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The Association of Maternal Smoking with Infant Mortality and Low Birth Weight in North Carolina, 1999

by

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ABSTRACT

Objectives: This study uses data from live birth and infant death certificates to measure the association of maternal smoking during pregnancy with infant mortality and low birth weight.

Methods: The 1999 composite linked birth file for North Carolina was used for the analyses. This file is created annually by the State Center for Health Statistics and includes live births for a calendar year linked individually to infant death and Medicaid records. Infant death rates and low-birth-weight percentages were computed for mothers who reported they had or had not smoked during pregnancy. Multiple logistic regression analysis was used to estimate the odds of an infant death or a low-weight birth for mothers who smoked, controlling for other risk factors for infant death and low birth weight.

Results: Mothers who smoked during pregnancy had nearly twice the risk of an infant death or low-weight birth as mothers who did not smoke. For SIDS, the risk associated with maternal smoking was more than five times as high. After controlling for a number of demographic and medical risk factors, the odds of an infant death or low-weight birth was still much higher for mothers who smoked, and these differences were statistically significant.

Conclusions: Smoking during pregnancy is likely to be somewhat underreported on birth certificates, but the main results of this study would not be affected unless the degree of underreporting differs markedly between women who did and those who did not have an adverse birth outcome. Not smoking during pregnancy and after birth would improve the health of both infants and their mothers.



INTRODUCTION

The association between maternal smoking during pregnancy and infant mortality is of great concern and the topic of numerous studies.¹⁻⁴ If women were to quit smoking while pregnant, the overall infant mortality rate would drop an estimated 10 to 20 percent.^{1,5} However, there is still the question of which particular causes of infant death are most affected by maternal smoking. The majority of the literature concentrates on either smoking's effect on overall infant mortality or on sudden infant death syndrome (SIDS). This study analyzes the relationship between maternal smoking and eight major cause-of-death categories for infants born in North Carolina during 1999.

Maternal smoking during pregnancy is also known to have a negative association with birth weight.^{3,6} Because low birth weight (LBW) is known to be a contributing factor to a number of causes of infant death, and because LBW babies who survive are more prone to various health problems,⁷ birth weight was also analyzed for the 1999 live births.

Live birth and infant death records for North Carolina were used for the analyses. The measures of cigarette smoking included in the birth records rely on self-reported data by the mother.

METHODS

This study was based on data from the 1999 North Carolina composite matched birth file. All live birth records were matched to infant death, Medicaid, and other health service records. Because multiple births (e.g., twins) are associated with a much higher risk for low birth weight and infant death, all of the analyses were limited to singleton births for purposes of estimating the effects of maternal smoking. Eight infant cause-of-death categories were analyzed to determine their relationship to maternal smoking during pregnancy: congenital anomalies, prematurity and LBW, respiratory conditions, SIDS, injuries (intentional and unintentional), infections, other perinatal conditions, and all other causes of infant death. Furthermore, we examined the association of maternal smoking with low birth weight (LBW, less than 2,500 grams), very low birth weight (VLBW, less than 1,500 grams), and infants who were small for their gestational age (SGA). SGA was

defined as babies who had a birth weight in approximately the lowest tenth percentile for their gestational age. SGA might measure fetal growth retardation associated with smoking.

Smoking was defined as either "yes" or "no," depending on the mother's response on the birth certificate whether she smoked at any time during pregnancy. Infants born to mothers whose smoking status was unknown were not included in these analyses.

The infant death causes and the three categories of birth weight were then analyzed using logistic regression. The association of maternal smoking with these dichotomous (1 or 0) outcomes was examined, while controlling for sex of the infant, parity, marital status, maternal education, maternal age, maternal race, presence of a medical risk factor*, and Medicaid enrollment (of the mother and/or the baby). These characteristics were selected based on an association with adverse birth outcomes found in previous studies.

RESULTS

Table 1 shows the infant mortality rates (IMRs) for each cause of infant death, for mothers who did and did not smoke during pregnancy. Also shown is the ratio (relative risk) of the IMRs for mothers who smoked and those who did not. For example, the smoking relative risk for SIDS is 5.6. For mothers who smoked, the IMR was higher for all categories except infections.

Table 2 shows the percentage of mothers who smoked during pregnancy for each cause of infant death. Consistent with the well-established link between SIDS and maternal smoking, Table 2 shows that 50 percent of infants who died of SIDS had mothers who smoked during pregnancy. The category with the second highest percentage of maternal smoking is all other causes of death, followed by injuries (intentional and unintentional), respiratory conditions, and other perinatal conditions.

* Includes one or more of the following (from the birth certificate): eclampsia, anemia (Hct < 30/Hgb < 10), incompetent cervix, cardiac disease, previous infant 4000+ grams, acute or chronic lung disease, previous preterm or small-for-gestational age infant, diabetes, renal disease, genital herpes, rh sensitization, hydramnios/oligohydramnios, uterine bleeding, hemoglobinopathy, chronic hypertension, pregnancy-related hypertension, or other non-specified medical conditions.

Table 1. Infant mortality rates for mothers who did and did not smoke during pregnancy, by cause of infant death: 1999 North Carolina singleton live births

	# Infant Deaths	Infant Mortality Rate*		Relative Risk
		Smoked	Did Not Smoke	
Total Infant Deaths	839	13.0	6.7	1.9
Congenital Anomalies	195	2.2	1.7	1.3
Prematurity/LBW	140	1.8	1.2	1.5
Respiratory Conditions	76	1.2	0.6	2.0
Other Perinatal Conditions	187	2.5	1.5	1.7
SIDS	86	2.8	0.5	5.6
Injuries	42	0.8	0.3	2.7
Infections	40	0.1	0.4	0.3
All other causes of death	73	1.6	0.5	3.2

*Infant Deaths per 1,000 live births.

The percentages for the three low-birth-weight categories for mothers who did and did not smoke during pregnancy are shown in Table 3. The percentage LBW is double for mothers who smoked during pregnancy compared to mothers who did not. The relative risk is even higher for infants who were SGA.

Table 4 lists the adjusted odds ratios and 95 percent confidence intervals for maternal smoking and other predictors of infant death. Confidence intervals that include 1.0 indicate that the adjusted odds ratio is not significantly different from 1.0. The odds of infant death for mothers who smoked was 1.77 times that for mothers who did not smoke, controlling for age, race, and the other factors shown in Table 4.

Table 2. Percentage of mothers who smoked during pregnancy, by cause of infant death: 1999 North Carolina singleton live births

	% Who Smoked
Total Infant Deaths	24.2
Congenital Anomalies	17.9
Prematurity/LBW	20.0
Respiratory Conditions	23.7
Other Perinatal Conditions	20.9
SIDS	50.0
Injuries	31.0
Infections	5.0
All other causes of death	34.2
No Infant Death	14.2
Total Live Births	14.3

Table 3. Low birth weight percentages for mothers who did and did not smoke during pregnancy: 1999 North Carolina singleton live births

	# Low-weight Births	Low Birth Weight (%)		Relative Risk
		Smoked	Did Not Smoke	
Low Birth Weight (LBW)	7,945	12.6	6.4	2.0
Very Low Birth Weight (VLBW)	1,639	2.2	1.4	1.6
Small for Gestational Age (SGA)	5,422	10.0	4.1	2.4

After controlling for the other risk factors shown in Table 4, the adjusted odds of a SIDS death for mothers who smoked was 5.11 times that for mothers who did not smoke (Table 5). Besides low maternal education (adjusted odds ratio = 1.69, not shown in tables), smoking was the only significant factor for SIDS deaths in this study. Based on the odds ratio of 5.11 and the prevalence of smoking among all live births, the estimated percentage of SIDS deaths attributable to smoking is 37 percent.

Other statistically significant odds ratios for maternal smoking (Table 5) were 2.65 for all other causes of infant death, 1.99 for prematurity/LBW, 1.88 for respiratory conditions, and 1.70 for other perinatal conditions. Though the smoking odds ratio for infections was substantially less than zero, it was not statistically significant, in part due to the relatively small number of infant deaths from infections. The relatively high adjusted odds ratio for injuries was also not statistically significant.

Smoking was significantly associated with all of the low-birth-weight measures (Tables 6 and 7). When controlling for the other characteristics in the regression models, the adjusted odds ratios for maternal smoking were 1.99 for LBW, 1.61 for VLBW, and 2.39 for SGA. Minority mothers and mothers with a medical risk factor also had greatly increased odds of having a low-birth-weight infant.

DISCUSSION

Not only is there an increased risk for SIDS associated with maternal smoking, but other leading causes of infant death are affected as well. Maternal smoking during pregnancy is also associated with a significantly increased odds of low birth weight, very low birth weight, and small for gestational age. The strong association of smoking with SGA suggests that smoking results in fetal growth retardation.

As noted before, if women were to quit smoking while pregnant, the overall infant mortality rate would drop an estimated 10 to 20 percent. It would be beneficial to develop a program that targets populations with a high smoking prevalence. For example, 22.3 percent of Medicaid mothers smoked during pregnancy, compared to 7.6 percent for non-Medicaid births. While representing 45.6 percent of all live births, Medicaid mothers

Table 4. Adjusted odds ratios and 95 percent confidence intervals for risk factors associated with infant mortality: 1999 North Carolina singleton live births

	Adjusted Odds Ratio	95% Confidence Interval
Mother Smoked	1.77	1.50 - 2.10
Unmarried	1.35	1.13 - 1.61
Education <12 years	1.27	1.06 - 1.51
Under 18 years old	1.16	0.87 - 1.53
Minority race	2.02	1.73 - 2.35
Medical risk factor	1.96	1.70 - 2.25
Medicaid	0.97	0.82 - 1.15
High parity (4 or more)	1.24	1.04 - 1.47
Female Infant	0.81	0.71 - 0.93

Table 5. Adjusted odds ratios and 95 percent confidence intervals for maternal smoking in relation to major causes of infant death: 1999 North Carolina singleton live births

	Adjusted Odds Ratio	95% Confidence Interval
Congenital Anomalies	1.09	0.75 - 1.60
Prematurity/LBW	1.99	1.88 - 2.11
Respiratory Conditions	1.88	1.06 - 3.35
Other Perinatal Conditions	1.70	1.17 - 2.47
SIDS	5.11	3.24 - 8.07
Injuries	1.95	0.98 - 3.92
Infections	0.30	0.07 - 1.27
All other causes of death	2.65	1.58 - 4.43

Table 6. Adjusted odds ratios and 95 percent confidence intervals for risk factors associated with low birth weight: 1999 North Carolina singleton live births

	Adjusted Odds Ratio	95% Confidence Interval
Mother smoked	1.99	1.88 - 2.11
Unmarried	1.25	1.18 - 1.32
Education <12 years	1.10	1.04 - 1.17
Under 18 years old	1.30	1.18 - 1.44
Minority race	1.87	1.77 - 1.97
Medical risk factor	2.65	2.52 - 2.77
Medicaid	1.12	1.05 - 1.18
High parity (4 or more)	1.09	1.02 - 1.16
Female Infant	1.14	1.09 - 1.19

Table 7. Adjusted odds ratios and 95 percent confidence intervals for maternal smoking in relation to sub-categories of low birth weight: 1999 North Carolina singleton live births

	Adjusted Odds Ratio	95% Confidence Interval
Very Low Birth Weight (VLBW)	1.61	1.42 - 1.83
Small for Gestational Age (SGA)	2.39	2.24 - 2.55

represented 69.2 percent of mothers who smoked during pregnancy. A successful smoking reduction program with this population might also reduce Medicaid expenditures for infants. Among 1999 North Carolina singleton Medicaid live births, the average cost per infant during the first year of life was \$4,353 for mothers who smoked, 15 percent greater than the \$3,769 for mothers who did not smoke. This calculates to nearly \$6.5 million in excess Medicaid costs during one year for the infants of mothers who smoked. National data also show much higher birth-related costs for smokers compared to non-smokers.⁸

Some caveats must be considered along with the data presented here.

- Smoking is self-reported on the birth certificate by the mother and is likely to be somewhat underreported.^{9,10} However, this would not affect the main results of the study unless the degree of underreporting differs markedly between women who did and did not have an adverse birth outcome. If women who delivered a small or sick baby were more likely to deny smoking during pregnancy (perhaps feeling responsible for the infant’s condition), then the results of this study will understate the impact of smoking on infant mortality and low birth weight.
- Besides Medicaid status and mother’s education, no other measures of socioeconomic status were available to assess potential confounding. It is likely that a number of conditions associated with low socioeconomic status play a significant role in determining birth outcomes (e.g., family income or housing conditions).

- Exposure to secondhand smoke/environmental tobacco smoke (ETS) was not measured. Several studies have linked maternal ETS exposure to LBW, and other studies have suggested a link to other growth-related problems.^{11,12} Postnatal infant exposure to ETS has also been linked to SIDS.^{11,12} The strong association found here between maternal smoking during pregnancy and SIDS is likely related to the fact that women who smoke during pregnancy are also likely to smoke after delivery.
- Although the amount of alcohol consumed during pregnancy is requested from the mother on the North Carolina birth certificate, this information is considered highly underreported and unreliable. Alcohol and tobacco are often used together, and it would be useful to analyze their separate effects on infant mortality.⁶ However, such analyses will depend on a more reliable method of gathering data on alcohol use during pregnancy.
- Using broad categories of infant death such as “congenital anomalies” will tend to dilute associations between smoking and specific outcomes within these heterogeneous groups. For example, we cannot infer from our results that smoking is not associated with some specific birth defects.

In conclusion, this study suggests that maternal smoking during pregnancy is significantly associated with higher rates of a variety of adverse birth outcomes. Not smoking during pregnancy and after birth would improve the health of both infants and their mothers. Effective interventions for pregnant smokers have been identified;^{13,14} for more information go to www.smokefreefamilies.org.

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