking cessation (43%) compared with other age groups; on PRAMS, smokers >29 years of age had the highest proportion of smoking cessation (50%). For both data sources, quitters were more likely to report smoking ≤5 cigarettes per day prepregnancy compared with women who did not quit (data not shown).

When comparing data sources, the independent associations between maternal characteristics and smoking cessation during pregnancy were generally in the same direction, although the strength of the association varied by data source, with few exceptions (Table 5). On both sources, compared with reference categories, having >12 years of education, not participating in WIC, and having an infant who weighed >2,500 grams were associated with smoking cessation. On the BC, being Hispanic, initiating PNC in the first trimester, and being privately insured were associated with smoking cessation. On PRAMS, being nulliparous was associated with smoking cessation.

DISCUSSION

When combining information on smoking status from both data sources, we estimated that one in four women smoked in the three months before pregnancy and 15.2% of women smoked during the last trimester of pregnancy in the eight study states. Compared with the BC, PRAMS captured more prepregnancy and prenatal smokers during the last trimester only; subgroups of women who were privately insured, were non-WIC participants, and smoked ≤5 cigarettes per day were more likely to report smoking on the PRAMS questionnaire than on the BC. Despite these differences in reporting, the two data sources identified similar predictors of prepregnancy and prenatal smoking among women who delivered live infants.

Among women who smoked prepregnancy, we found that 35% and 46% quit smoking by the last trimester based on BC and PRAMS, respectively. The discrepancy

was largely due to the substantial number of women indicated as prepregnancy smokers on PRAMS but not on the BC; the majority (69%) of these women reported not smoking during the last trimester of pregnancy. The characteristics of these women were consistent with those most likely to quit smoking during pregnancy: higher education, Hispanic, privately insured, not a WIC participant, and smoking fewer cigarettes per day prepregnancy.

Limitations

This study was subject to several limitations. A national study validating self-reports with serum cotinine found that 23% of pregnant smokers and 10% of nonpregnant smokers did not disclose their smoking.¹² PRAMS is a confidential survey completed by the mother, on average, four months after delivery. In contrast, the BC is completed during the delivery hospitalization, and information on smoking status is obtained from the mother using a worksheet.¹³ Thus, nondisclosure and recall bias may affect the reporting of smoking status for both sources. The higher prevalence of smoking reported on PRAMS suggests that nondisclosure is of less concern for PRAMS than for the BC. Furthermore, the PRAMS and BC questions that ascertain smoking status are different, which could affect estimates. In particular, non-daily smokers (i.e., those who smoke <1 cigarette per day) would likely not be identified using the BC. Also, the 100 cigarettes filter question could result in PRAMS not detecting women who recently initiated smoking or who do not smoke frequently. It was also not possible to compare differences in the level of smoking between data sources, as only a categorical response for the number of cigarettes smoked per day is captured on PRAMS.

PRAMS asks about smoking during the last three months of pregnancy; thus, the timing of smoking cessation (before or during pregnancy) cannot be determined using PRAMS alone. However, an advantage of the revised BC is being able to calculate smoking cessation and relapsing within pregnancy using first- and second-trimester smoking status.⁸ These study findings also may not be generalizable to women who have delivered a live birth outside of the eight study states or to women whose pregnancy ended in a stillbirth. As mentioned previously, we examined only last trimester smoking; therefore, published estimates of smoking at any time during pregnancy using the revised BC among the states included in this study (range: 8.6% in Colorado to 20.2% in Wyoming) were higher than our study BC estimates of last trimester smoking.⁸

PRAMS identified more smokers before pregnancy and during the last trimester of pregnancy than the

Table 5. Percentage and APR of U.S. women who quit smoking by last trimester of pregnancy among women who smoked prepregnancy, by sociodemographic characteristics and data source, 2008^a

	Birth certificate		PRAMS	
	Quit Percent ^b	APR (95% CI) ^c	Quit Percent ^d	APR (95% CI) ^c
Age (in years)				
<20 ^e	42.6	1.81 (1.28, 2.56)	40.7	1.21 (0.90, 1.61)
20–24	34.7	1.26 (0.93, 1.70)	42.6	1.06 (0.85, 1.32)
25–29	28.5	0.79 (0.57, 1.08)	37.9	0.82 (0.65, 1.02)
>29 ^e	40.8	Ref.	49.9	Ref.
Education (in years)				
<12 ^e	19.5	0.47 (0.31, 0.72)	22.9	0.55 (0.41, 0.75)
12	31.6	0.66 (0.52, 0.84)	41.7	0.82 (0.69, 0.99)
>12 ^e	49.6	Ref.	54.6	Ref.
Race/ethnicity				
Non-Hispanic white ^e	34.2	1.09 (0.66, 1.80)	41.6	0.93 (0.66, 1.32)
Non-Hispanic black	37.0	1.54 (0.90, 2.64)	42.9	1.22 (0.82, 1.81)
Hispanic	53.2	2.05 (1.16, 3.60)	56.7	1.44 (0.97, 2.13)
Other	28.4	Ref.	40.4	Ref.
Marital status				
Not married	30.6	0.91 (0.71, 1.18)	37.2	0.88 (0.73, 1.05)
Married ^e	42.3	Ref.	50.1	Ref.
PNC				
First trimester ^e	37.9	Ref.	45.7	Ref.
Second trimester	24.7	0.70 (0.49, 0.99)	34.6	0.84 (0.66, 1.07)
Third trimester/no PNC	23.4	0.72 (0.46, 1.12)	26.8	0.66 (0.41, 1.07)
Insurance during PNC				
Medicaid	27.1	0.69 (0.52, 0.93)	36.7	0.92 (0.76, 1.12)
Uninsured	26.4	0.67 (0.45, 0.99)	34.0	0.78 (0.58, 1.05)
Other ^e	54.0	Ref.	55.4	Ref.
WIC				
Participant ^e	26.9	0.64 (0.50, 0.82)	33.7	0.72 (0.60, 0.86)
Not a participant	51.3	Ref.	55.2	Ref.
Parity				
0 ^e	43.6	1.08 (0.86, 1.35)	51.4	1.28 (1.08, 1.53)
≥1 ^e	29.3	Ref.	35.9	Ref.
Infant birthweight (in grams)				
<1,500	32.5	0.97 (0.69, 1.35)	40.1	0.89 (0.66, 1.21)
1,500–2,500 ^e	24.1	0.76 (0.60, 0.96)	29.6	0.78 (0.65, 0.93)
>2,500 ^e	36.2	Ref.	43.8	Ref.

^aData include eight states that have implemented PRAMS and the 2003 revised birth certificate (Colorado, Delaware, New York State [excludes New York City], Ohio, Oregon, Tennessee, Washington, and Wyoming).

^bThe estimate of smoking cessation was determined among women who reported prepregnancy smoking on the birth certificate ($n=1,641$).

^cAdjusted for age, education, race/ethnicity, marital status, PNC, insurance, WIC, parity, and infant birthweight

^dThe estimate of smoking cessation was determined among women who reported prepregnancy smoking on PRAMS ($n=2,460$).

^eStatistically significant difference in smoking cessation estimates between birth certificates and the PRAMS questionnaire, as assessed by t-tests, $p<0.05$

APR = adjusted prevalence ratio

PRAMS = Pregnancy Risk Assessment Monitoring System

CI = confidence interval

Ref. = reference group

PNC = prenatal care

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

BC. When reporting estimates of smoking based solely on the BC, the likelihood of underreporting the “true” smoking prevalence should be acknowledged. For states implementing PRAMS and the 1989 BC, using the PRAMS survey only will be sufficient in ascertaining smoking status before and during pregnancy.

CONCLUSIONS

PRAMS, a confidential, anonymous survey administered during the postpartum period, captured more women who smoked before pregnancy and who smoked during the last trimester of pregnancy than the 2003 revised BC. States implementing PRAMS and the revised BC should consider information from both sources when developing population-based estimates of smoking before pregnancy and during the last trimester of pregnancy.

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