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Smoking Cessation in Pregnancy and Gestational Weight Gain in South Carolinian Mothers, 2009-2011

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**SMOKING CESSATION IN PREGNANCY AND GESTATIONAL WEIGHT
GAIN IN SOUTH CAROLINIAN MOTHERS, 2009-2011**

by

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Bachelor of Science,
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Submitted in Partial Fulfillment of the Requirements
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Epidemiology

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ABSTRACT

Purpose: To determine if smoking cessation during pregnancy is associated with excessive gestational weight gain (GWG).

Methods: Data came from the 2009-2011 Pregnancy Risk Assessment Monitoring System (PRAMS), an ongoing population-based survey of live births in South Carolina (n=2,603). Participant smoking status was classified as nonsmoker (did not smoke before or during pregnancy), persistent smoker (smoked before and throughout pregnancy), or quitter (smoked before but quit during pregnancy). Multinomial logistic regression model was estimated to examine the association between smoking status and meeting the 2009 Institute of Medicine guidelines, while linear regression model was used for the continuous outcomes such as the rate of weight gain in the 2nd and 3rd trimesters and total GWG (full term births only).

Results: Over half (51.2%) of South Carolinian mothers had excessive GWG during pregnancy with an additional quarter of women gaining weight below (24.4%) or within (24.4%) the guidelines. The mean total weight gain was 28.5 lbs (± 0.55). Regarding smoking status, about 69.5% were non-smokers, 14.5% were

persistent smokers, and 16% were quitters. After adjusting for potential confounders, nonsmokers had a significantly lower weekly rate of weight gain in the 2nd and 3rd trimesters (-0.23 lb) and gained about 6 lbs less than quitters. The weight gain experiences were similar between persistent smokers and quitters. Smoking status was not associated with meeting IOM guidelines.

Conclusions: Higher GWG among quitters than non-smokers suggests a need for smoking cessation programs to promote healthy GWG, perhaps through counseling on healthy eating and active living.

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CHAPTER 1

INTRODUCTION

Evidence concerning the association between smoking cessation and gestational weight gain is inconclusive. Since smoking is strongly discouraged during pregnancy, many women choose to quit. However, cessation may lead to a substantial increase in weight gain, contributing to new or persistent obesity and other adverse health outcomes for both the mother and infant¹⁻⁴. In non-pregnant population, women gain about 5 kg on average following one year of successful cessation⁵. However, the amount of weight gain in the pregnant population varies dependent on whether physical activity or nutrition counseling is part of the intervention. To date, few observational studies have examined the association between smoking cessation and gestational weight gain. Therefore, we used data from the 2009-2011 South Carolina Pregnancy Risk Assessment Monitoring System (PRAMS) to determine the effect of smoking cessation during pregnancy on gestational weight gain. We hypothesize that nonsmokers and persistent smokers are less likely to gain a higher amount of weight and exceed the recommended weight gain guidelines compared to

quitters after adjusting for potential confounders. We believe that our findings will contribute to existing literature about perinatal smoking and gestational weight gain and stress the importance of a weight management component in the development of smoking cessation programs for pregnant women.

CHAPTER 2

LITERATURE REVIEW

Trends in Smoking in Pregnancy

Historically, cigarette smoking was very rare among American women. However, its prevalence among women increased over time and became comparable with men between 1965 and 1985⁶ through tobacco marketing campaigns designed to appeal women⁷.

Much lower than the national average among non-pregnant women (23.2%), 12% of US women smoked during pregnancy in 2000 according to national birth certificates data⁸. High parity, young age when first starting smoking, not living with infant's father, heavy smoking, no steady job, and living with current smokers are associated with a greater chance of continuing to smoke during pregnancy⁹. Reasons women choose to smoke include reducing anxiety and stress, combatting depression, and controlling weight⁷.

Weight Gain Following Smoking Cessation in Non-Pregnant Population

Nicotine may increase energy expenditure (EE), reduce appetite, increase insulin resistance, and contribute to higher levels of fasting plasma cortisol concentrations. So smokers tend to weigh less and have lower levels of body fat, BMI, and waist circumference compared to non-smokers and quitters in the non-pregnant population¹⁰⁻¹². After successful cessation however, average weight increases to, but does not surpass that of non-smokers, prompting some to believe that smoking contributes to weight gain through the “set-point” hypothesis. This hypothesis states changes in one’s body weight below or above a set point is a response to a change in eating habits or energy expenditure. Because nicotine may lower the set point, quitters usually return to their usual set point, thus gaining weight¹²⁻¹³.

According to national data, the average weight gain after ten years of cessation is 3.8 kg in women with most weight gain occurring within the first year of quitting (3-5 kg)^{5,12-13}. There are also cases of gaining excessive weight following smoking cessation coining the term “super gainers.” In these studies, quitters may gain between 8-10 kg within the first 5 years and more than 13 kg 7 years following cessation^{5,12,14}.

Overall, there are many different predictors of weight gain following quitting smoking. It is speculated that African Americans, people under the age of 55, high BMI, and underweight or sedentary women are at a higher risk of gaining more weight after cessation^{5,12}. Bamia et.al (2004)¹⁵ suggested that personality and lifestyle characteristics of smokers may account for the change in weight following cessation rather than tobacco-related and genetic reasons, while Swan and Carmelli (1995)¹⁴ proposed that weight changes are influenced by genetic factors solely.

Institute of Medicine (IOM) Guidelines for Gestational Weight Gain

The IOM decided to reexamine the guidelines that were put in place for weight gain during pregnancy in 1990 because many health factors have changed for women who are able to conceive¹⁶. The new guidelines are based on prepregnancy BMI as defined by the World Health Organization and listed as a recommended range of weight gain. Essentially, women weighing more at prepregnancy should gain less during pregnancy and vice versa for those who are obese. Generally, pregnant women should always seek advice from their healthcare provider to determine adequate weight gain. The below table depicts recommended weight gain for each BMI category¹⁶.

Table 2.1 Institute of Medicine's Recommended Weight Gain According to Prepregnancy Body Mass Index.

Prepregnancy BMI (kg/m²)	Total Recommended Weight Gain (in lbs)	Rates of Weight Gain 2nd & 3rd Trimester (Mean Range in lbs/wk)
Underweight (<18.5)	28-40	1 (1-1.3)
Normal Weight (18.5 – 24.9)	25-35	1 (0.8-1.0)
Overweight (25.0 – 29.9)	15-25	0.6 (0.5-0.7)
Obese (>30.0)	11-20	0.5 (0.4-0.6)

Adapted from the IOM gestational weight gain recommendations. Based on full term deliveries only.

Anyone gaining above the recommended range is considered gaining excessively while those gaining below are considered inadequate. Although these guidelines have been implemented, only a third of all pregnant women gain within recommended weight in the US¹⁶. Overall, excessive GWG is more common than inadequate GWG. In 2004, about 36% of women gained above the guidelines, while 23% gained below according to data from the Pregnancy Nutrition Surveillance System¹⁷. Overweight and obese women are at a higher risk of gaining above the guidelines while underweight women are more likely to gain below. Risk factors associated with inadequate or excessive weight gain include family income, education, dietary intake, and physical activity¹⁷.

Health Effects of Inadequate and Excessive GWG

Mean gestational weight gain (GWG) usually decreases with increasing prepregnancy BMI^{1,17}. Women with low GWG are more likely to have low birth

weight infants and underweight women with low weight gain have an increased risk for delivery of small for gestational age (SGA) infants¹⁷. On the other hand, women with high weight gains are more likely to have macrosomic infants or large for gestational age (LGA) infants and an increased risk for cesarean delivery, preeclampsia, and gestational hypertension¹⁻³. Excessive weight gain is usually retained and maintained up to 6 months post-partum resulting in overweight/obesity for the mother⁴.

Since obese women are already at a higher risk for pregnancy complications such as gestational diabetes, gestational hypertension, and cesarean delivery, they may benefit from low weight gain during pregnancy¹⁷⁻¹⁸. However, obese women who lose or gain little weight are more likely to deliver SGA infants¹⁹. Overall, women gaining within the IOM recommendation have a lower occurrence of pregnancy/delivery complications compared to those gaining above or below the recommendations²⁰⁻²¹.

Association between Smoking Cessation during Pregnancy and GWG

A number of studies have examined the association between smoking cessation during pregnancy and gestational weight gain²²⁻²⁷. The sample sizes range from 154 to 4000 participants and included women giving birth from 1984 to 2008. Gestational weight gain was calculated using self-reported

prepregnancy weight and weight obtained from birth certificates²⁷, last visits before delivery^{22,23,25}, weight at 37 weeks gestation²⁶, or medical charts²⁴. Two studies used self-reported data along with biochemical validation to confirm smoking status through either urinary cotinine or expired carbon monoxide samples^{24,27} while the others used self-reported smoking status solely. Four of the studies were conducted in the US^{24-25,27}, one in Brazil²³, one in Sweden²², and the other in Denmark²⁶.

International Studies

Using the data from the participants in the Brazilian Study of Gestational Diabetes, Favaretto et al. (2007)²³ included 4,000 women pregnant between 1991 and 1995, who were diabetes free at enrollment and between 20 and 28 weeks of gestation. Quitters were defined as those quitting anytime from 6 months before conception to 20-28 weeks gestation²³. They found quitters gained more ($p < .0001$) weight (12.1 kg) than non-smokers (11.2 kg).

Using data from 1,753 Swedish women giving birth in 1984/1985 and being enrolled in the Stockholm Pregnancy and Weight Development Study, Adegboye et.al (2010) assessed the effect of quitting smoking in the first trimester on GWG. Swedish women gained about 15.3 kg (SD 4.4), 14.1 kg (SD 43.0), and 13.8 kg (SD 4.3) among quitters, non-smokers, and persistent smokers

respectively. Quitters gained significantly more weight than both non-smokers and persistent smokers ($p < .0001$) and had a greater risk ($OR = 2.0$; 95% $CI = 1.4-3.0$) of gaining weight above the IOM recommendations compared to non-smokers in this population. There was no significant difference in gaining excessive weight between persistent smokers and nonsmokers²².

Among 1774 Danish women pregnant between November 1996 and October 1999 enrolled in the Smoke-free Newborn study in Copenhagen, Denmark, the mean gestational weight gain at 37 weeks gestation was 2.0 kg (95% $CI = 1.5-2.6$) higher in quitters compared to nonsmokers²⁷.

American Studies

The two American studies that found an association between smoking cessation and gestational weight gain only included persistent smokers and quitters. In the first, 238 non-Hispanic white pregnant Texans selected from Project PANDA (Parents and Newborns Developing and Adjusting) were followed. They found that quitters gained 36.6 pounds (SD 14.5) and smokers gained 28.9 pounds (SD 11.7) on average. Quitters were also more likely to gain above the IOM recommendations ($RR = 1.74$; 95% $CI = 1.21-2.51$) compared to persistent smokers²⁶. Next, Levine and colleagues (2013) conducted a study of 357 women enrolled in the Stop Tobacco in Pregnancy (STOP) program designed

to promote smoking cessation among low income groups. They also found that women who quit in early pregnancy gained more weight (16.9 ± 7.5 kg) than persistent smokers (13.6 ± 8.9)²⁵.

Conversely, two studies did not detect an association between smoking and gestational weight gain^{24,28}. One used Medicaid recipients enrolled in a randomized intervention to reduce lead exposure in children²⁴ while the other was a randomized controlled trial using women from local obstetric practices and a WIC nutritional program in Vermont²⁸.

Overall, results are mixed with a majority of studies finding that quitters gained more total weight than both persistent smokers and nonsmokers^{22-23,25-27} and two studies not detecting an association^{24,28}. Of the few studies measuring meeting IOM guidelines, persistent smokers were more likely to have inadequate weight gain while quitters were more likely to gain excessively^{22,26}

Table 2.2 Summary Table of Epidemiologic Literature on the Association of Smoking Cessation and Gestational Weight Gain

Author (Year)	Study Design & Population	Measurements & Methods	Confounders	Major Findings
Mongoven et.al (1996)²⁶	Sample of quitters and continuing smokers selected from Project Panda N = 238 All white non-Hispanic women	Exposure: self-report smoking status (quitter or smoker) Difference between weight recorded in medical record at first visit and last visit before delivery was used to identify GWG t-tests for group differences (quitter vs. smoker)		On average, quitters gained more weight than persistent smokers (36.6 vs 28.9 lbs respectively) Quitters were more likely to gain more than the IOM recommendations (RR = 1.74; 95% CI= 1.21-2.51)
Furuno, Gallicchio, & Sexton (2004)²⁴	Medicaid recipients enrolled in a randomized intervention to reduce lead exposure in young children N = 265	Exposure: self-report smoking status GWG was calculated using self-reported weight before pregnancy delivery Logistic regression	Age, length gestation, race, education, gravida, alcohol use, prepregnancy BMI, height, caloric intake	No difference in mean maternal weight gain between smokers and nonsmokers (14.4 vs 13.9 kg).
Favaretto et.al (2007)²³	Brazilian Study of Gestational Diabetes prospective cohort 6 Brazilian centers (1991-1995) Women between 20-28 weeks gestation were included N=4000	Self-report Smoking status: Smokers or quitters GWG was calculated using last prenatal weight from medical records and self-reported prepregnancy weight Multiple linear regression	Age, race, education, parity, prepregnancy BMI, clinical center	Quitters gained more weight (12.1 kg) than non-smokers (11.2 kg)

Adegboye et.al (2010)²²	<p>1 year follow up of Stockholm Pregnancy and Weight Development Study</p> <p>N = 1753</p> <p>women who gave birth in 1984/85 Stockholm, Sweden in 14 selected maternity units</p>	<p>Self-reported smoking classified as non-smokers, quitters (stopped during 1st trimester), and smokers</p> <p>GWG was calculated using weight measured at end of gestation from self-reported prepregnancy weight and classified according to IOM guidelines</p> <p>Logistic regression</p>	<p>infant birth weight, gestational age, maternal parity, pre-pregnancy BMI, alcohol consumption, physical activity, and breakfast frequency</p>	<p>Quitters (15.3 kg) gain more weight than both persistent smokers (13.8 kg) and non- smokers (14.1 kg)</p> <p>Quitters also had a greater risk (OR = 2.0; 95% CI = 1.4-3.0) of gaining weight above the IOM recommendations compared to non-smokers</p>
Levine et.al (2013)²⁵	<p>Stop Tobacco in Pregnancy (STOP) cohort</p> <p>N = 357</p> <p>All low income women</p>	<p>Smoking status was self-reported with biochemical validation</p> <p>GWG was calculated using self-reported prepregnancy from final weight on medical chart</p> <p>t-tests and regression models</p>	<p>age, weeks' gestation, prepregnancy BMI, baseline cigs/day, marital status</p>	<p>Women who quit early in pregnancy gained more weight (16.9 ± 7.5 kg) than persistent smokers (13.6 ± 8.9)</p>
Washio et.al (2011)²⁸	<p>women from local obstetric practices and a WIC nutritional program in Vermont</p> <p>N = 154</p> <p>Women enrolled in a controlled trial examining the efficacy of contingency management for smoking cessation</p>	<p>smoking abstinence was defined as self-report of no smoking in the past 7 days confirmed by urinary cotinine levels of 80 nh/ml or less</p> <p>Multiple linear regression</p>	<p>age, race, education, gravida, marital status, insurance status, employment status, smoking characteristics, psychiatric symptoms</p>	<p>maternal weight gain did not differ significantly between abstinence-contingent group and control group (15.0 ± 0.8 kg vs. 15.0 ± 0.9 kg)</p>

Rode et.al (2013)²⁷	<p>Data from Smoke-free Newborn Study (November 1996 – October 1999)</p> <p>Copenhagen, Denmark</p> <p>N = 1774</p>	<p>Self-report (non-smokers, smokers, and quitters) & saliva cotinine levels ,measured from a subset for validity</p> <p>GWG was calculated from self-reported pre-pregnancy weight and weight at 37 weeks gestation</p>	<p>prepregnancy BMI, age, parity, marital status, education, caffeine intake, partner smoking</p>	<p>Mean gestational weight gain at 37 weeks gestation was 2.0 kg (95% CI = 1.5-2.6) higher in quitters compared to nonsmokers.</p> <p>Quitters had a greater odds (OR = 1.9; 95% CI = 1.5-2.4) of gaining weight above the IOM recommendations compared to non-smokers</p>
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CHAPTER 3

STATEMENT OF PURPOSE

Smoking during pregnancy causes low birth weight infants, preterm delivery, premature rupture of the membrane and other adverse pregnancy outcomes⁷. Additionally, inadequate and excessive gestational weight gain has been associated with adverse health outcomes for both the mother and unborn child^{2,17}. Over the past decade, smoking during pregnancy has been changing with more women choosing to quit during pregnancy to prevent these outcomes¹⁵. It is valuable to discern how smoking cessation impacts gestational weight gain since pregnancy is often a teachable moment that can be used to promote healthy behaviors.

In terms of GWG, research has shown that smoking cessation may lead to excessive weight gain^{22-23,25-27}. However, these studies focus on a predominately non-Hispanic White population^{22,26,27} pregnant between 1984 and 1999²²⁻²⁸. Therefore, we are not sure if this holds true for other races in a diverse setting in the past decade when the obesity epidemic has worsen²⁹. Furthermore, some only viewed the association between quitters and persistent smokers^{25,26}, smokers

and nonsmokers²⁴, or quitters and nonsmokers²³ while having all three groups can better assess how weight gain is compared to each population. The use of quitters as a reference group (compared to nonsmokers), is also important because quitters come from the smoking population allowing to control for some unmeasured confounders such as diet and exercise. Also, the use of a statistical method to account for gestational age (GA) is absent from previous literature²²⁻²⁸ although it is imperative in weight gain calculations because GA is usually a predictor of GWG; women delivering preterm usually have lower weight gain than those delivering full term.

Study Objectives

While some studies have found an association between smoking and gestational weight gain, others have not. Those conducted in the US have included small sample sizes (<400 participants)^{24-26,28} and no study has examined the association of smoking cessation and gestational weight gain using the 2009 IOM guidelines in a population-based sample to date. Thus, the overall objective of this thesis is to use the South Carolina Pregnancy Risk Assessment Monitoring System (PRAMS) data to determine if there is an association between smoking cessation and excessive GWG during pregnancy. We will accomplish this objective by assessing the relationships of meeting the 2009 IOM

recommendations, rate of weight gain in 2nd and 3rd trimesters, and total GWG among all full term deliveries with prenatal smoking cessation.

By investigating the association between maternal smoking and gestational weight gain, we can gain insight into this relationship during the obesity epidemic. If it holds true that these findings are similar to other studies and suggest that smoking is inversely related to gestational weight gain, smoking cessation programs among pregnant women should include a weight management component to help decrease fetal outcomes and maternal complications during and after pregnancy, which are known to be associated with excessive gestational weight gain¹⁻³.

Study Hypotheses

We hypothesize: Compared to quitters: 1) Nonsmokers and persistent smokers are less likely to exceed IOM guidelines 2) nonsmokers and persistent smokers are less likely to have higher weekly rates of weight gain in 2nd and 3rd trimesters;; and 3) among women who delivered full-term infants, nonsmokers and persistent smokers are more likely to have lower total weight gain.

CHAPTER 4

DATA AND METHODS

We used cross-sectional data from the 2009-2011 South Carolina Pregnancy Risk Assessment Monitoring System (PRAMS), an ongoing population-based survey that collects information from mothers who have recently given birth to a live infant. SC PRAMS was implemented in 1991 through a collaborative agreement with the Centers for Disease Control and Prevention (CDC) and SC Department of Health and Environmental Control (DHEC). Each month, about 200 women are sampled from the live birth registry with women giving birth to low birth weight infants being oversampled. A questionnaire is mailed to selected mothers up to three times within 2-6 months following delivery before a telephone call is placed in order to collect the information. To minimize recall bias, women are not contacted after 9 months post-partum. Overall, the PRAMS survey offers information regarding maternal behaviors, experiences, and attitudes before, during, and shortly after delivery. Some states have state-specific additional questions including pregnancy intendedness (maternal feelings towards getting pregnant), smoking and alcohol

use, family planning, maternal nutrition, infant health care, maternal obstetric history, and barriers to health services.

About 2,300 South Carolina mothers are sampled and surveyed each year. The questionnaire consists of 77 questions and the data are weighted to adjust for the sampling design, non-response, and non-coverage. The weighted data are representative of all women who gave a singleton live birth in South Carolina for the year. Birth certificate data are linked with the PRAMS survey data to provide additional information about maternal and infant outcomes and characteristics. Additional information about PRAMS methodology has been published elsewhere³¹.

Study Sample

From 2009 to 2011, out of 5821 women sampled from birth certificates in SC PRAMS, 3198 women completed the survey. The weighted response rate for 2009 – 2011 was 59%. Since women with plural births usually have higher gestational weight gains, they were excluded from the analysis (n=303). We also excluded mothers with missing information on smoking status (n=15), gestational weight gain (n=105), and other covariates (n=169). An additional 3 participants were excluded because they changed from nonsmokers prior to

pregnancy to smokers during pregnancy. A sample of 2603 women was used in the final analysis.

Gestational Weight Gain Measures

In this study, we used three measures of GWG: 1) adequacy of weight gain in accordance with 2009 IOM guidelines, 2) weekly rate of weight gain during the 2nd and 3rd trimesters, and 3) total weight gain among all full term births.

Maternal weight gain was calculated using self-reported prepregnancy weight and weight at delivery from birth certificates. Prepregnancy body mass index (BMI) was also calculated using the data on height and weight from birth certificates. Using the IOM guidelines, women were classified into the following categories: underweight (BMI <18.5), normal weight (BMI 18.5-24.99), overweight (BMI 25-29.99) and obese (BMI ≥ 30). To determine the adequacy of GWG according to the 2009 IOM guidelines, the approach developed by Bodnar et.al (2004) was selected because of its advantage of considering gestational age at delivery³². The approach first calculated expected GWG by using the following equation: Expected GWG = recommended 1st trimester GWG + [(gestational age – 13 weeks) × (recommended rate of weight gain in the 2nd and 3rd trimesters)]. Next, an adequate ratio of weight gain was calculated as the

expected weight gain divided by actual total weight gain. Since the IOM recommends a weight gain rate of 4.4 lb (2 kg) in the first trimester and 1.0 lb (0.4 kg)/week in the last two trimesters for a normal weight mother, expected gestational weight gain at 40 weeks is $2.0 \text{ kg} + [(40 \text{ weeks} - 13 \text{ weeks}) \times 0.4 \text{ kg week}] = 13 \text{ kg}$ (28 lbs). The expected GWG calculated for all BMI groups would be meeting 100% of the guidelines. To meet the IOM range of 25-35 pound, a normal weight woman would have to gain between 86% - 120% of the weekly rate of 1 pound or between 0.86 and 1.2 pounds per week in the 2nd and 3rd trimesters of the pregnancy. Therefore, any woman gaining less than this range was defined as inadequate, within this range as adequate, and above this range as excessive. A similar method can be used to determine adequacy of weight gain for normal weight women at different gestational ages as well as mothers with other prepregnancy BMI categories.

Weekly rates of weight gain during the 2nd and 3rd trimesters were calculated for each mother according to BMI class using the equation: $[(\text{actual weight gain}) - (\text{expected weight gain in the first trimester}) / (\text{gestational age} - 13)]$. Because weight gain would increase with a longer duration of pregnancy, when we examined the association using total GWG, we restricted the analysis to full term births (N=1138).

Prenatal Smoking Status Measure

Since using combined smoking estimates from both sources rather than each source alone yields the best estimate of smoking status during pregnancy³⁴⁻³⁶, four mutually exclusive categories were created using combined data from both PRAMS and birth certificates: (1) *nonsmokers*, reported no smoking before and during pregnancy on both sources (2) *quitters*, reported smoking before on either source, but quit during any trimester on BC and within 3rd trimester on PRAMS (3) *persistent smokers*, reported smoking throughout pregnancy on either source or both sources (4) *new smokers*, reported not smoking before pregnancy on either source but started to smoke during pregnancy on either source. Smoking assessment questions for PRAMS and birth certificates are located in Appendix B.

We excluded 15 (0.47%) mothers with missing information regarding smoking and 3 participants who were new smokers.

Covariates

After reviewing previous literature on the factors affecting GWG and smoking during pregnancy, we adjusted for the following potential confounders: maternal age (<20, 20-29, and ≥30), race (non-Hispanic White, non-Hispanic Black, or other), education (<12 years or ≥12 years), gestational age (in weeks),

and parity (0, 1, 2+); pregnancy intention (sooner, later, then, or did not want); smoking rules at home (not allowed, allowed, sometimes); WIC participation (yes or no); and prepregnancy BMI (<18.5, 18.5-24.99, 25-29.99, ≥ 30). All information came from birth certificates except pregnancy intention, WIC participation, and smoking rules at homes which came from PRAMS.

Statistical Analyses

While most studies would choose nonsmokers as the reference group, we chose quitters instead. This would allow us to assess the impact of smoking cessation on weight gain. Because quitters and persistent smokers were both smokers before pregnancy, they might share some common risk factors for GWG such as behavioral lifestyles, which are not measured in most studies. Multinomial logistic regression was selected to examine the association between smoking and meeting 2009 IOM guidelines, considering our outcome has 3 categories (adequate, inadequate, or excessive). We ran two models. The first examined the crude association between smoking status and GWG while the second model produced adjusted odds ratio, which contained smoking status and all covariates. Linear regression model was used to examine the association between smoking status and continuous measures of GWG (i.e., weekly rate of weight gain in the 2nd and 3rd trimesters and total weight gain) after adjusting for

confounders. All analyses were conducted using SAS 9.3 statistical software survey procedures (SAS Institute, Cary, NC) to allow for the complex survey design. All percentages reported were weighted. Alpha level was set at 0.05 for statistical significance.

CHAPTER 5

RESULTS

Study Population: Sample Characteristics

A sample of 5,821 women were randomly selected from birth certificates and invited to participate in SC PRAMS from 2009-2011. Among them, 3,198 completed the questionnaire. The final analytical sample included 2603 women after excluding those based on the criteria listed in Chapter 4. Overall, about 69.5% were nonsmokers, 16% quitters, 14.5% persistent smokers. Most of the women were between 20 and 29 years old (54.3%), non-Hispanic White (59%), and reported this being their first pregnancy (43.1%) (see Table 5.1). The majority of the population (80.8%) received more than 12 years' education and was enrolled in the Special Supplemental Nutrition Program for Women, Infant, and Children (WIC) during pregnancy (58.2%). In this population, 42.4% of the women began pregnancy with normal weight, 3.3% were underweight, 25.2% overweight, and 29.1% obese. Persistent smokers were more likely to be non-Hispanic Whites, 20-29 years old, and have less than 12 years' education. Both quitters and persistent smokers intended pregnancy later, participated in the

WIC program, and allowed smoking more often in their homes compared to nonsmokers (Table 5.1). On average, women delivered the baby at 38.5 weeks gestation (SD: 0.04 weeks).

Gestational Weight Gain

On average, women gained about 28.5 pounds (SD: 0.55 pounds) during the pregnancy. Overall, gaining excessive weight (51.2%) was more common than gaining adequately (24.4%) and inadequately (24.4%). Non-Hispanic Blacks, having less than 12 years education, and those participating in the WIC programs were more likely to gain inadequately while nulliparity was associated with gaining excessively (Table 5.2).

**Table 5.1. Sample Characteristics and Correlates of Smoking Status, 2009-2011
SC PRAMS**

	Total (n=2599) %^a(No.)^b	Non-Smokers (n=1828) %^a(No.)^b	Persistent Smokers (n=469) %^a(No.)^b	Quitters (n=302) %^a(No.)^b	P- value^c
Maternal Age, Years					<.0001
<20	12.5 (314)	10.3 (206)	15.7 (56)	19.2 (52)	
20-29	54.3 (1412)	52.0 (931)	62.9 (265)	56.7 (216)	
≥30	33.1 (877)	37.6 (691)	21.4 (93)	24.1 (93)	
Maternal Race/Ethnicity					<.0001
Non-Hispanic White	59.0 (1352)	53.9 (854)	72.4 (278)	69.0 (220)	
Non-Hispanic Black	32.5 (1060)	35.9 (817)	25.2 (123)	24.1 (120)	
Non-Hispanic Other	8.5 (191)	10.2 (157)	2.5 (13)	6.9 (21)	
Maternal education					<.0001
<12 years	19.2 (465)	15.7 (250)	37.0 (152)	18.5 (63)	
≥12 years	80.8 (2138)	84.3 (1578)	63.0 (262)	81.5 (298)	
Pregnancy Intention					.0004
Sooner	15.4 (424)	15.7 (310)	9.5 (48)	19.1 (66)	
Later	33.8 (891)	30.9 (579)	39.3 (174)	41.0 (138)	
Right Then	39.6 (947)	43.5 (722)	33.1 (119)	28.8 (106)	
Did not want	11.3 (341)	9.8 (217)	18.1 (73)	11.2 (51)	
Smoking Rules At Home					<.0001
Not Allowed	92.9 (2418)	96.1 (1748)	83.6 (349)	87.4 (321)	
Allowed Sometimes	5.3 (125)	2.4 (47)	14.3 (51)	9.4 (27)	
Allowed Anytime	1.8 (60)	1.4 (33)	2.1 (14)	3.1 (13)	
Parity					.0125
None	43.1 (1303)	41.7 (929)	36.5 (166)	55.2 (208)	
One	32.2 (717)	32.3 (500)	35.5 (123)	28.4 (94)	
Two or more	24.8 (583)	26.0 (399)	28.0 (125)	16.4 (59)	
Child's Gender					.4145
Male	50.2 (1309)	50.6 (914)	53.2 (212)	45.6 (183)	
Female	49.8 (1294)	49.4 (914)	46.8 (202)	54.4 (178)	
WIC Participation (during pregnancy)					<.0001
Yes	58.2 (1427)	51.7 (924)	84.2 (295)	62.7 (208)	
No	41.8 (1176)	48.3 (904)	75.8 (119)	37.3 (153)	
Meeting 2009 IOM Guidelines					.0212
Adequate	24.4 (539)	26.0 (406)	19.8 (64)	21.4 (69)	
Inadequate	24.4 (818)	26.1 (584)	24.8 (151)	16.7 (83)	
Excessive	51.2 (1246)	47.9 (838)	55.3 (199)	61.9 (209)	
Prepregnancy BMI (kg/m²)					.5032
Underweight (<18.5)	3.3 (127)	2.7 (75)	3.8 (28)	5.4 (24)	
Normal (18.5-24.99)	42.4 (1053)	42.2 (735)	46.8 (185)	38.8 (133)	
Overweight (25-29.99)	25.2 (622)	26.2 (447)	21.8 (92)	24.4 (83)	
Obese (≥30)	29.1 (801)	28.9 (571)	27.6 (109)	31.4 (121)	

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

^a Percentages were weighted to account for survey oversampling, non-response, and non-coverage.

^b Numbers of women from unweighted sample distribution

^c P-values were based on chi-square tests of independence.

Table 5.2. Correlates of Meeting 2009 IOM's Guidelines of Gestational Weight Gain, 2009-2011 SC PRAMS

	Total (n=2599) %^a(No.)^b	Inadequate (n=815) %^a(No.)^b	Excessive (n=1246) %^a(No.)^b	Adequate (n=538) %^a(No.)^b	P- value^c
Maternal Age, Years					0.3193
<20	12.5 (314)	31.1 (118)	48.3 (143)	20.6 (53)	
20-29	54.3 (1412)	22.7 (441)	53.3 (579)	24.0 (292)	
≥30	33.1 (877)	24.6 (259)	49.0 (424)	26.4 (194)	
Maternal Race/Ethnicity					0.0021
Non-Hispanic White	59.0 (1352)	19.8 (350)	54.1 (693)	26.1 (309)	
Non-Hispanic Black	32.5 (1060)	32.3 (396)	47.2 (486)	20.5 (178)	
Non-Hispanic Other	8.5 (191)	26.4 (72)	46.6 (67)	27.0 (52)	
Maternal education					0.0463
<12 years	19.2 (465)	31.5 (189)	43.7 (187)	24.8 (89)	
≥12 years	80.8 (2138)	22.7 (629)	53.0 (1059)	24.3 (450)	
Pregnancy Intention					0.3940
Sooner	15.4 (424)	29.7 (133)	53.2 (212)	17.1 (79)	
Later	33.8 (891)	22.6 (297)	52.3 (409)	25.1 (185)	
Right Then	39.6 (947)	24.1 (287)	49.6 (459)	26.3 (201)	
Did not want	11.3 (341)	23.7 (101)	51.1 (166)	25.2 (74)	
Smoking Rules At Home					0.0665
Not Allowed	92.9 (2418)	23.3 (736)	51.6 (1166)	25.1 (516)	
Allowed Sometimes	5.3 (125)	34.6 (53)	50.5 (54)	14.8 (18)	
Allowed Anytime	1.8 (60)	49.3 (29)	34.8 (26)	15.8 (5)	
Parity					0.0004
None	43.1 (1303)	22.6 (374)	58.1 (682)	19.3 (247)	
One	32.2 (717)	22.3 (233)	46.6 (313)	31.0 (171)	
Two or more	24.8 (583)	30.2 (211)	45.1 (251)	24.7 (121)	
Child Gender					0.4333
Male	50.2 (1309)	22.8 (402)	53.2 (640)	24.0 (267)	
Female	49.8 (1294)	26.0 (416)	49.3 (606)	24.8 (272)	
WIC Participation (during pregnancy)					0.0008
Yes	58.2 (1427)	28.7 (489)	49.2 (673)	22.2 (265)	
No	41.8 (1176)	18.4 (329)	54.1 (573)	27.5 (274)	
Prepregnancy BMI (kg/m²)					<.0001
Underweight (<18.5)	3.3 (127)	21.3 (51)	45.0 (41)	33.6 (35)	
Normal (18.5-24.99)	42.4 (1053)	22.8 (344)	43.4 (405)	33.8 (304)	
Overweight (25-29.99)	25.2 (622)	22.4 (157)	57.6 (354)	20.0 (111)	
Obese (≥30)	29.1 (801)	28.7 (266)	57.9 (446)	13.4 (89)	

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

^a Percentages were weighted to account for survey oversampling, non-response, and non-coverage.

^b Numbers of women from unweighted sample distribution

^c P-values were based on chi-square tests of independence.

Associations between Smoking Cessation and Gestational Weight Gain Measures

Adequacy of Weight Gain. Within this population, half of women (51%) gained excessively during pregnancy. Quitters had a higher percentage of gaining excessive weight during pregnancy than persistent smokers and non-smokers ($p=0.02$) (see Table 5.1). However, compared to quitters, non-smokers and persistent smokers were similar in terms of their odds of meeting IOM guidelines in GWG after adjusting for confounders (Table 5.3).

Table 5.3. Associations between Smoking Cessation and Adequacy of Gestational Weight Gain

	Inadequate GWG		Excessive GWG	
	Crude OR (95% CI)	Adjusted OR* (95% CI)	Crude OR (95% CI)	Adjusted OR* (95% CI)
Non-Smokers	1.28 (0.72-2.28)	1.42 (0.79-2.52)	0.64 (0.41-0.99)	0.68 (0.43-1.07)
Quitters	Reference	Reference	Reference	Reference
Persistent Smokers	1.60 (0.75-3.40)	1.84 (0.83-4.07)	0.96 (0.52-1.80)	1.35 (0.71-2.58)

*Adjusted for maternal age, race, education, pregnant intention, home smoking rules, parity, and WIC participation

Weekly Rates of Weight Gain in the 2nd and 3rd Trimesters. After adjusting for potential confounders, compared to quitters, on average nonsmokers gained about 0.23 pounds/week less ($p=0.0002$) (See Table 5.4). There was no significant

difference in weekly rates of weight gain between persistent smokers and quitters (p=0.31).

Total Gestational Weight Gain. Among women with full-term deliveries, the average total weight gain was 28.1 pounds (SD 15.96). On average, nonsmokers gained about 6.00 pounds less (SD 1.72) than quitters after adjusting for potential confounders (see Table 5.4). There was no significant difference in total GWG among persistent smokers and quitters (p=0.41).

Table 5.4. Associations between Smoking Status and Weekly Rates of Weight Gain in 2nd and 3rd Trimesters and Total Weight Gain

	Weekly Rates of Weight Gain in 2 nd and 3 rd Trimesters		Total Gestational Weight Gain (among full-term births)*	
	Crude (p-value)	Adjusted** (p-value)	Crude (p-value)	Adjusted** (p-value)
Non-smokers				
Quitter	Reference	Reference	Reference	Reference
Persistent Smoker	-0.14 (0.07)	-0.08 (0.31)	-3.27 (0.13)	-1.81 (0.41)

*unweighted sample size (n=1136)

**Adjusted for maternal age, race, education, pregnant intention, home smoking rules, parity, and WIC participation

Bold indicates variables significant at the 0.05 level

Sensitivity Analysis

When we coded smoking status using the birth certificates data source alone, there was no significant difference in smoking status and gestational

weight gain. However, using data from PRAMS only resulted in nonsmokers having a lower total weight gain, lower weekly rate of weight gain in the 2nd and 3rd trimesters, and lower odds of gaining excessively than quitters. After combining the two data sources, we found that nonsmokers had lower weekly rates and total weight gain compared to quitters (see Appendix C).

Furthermore, smoking prevalence differed in each source. Using PRAMS data only results in 15% prevalence while birth certificates data provided a prevalence of 9%. Using the combined sources gives a similar smoking prevalence estimate (16%) among South Carolinian women of childbearing ages in 2010 (17%)³⁸.

CHAPTER 6

DISCUSSION

In this study, we set out to examine the association between smoking cessation and gestational weight gain in a representative sample of pregnant women in South Carolina. Consistent with other studies⁹, women between ages 20-29, non-Hispanic White, being enrolled in WIC program during pregnancy, planning to become pregnant later, and having less than 12 years education were more likely to persistently smoke throughout pregnancy. On the other hand, most quitters were women with low parity and/or more than 12 years education. Within this population, a majority of the women (51.3%) exceeded gestational weight gain guidelines.

While other studies found that persistent smokers²⁶ and nonsmokers^{22,27} were less likely to gain above the IOM recommendations compared to quitters, we did not detect a significant difference. This insignificant association might be due to the large proportion of participants that gained excessively in the entire population. Since all smoking strata have a high proportion of excessive gaining, it is hard to detect a true association in other words. Consistent with

existing studies^{22-23,27}, nonsmokers had lower total weight gain compared to quitters while, unlike others^{22,25,26}, we did not see a difference in total weight gain between quitters and persistent smokers. Future studies are needed to reevaluate the association between persistent smoking and GWG.

Study Strengths

Since we were able to assess smoking status at different time points before and during pregnancy, this allowed us to examine the roles of smoking cessation on gestational weight gain. A major strength of this study is that it is a population-based study with a representative sample of all South Carolina mothers who gave a singleton birth between 2009 and 2011 and includes a high proportion of African American women. Additionally, using combined estimates from both PRAMS and birth certificates increased sensitivity and led to the best ascertainment of smoking status than using each data source alone³⁴⁻³⁶ (see appendix B). Compared to other studies²²⁻²⁸, we improved the adequacy of gestational weight gain measurement by taking into account gestational age at delivery and restricted our analysis to full term deliveries when studying total gestational weight gain. To our knowledge, no other study has examined rate of weight gain and its association with perinatal smoking status.

Study Limitations

As with all self-reported smoking, maternal concern or social desirability of smoking during pregnancy⁴ may impact reporting, so use of a validation technique such as measuring cotinine levels would have been ideal. If women reported quitting but persistently smoked throughout pregnancy, this could overestimate the magnitude of the association between smoking and weight gain. Recall bias could also be a potential concern because the questionnaire was conducted after delivery about smoking behaviors before and during pregnancy.

Furthermore, self-reported weight is also prone to bias because smaller women usually overestimate their weight while heavier women underestimate it on birth certificates. However, the effects may be small and usually do not impact the validity of the study³⁶. However, most cross-sectional studies are based on self-reported data as it is not practicable in large populations to use objective measures. As we mentioned earlier, unmeasured lifestyle and behavioral confounders such as healthy eating and physical activity may have also biased our results especially related to our unexpected finding on adequacy of weight gain.

Conclusions

Weight gain during pregnancy is of great concern because women who gained excessively retain about 40% of their GWG at 6 months postpartum and 2.89 times more likely to become overweight after pregnancy compared to those who gain adequately⁵ making them at an increased risk for future obesity-related complications. Furthermore, excessive GWG may also lead to large for gestational age infants, increased risk for cesarean delivery, preeclampsia, and gestational hypertension¹⁻⁴.

In our study, nonsmokers gained less total gestational weight and had lower weekly rates of weight gain than quitters. However, there was no significant difference in the adequacy of weight gain using the IOM's guidelines. These findings suggest that women who quit smoking during pregnancy should be advised to monitor their weight gain and modify nutrition and physical activity levels. These results do not suggest that women should not quit smoking due to higher weight gain because cessation may reduce the risk of cardiovascular disease, many lung diseases, and other ailments while increasing life expectancy³⁹⁻⁴⁰. Instead, we encourage those who are successful at cessation to monitor and try to prevent excessive weight gain. Providers should counsel pregnant women on healthy eating habits and maintaining an active lifestyle

while public health programs should be developed to assist women during pregnancy to help aid with weight gain. Future studies are also needed to reevaluate the association between persistent smoking and GWG.

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APPENDIX A

COMPARISON OF SAMPLE CHARACTERISTICS OF THOSE INCLUDED AND EXCLUDED PARTICIPANTS

Characteristic	Included No. ^a (%) ^b	Excluded No. ^a (%) ^b	P-value No. ^a (%) ^b
Maternal Age, Years			0.6789
<20	271 (12.1)	102 (14.3)	
20-29	1245 (54.7)	469 (52.2)	
≥30	780 (33.2)	331 (33.5)	
Maternal Race/Ethnicity			0.0065*
Non-Hispanic White	1253 (61.0)	408 (49.2)	
Non-Hispanic Black	875 (30.4)	412 (42.1)	
Non-Hispanic Other	168 (8.5)	77 (8.7)	
Maternal education			0.0131*
<12 years	398 (18.4)	188 (26.8)	
≥12 years	1898 (81.6)	701 (73.2)	
Pregnancy Intention			0.2292
Sooner	370 (14.4)	183 (19.6)	
Later	774 (34.5)	264 (31.8)	
Right Then	851 (40.0)	261 (35.1)	
Did not want	301 (11.1)	106 (13.5)	
Smoking Rules At Home			0.1971
Not Allowed	2143 (93.0)	766 (94.0)	
Allowed Sometimes	109 (5.6)	47 (3.2)	
Allowed Anytime	44 (1.4)	27 (2.8)	
Parity			0.2492
None	1147 (43.2)	372 (38.4)	
One	641 (32.8)	263 (32.1)	
Two or more	508 (24.0)	264 (29.5)	
Child's Gender			0.5245
Male	1168 (50.7)	421 (48.2)	
Female	1128 (49.3)	481 (51.8)	
WIC Participation (during pregnancy)			0.0029*
Yes	1120 (56.2)	471 (68.1)	
No	1076 (43.8)	328 (31.9)	
Meeting 2009 IOM Guidelines			<.0001*
Adequate	538 (26.7)	81 (13.2)	
Inadequate	512 (17.1)	439 (63.1)	
Excessive	1246 (56.2)	270 (23.7)	
Prepregnancy BMI (kg/m²)			<.0001*
Underweight (<18.5)	123 (3.6)	21 (1.6)	
Normal (18.5-24.99)	995 (45.7)	276 (30.3)	
Overweight (25-29.99)	547 (24.8)	187 (23.9)	
Obese (≥30)	631 (25.9)	333 (44.2)	

Note: Some women were not included in the analyses due to non-response to PRAMS questionnaire (n=2673) or missing values in variables used in the analyses (n=373).

*Indicates a significant p-value at 0.05 level

APPENDIX B

FORMAT OF SMOKING QUESTIONS FROM BIRTH CERTIFICATES AND PRAMS

LOCAL FILE NO.		U.S. STANDARD CERTIFICATE OF LIVE BIRTH			
CHILD	1. CHILD'S NAME (First, Middle, Last, Suffix)		2. TIME OF BIRTH (24 hr)	3. SEX	4. DATE OF BIRTH (Mo/Day/Yr)
	5. FACILITY NAME (If not institution, give street and number)		6. CITY, TOWN, OR LOCATION OF BIRTH	7. COUNTY OF BIRTH	
MOTHER	8a. MOTHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)		8b. DATE OF BIRTH (Mo/Day/Yr)		
	8c. MOTHER'S NAME PRIOR TO FIRST MARRIAGE (First, Middle, Last, Suffix)		8d. BIRTHPLACE (State, Territory, or Foreign Country)		
	9a. RESIDENCE OF MOTHER-STATE	9b. COUNTY	9c. CITY, TOWN, OR LOCATION		
	9d. STREET AND NUMBER		9e. APT. NO.	9f. ZIP CODE	9g. INSIDE CITY LIMITS? <input type="checkbox"/> Yes <input type="checkbox"/> No
FATHER	10a. FATHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)		10b. DATE OF BIRTH (Mo/Day/Yr)	10c. BIRTHPLACE (State, Territory, or Foreign Country)	
	11. CERTIFIER'S NAME: TITLE: <input type="checkbox"/> MD <input type="checkbox"/> DO <input type="checkbox"/> HOSPITAL ADMIN. <input type="checkbox"/> CNM/CM <input type="checkbox"/> OTHER MIDWIFE <input type="checkbox"/> OTHER (Specify) _____		12. DATE CERTIFIED MM / DD / YYYY	13. DATE FILED BY REGISTRAR MM / DD / YYYY	
INFORMATION FOR ADMINISTRATIVE USE					
MOTHER	14. MOTHER'S MAILING ADDRESS: <input type="checkbox"/> Same as residence, or: State: _____ City, Town, or Location: _____ Apartment No.: _____ Zip Code: _____		15. MOTHER MARRIED? (At birth, conception, or any time between) IF NO, HAS PATERNITY ACKNOWLEDGEMENT BEEN SIGNED IN THE HOSPITAL? <input type="checkbox"/> Yes <input type="checkbox"/> No		
	16. SOCIAL SECURITY NUMBER REQUESTED FOR CHILD? <input type="checkbox"/> Yes <input type="checkbox"/> No		17. FACILITY ID. (NPI)		
INFORMATION FOR MEDICAL AND HEALTH PURPOSES ONLY					
MOTHER	20. MOTHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery) <input type="checkbox"/> 8th grade or less <input type="checkbox"/> 9th - 12th grade, no diploma <input type="checkbox"/> High school graduate or GED completed <input type="checkbox"/> Some college credit but no degree <input type="checkbox"/> Associate degree (e.g., AA, AS) <input type="checkbox"/> Bachelor's degree (e.g., BA, BS) <input type="checkbox"/> Master's degree (e.g., MA, MS, MEd, MEd, MEd, MEd) <input type="checkbox"/> Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)		21. MOTHER OF HISPANIC ORIGIN? (Check the box that best describes whether the mother is Spanish/Hispanic/Latino. Check the "No" box if mother is not Spanish/Hispanic/Latino) <input type="checkbox"/> No, not Spanish/Hispanic/Latino <input type="checkbox"/> Yes, Mexican, Mexican American, Chicana <input type="checkbox"/> Yes, Puerto Rican <input type="checkbox"/> Yes, Cuban <input type="checkbox"/> Yes, other Spanish/Hispanic/Latino (Specify) _____		22. MOTHER'S RACE (Check one or more races to indicate what the mother considers herself to be) <input type="checkbox"/> White <input type="checkbox"/> Black or African American <input type="checkbox"/> American Indian or Alaska Native (Name of the enrolled or principal tribe) _____ <input type="checkbox"/> Asian Indian <input type="checkbox"/> Chinese <input type="checkbox"/> Filipino <input type="checkbox"/> Japanese <input type="checkbox"/> Korean <input type="checkbox"/> Vietnamese <input type="checkbox"/> Other Asian (Specify) _____ <input type="checkbox"/> Native Hawaiian <input type="checkbox"/> Guamanian or Chamorro <input type="checkbox"/> Samoan <input type="checkbox"/> Other Pacific Islander (Specify) _____ <input type="checkbox"/> Other (Specify) _____
	FATHER	23. FATHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery) <input type="checkbox"/> 8th grade or less <input type="checkbox"/> 9th - 12th grade, no diploma <input type="checkbox"/> High school graduate or GED completed <input type="checkbox"/> Some college credit but no degree <input type="checkbox"/> Associate degree (e.g., AA, AS) <input type="checkbox"/> Bachelor's degree (e.g., BA, BS) <input type="checkbox"/> Master's degree (e.g., MA, MS, MEd, MEd, MEd, MEd) <input type="checkbox"/> Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)		24. FATHER OF HISPANIC ORIGIN? (Check the box that best describes whether the father is Spanish/Hispanic/Latino. Check the "No" box if father is not Spanish/Hispanic/Latino) <input type="checkbox"/> No, not Spanish/Hispanic/Latino <input type="checkbox"/> Yes, Mexican, Mexican American, Chicano <input type="checkbox"/> Yes, Puerto Rican <input type="checkbox"/> Yes, Cuban <input type="checkbox"/> Yes, other Spanish/Hispanic/Latino (Specify) _____	
26. PLACE WHERE BIRTH OCCURRED (Check one) <input type="checkbox"/> Hospital <input type="checkbox"/> Freestanding birthing center <input type="checkbox"/> Home Birth: Planned to deliver at home? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Clinic/Doctor's office <input type="checkbox"/> Other (Specify) _____		27. ATTENDANT'S NAME, TITLE, AND NPI NAME: _____ NPI: _____ TITLE: <input type="checkbox"/> MD <input type="checkbox"/> DO <input type="checkbox"/> CNM/CM <input type="checkbox"/> OTHER MIDWIFE <input type="checkbox"/> OTHER (Specify) _____		28. MOTHER TRANSFERRED FOR MATERNAL MEDICAL OR FETAL INDICATIONS FOR DELIVERY? <input type="checkbox"/> Yes <input type="checkbox"/> No IF YES, ENTER NAME OF FACILITY MOTHER TRANSFERRED FROM: _____	

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The next questions are about smoking cigarettes around the time of pregnancy (before, during, and after).

25. Have you smoked any cigarettes in the *past 2 years*?

No = Go to Question 29

Yes

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26. In the *3 months before* you got pregnant, how many cigarettes did you smoke on an average day? (A pack has 20 cigarettes.)

- 41 cigarettes or more
- 21 to 40 cigarettes
- 11 to 20 cigarettes
- 6 to 10 cigarettes
- 1 to 5 cigarettes
- Less than 1 cigarette
- I didn't smoke then

27. In the *last 3 months* of your pregnancy, how many cigarettes did you smoke on an average day? (A pack has 20 cigarettes.)

- 41 cigarettes or more
- 21 to 40 cigarettes
- 11 to 20 cigarettes
- 6 to 10 cigarettes
- 1 to 5 cigarettes
- Less than 1 cigarette
- I didn't smoke then

APPENDIX C

SENSITIVITY ANALYSIS

Associations Between Smoking Status and Adequacy of GWG (Bodnar)						
	PRAMS ONLY		Birth Certificates Only		Combined Sources	
	Inadequate GWG	Excessive GWG	Inadequate GWG	Excessive GWG	Inadequate GWG	Excessive GWG
	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)
Nonsmoker	1.36 (0.76-2.44)	0.59 (0.37-0.94)	1.32 (0.59-2.98)	0.75 (0.40-1.42)	1.42 (0.79-2.52)	0.68 (0.43-1.07)
Quitter	Reference	Reference	Reference	Reference	Reference	Reference
Persistent	1.54 (0.68-3.48)	1.06 (0.55-2.03)	1.13 (0.39-3.27)	0.98 (0.41-2.32)	1.84 (0.83-4.07)	1.35 (0.71-2.58)

*Adjusted for maternal age, race, education, , pregnancy intention, smoking rules, parity,, and WIC participation

Bold indicates that the variable is a significant predictor of GWG

Weekly Rates of Weight Gain in 2nd and 3rd Trimesters				Total Gestations Weight Gain (Among All Full Term Deliveries)			
	PRAMS Adjusted (P-Value)	BC Adjusted (P-Value)	Combined Adjusted (P-Value)		PRAMS Adjusted (P-Value)	BC Adjusted (P-Value)	Combined Adjusted (P-Value)
Nonsmoker	-0.23 (.0001)	-0.50 (0.1439)	-0.22 (0.0004)	Nonsmoker	-6.30 (0.0002)	-11.47 (0.2208)	-6.00 (0.0005)
	-0.07 (0.3887)	-0.13 (0.0927)	-0.06 (0.4444)		-1.98 (0.3771)	-2.29 (0.2726)	-1.81 (0.4075)
Persistent				Persistent			

*Adjusted for maternal age, race, education, , pregnancy intention, smoking rules, parity, and WIC participation

Bold indicates that the variable is a significant predictor of GWG

*Adjusted for maternal age, race, education, , pregnancy intention, smoking rules, parity, and WIC participation

Bold indicates that the variable is a significant predictor of GWG