

Association of Maternal Chronic Disease and Negative Birth Outcomes in a Non-Hispanic Black-White Mississippi Birth Cohort

Juanita Graham, Lei Zhang, and Renee Schwalberg

ABSTRACT Objective: To investigate the impact of selected maternal chronic medical conditions, race, and age on preterm birth (PTB), low birth weight (LBW), and infant mortality among Mississippi mothers from 1999 to 2003. **Design:** A retrospective cohort analysis of linked birth and death certificates. **Sample:** The 1999–2003 Mississippi birth cohort comprising 202,931 singleton infants born to African American and White women. **Measurements:** The relationship between maternal chronic conditions and the dependent variables of PTB, LBW, and infant mortality were investigated using logistic regression analysis. **Results:** PTB, LBW, and infant mortality were more prevalent among African American women, very young women (15 years), and women with certain chronic medical conditions. Among White mothers, maternal chronic hypertension was significantly associated with PTB and LBW, and maternal diabetes with PTB and infant mortality. Among African American mothers, maternal cardiac disease was significantly associated with PTB and LBW; maternal chronic hypertension was significantly associated with LBW and infant mortality; and maternal diabetes with PTB. **Conclusions:** Maternal chronic hypertension and diabetes were significantly associated with negative birth outcomes regardless of maternal race. Maternal cardiac disease was only significantly associated with PTB and LBW among African Americans. **Key words:** chronic disease, infant mortality, low birth weight, prematurity.

Background and Significance

Mississippi has a long history of high morbidity and negative birth outcomes, traditionally ranking among the states with the highest prevalence of obesity, diabetes, and hypertension. Mississippi is also burdened with some of the highest rates of low birth weight (LBW) (< 2,500 g), preterm birth (PTB) (< 37 weeks gestation), and infant mortality (infant

death during the first year of life) in the United States. In 2004, the rate of PTB in Mississippi was 17.9% and the rate of low birth weight was 11.6%; both rates were the highest in the nation (Martin et al., 2006). Mississippi's infant mortality rate in 2001–2003, the latest period for which state-level data are available, was 10.3 per 1,000 live births, also among the nation's highest (National Center for Health Statistics, 2006). LBW and PTB are associated with both immediate and long-term effects on both the individual and the societal levels. LBW infants generally have higher rates of subnormal growth, illness, and neurodevelopmental problems (Hack, Klein, & Taylor, 1995; van Wassenaer, 2005), late-onset sepsis (Stoll et al., 1996), and an increased risk of infant mortality (McCormick, 1985). LBW is also associated with adult hypertension and diabetes (Curhan et al., 1996), high systolic blood pressure in adulthood (Ramadhani et al., 2006), adult psychological distress (Wiles, Peters, Leon, & Lewis, 2005), and increased risk of adult mortality (Kajantie et al., 2005). Because of the public health implications of these negative birth outcomes, reducing PTBs, LBW and very low birth weight, and fetal and infant deaths are

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a priority among public health departments at the local, state, and federal levels.

Numerous risk factors have been linked to negative birth outcomes. Determinants of LBW and PTB include maternal smoking (Kleinman, Pierre, Madans, Land, & Schramm, 1988; Kramer, 1987), multiple gestations (Luke & Keith, 1992), preeclampsia, and hypertension (Lau, Pang, Sahota, & Leung, 2005; Ray, Burrows, Burrows, & Vermeulen, 2001). In addition, maternal chronic diseases, such as diabetes (Rosenberg, Garbers, Lipkind, & Chiasson, 2005), asthma (Dewyea, Nelson, & Martin, 2005; Hanania & Belfort, 2005), hypertension (Ray et al., 2001), and cardiac disease (Sibai et al., 2000), can contribute to the risk of poor birth outcomes. Because progesterone is a respiratory stimulant, maternal asthma and other pulmonary complications can endanger the fetus by causing carbon dioxide retention, leading to perinatal hypoxemia (Curran, 2006). Severe or uncontrolled maternal asthma is associated with preterm delivery, preeclampsia, and intrauterine growth restriction (Dombrowski, 2006). Maternal chronic diabetes is associated with preeclampsia, an association that increases with the severity of diabetes (Sibai et al., 2000); similarly, maternal chronic hypertension, which may or may not be accompanied by preeclampsia, often results in poor perinatal outcomes (Ray et al., 2001). Various other forms of maternal heart disease, including valvular heart disease and congenital heart disease, are also associated with PTB and intrauterine growth retardation (Hameed et al., 2001; Khairy et al., 2006; Siu et al., 1997), risks that appear to increase with the severity of the mother's condition.

These risks may be magnified if maternal chronic conditions are not well controlled (Cundy, Slee, Gamble, & Neale, 2002; MacMullen, Tymkow, & Shen, 2006; Sibai et al., 2000). Women of low socioeconomic status may therefore be at particular risk if they experience barriers to care, such as lack of health care coverage, inability to purchase maintenance medications, access to transportation, and related issues.

Given the historical and rising prevalence of chronic disease among low-income and minority women in Mississippi, clarifying the relationship between maternal chronic disease and pregnancy outcomes for both White and African American women

could prove highly valuable for health program planning and policy development. We hypothesize that maternal chronic cardiac and lung disease and diabetes contribute to poor birth outcomes, including PTB and LBW, and ultimately to infant mortality, and that these effects are more pronounced among minority populations. This hypothesis is tested through multivariate analysis of Mississippi birth linked with infant death data.

Methods

Data were obtained from the linked birth and death certificate files for all Mississippi infants delivered between 1999 and 2003. Analysis was limited to all live-born singleton infants. Infants with missing data for birth weight, gestational age, or any selected maternal factor (age, education, marital status, or tobacco use) were excluded from all analyses. The final analysis consisted of 202,931 non-Hispanic White (53.9%) and non-Hispanic Black (44.5%) singleton infants. The number of infants of other races (1.6%) was too small to include in the analysis.

For this study, maternal cardiac disease diagnosed before pregnancy was considered to be chronic. Likewise, maternal hypertension was defined as chronic hypertension if diagnosed before pregnancy. Women with self-reported gestational hypertension (pregnancy induced, preeclampsia, or eclampsia) were not considered to have chronic hypertension. Maternal diabetes was considered to be present for women with overt (or chronic) diabetes and not present for women who either did not have diabetes before pregnancy or were diagnosed with diabetes during pregnancy (gestational diabetes). Maternal lung disease included a variety of upper and lower respiratory diseases such as emphysema and asthma. Examples of maternal coronary heart disease include congenital heart disease, mitral valve complications, and cardiac dysrhythmias.

Maternal history of giving birth to a preterm or small-for-gestational-age infant was considered as a covariate for the study. The study variables were extracted from self-reported maternal medical risk factors in the infant birth file. The dichotomous response (yes or no) from the birth file was used directly. The three outcome variables for analysis were PTB, LBW, and infant death. PTB was defined as an infant born at <37 completed weeks of gestation. Gesta-

tional age was calculated based upon the date of infant birth and the date of the last menstrual period. In order to minimize missing data for gestational age, if the date of the last menstrual period was unavailable, a clinical estimation of gestational age was used for PTB classification. LBW was defined as an infant weighing < 2,500 g at birth. Infant death was defined as a death during the first 364 days of life; data on the timing of infant death (neonatal or post-neonatal) were unavailable for this analysis.

Maternal age was included in the analyses as a potential confounder. Maternal age categories (11–15, 16–19, 20–34, and 35+ years) were used to describe birth patterns and infant mortality. However, age was considered as a continuous variable in all regression models. Maternal race was classified as non-Hispanic White or non-Hispanic Black.

SAS 9.1 (SAS Institute Inc., Cary, NC, U.S.A, 2005) was used for all statistical analyses. Multiple logistic regression models were used to identify factors associated with PTB, LBW, and infant death among Mississippi infants. The analyses were stratified by maternal race. The adjusted odds ratios (ORs) for negative birth outcomes were obtained in each subgroup (e.g., African American) relative to a base group (e.g., White) while controlling for mothers' other characteristics: cardiac disease, chronic hypertension, diabetes, and lung disease. Adjusted ORs were considered to be statistically significant if their 95% CIs did not include 1.0.

Results

Summary statistics

The percentage of mothers in each racial group with selected chronic medical conditions is presented in Table 1. Diabetes was the most prevalent chronic disease, indicated by 2.6% of mothers, followed by chronic hypertension at 1.6%. The least frequently reported maternal condition was cardiac disease, reported by only 0.5% of mothers. African American mothers reported higher rates of chronic hypertension and lung disease than their White counterparts, while White mothers reported higher rates of cardiac disease and diabetes.

Table 2 presents the rates of PTB, LBW, and infant death by selected maternal characteristics.

TABLE 1. *Percentage of Selected Chronic Medical Conditions Among Mississippi Mothers by Maternal Race: 1999–2003 Birth Cohort^a*

	Frequency (%)		
	Total	African American	White
Total	202,931	91,718	111,213
Cardiac disease			
Yes	965(0.5)	217(0.2)	748(0.7)
No	201,966(99.5)	91,501(99.8)	110,465(99.3)
Chronic hypertension			
Yes	3,200(1.6)	2,042(2.2)	1,158(1.0)
No	199,731(98.4)	89,676(97.8)	110,055(99.0)
Diabetes			
Yes	5,194(2.6)	2,244(2.5)	2,950(2.7)
No	197,737(97.4)	89,474(97.6)	108,263(97.4)
Lung disease			
Yes	1,768(0.9)	836(0.9)	932(0.8)
No	201,163(99.1)	90,882(99.1)	110,281(99.2)

Note. ^aLimited to African American and White singleton live births (all other races: 1.6%).

Overall, PTB occurred among 16.2% of births, while LBW occurred among 9.1% of births, and infant death occurred among 9.4 per 1,000 live births. The rate of PTB for African American mothers was 59.8% higher than that of White mothers. The LBW and infant mortality rates for infants of African American mothers were more than twice the rates of White mothers. Overall, the rates of negative birth outcomes decreased with maternal age. Negative birth outcomes were more common among mothers with the chronic medical conditions compared with their counterparts.

Maternal chronic conditions

The results of the logistic regression analysis stratified by maternal race are presented in Table 3. As the table shows, infants of African American mothers with cardiac disease had a higher risk of PTB, LBW, and infant death than White mothers with the same condition. The effect of cardiac disease

was statistically significant for PTB ($p = .018$) and LBW ($p = .0251$) among African American mothers.

White mothers with chronic hypertension had a higher risk of having PTB, LBW, and infant death than African American mothers. The effect of cardiac

TABLE 2. Frequency of Preterm Birth (PTB), Low Birth Weight (LBW), and Infant Mortality Within Subgroups: Mississippi, 1999–2003 Birth Cohort^a

	PTB ^b	LBW ^b	Infant Mortality
	n(%)	n(%)	n (rate per 1,000 live births)
Total	30,469(16.2)	18,526(9.1)	1,912(9.4)
Race			
African American	17,203(20.5)	11,593(12.6)	1,223(13.3)
White	13,266(12.8)	6,933(6.2)	689(6.2)
Age (years)			
≤15	671(26.4)	437(15.0)	45(15.4)
16–19	5,812(18.7)	3,961(11.6)	404(11.8)
20–34	21,531(15.4)	12,653(8.37)	1,327(8.8)
≥ 35	2,450(17.9)	1,472(10.0)	134(9.1)
Cardiac disease			
Yes	142(16.8)	97(10.1)	13(13.5)
No	30,327 (16.2)	18,429(9.1)	1,899(9.4)
Chronic hypertension			
Yes	835(28.7)	685(21.4)	49(15.3)
No	29,634(16.1)	17,841(8.9)	1,863(9.3)
Diabetes			
Yes	993(20.7)	490(9.4)	69(13.3)
No	29,476(16.1)	18,036(9.1)	1,843(9.3)
Lung disease			
Yes	285(18.1)	188(10.6)	22(12.4)
No	30,184(16.2)	18,338(9.1)	1,890(9.4)

Note. ^aLimited to African American and White singleton live births (all other races: 1.6%).

^bAnalysis excluded missing birth weight or gestational age data: LBW: 0.02% ($n=50$) and PTB: 7.6% ($n= 15,333$).

disease was statistically significant for PTB ($p < .000$) and LBW ($p < .000$) among White mothers. It was statistically significant for PTB ($p < .000$), LBW ($p < .000$), and infant death ($p = .0427$) among African American mothers.

White mothers with diabetes had a higher risk of having PTB, LBW, and infant death than African American mothers with the same condition. Infants of African American mothers with diabetes were actually less likely to be born at LBW than those without diabetes. The effect of diabetes was statistically significant for PTB ($p < .000$) and infant death ($p < .000$) among White mothers. It was only statistically significant for PTB ($p = .0004$) among African American mothers.

White mothers with lung disease had higher risk of having LBW than African American mothers with the same condition. However, White mothers with lung disease had a lower risk of having PTB and infant death than African American mothers with the same condition. The effect of maternal lung disease was not statistically significant for PTB, LBW, and infant death regardless of the mother's race.

Discussion

The findings of this study support the hypothesis that cardiac disease, chronic hypertension, and diabetes are significant maternal chronic medical risk factors associated with PTB, LBW, and infant mortality in Mississippi, and these risks vary by the mother's race and ethnicity. This supports the findings of previous research, with the addition of new findings on the independent effects of race/ethnicity and maternal chronic conditions on birth outcomes. The finding that infants of White and African American mothers experience different levels of risk associated with maternal chronic disease has important implications for prenatal and preconception interventions.

While significant for both racial groups, the finding that risks associated with chronic hypertension and diabetes are higher among White infants challenges our assumptions about risk and vulnerability. Of particular interest is that diabetes actually doubles the risk of infant mortality in Whites. These findings contribute to our understanding of the multifactorial causes of poor birth outcomes. Further research is clearly needed on the relative contributions of biological and socioeconomic risk factors among different racial groups.

While early prenatal care offers an opportunity to identify maternal risk factors for poor birth outcomes,

15.6% of women (and 22.4% of non-Hispanic Black women) in Mississippi did not enter care in the first trimester in 2004 (Martin et al., 2006). Although first-trimester entry into prenatal care is associated with

more positive outcomes, the gestational age at the time of pregnancy diagnosis is often too late to prevent some complications. The mean time of entry

TABLE 3. *Adjusted Odds Ratios (ORs) Stratified by Maternal Race for Preterm Birth (PTB), Low Birth Weight (LBW), and Infant Death by Selected Factors: Mississippi, 1999–2003 Birth Cohort^a*

	PTB OR (95% CI)	LBW OR (95% CI)	Infant death OR (95% CI)
White			
Age of mother (years)	1.00 (1.00–1.00)	0.98 (0.98–0.98)	0.97(0.96–0.98)
Cardiac disease	1.03 (0.82–1.28)	1.21 (0.92–1.59)	1.55 (0.73–3.27)
Chronic hypertension	1.95 (1.69–2.25)	3.12 (2.66–3.65)	1.52 (0.83–2.77)
Diabetes	1.44 (1.30–1.58)	1.13 (0.98–1.30)	2.11 (1.50–2.98)
Lung disease	1.07(0.88–1.30)	1.17 (0.91–1.48)	1.12 (0.53–2.36)
African American			
Age of mother (years)	0.99 (0.99–0.99)	0.99 (0.99–0.99)	1.00 (0.99–1.00)
Cardiac disease	1.47(1.07–2.01)	1.48 (1.05–2.08)	2.01 (0.89–4.54)
Chronic hypertension	1.85 (1.67–2.04)	2.35 (2.11–2.61)	1.41 (1.01–1.96)
Diabetes	1.21 (1.09–1.33)	0.90 (0.79–1.02)	1.11 (0.78–1.57)
Lung disease	1.11 (0.93–1.31)	1.08 (0.89–1.32)	1.32 (0.79–2.20)

Note. CI = confidence interval.

^aLimited to African American and White singleton live births (all other races: 1.6%).

into prenatal care is around the 10th or 11th week of gestation. By that time, nearly all critical periods of development have already occurred. Thus, even standard clinical practices in prenatal care become too late to prevent some negative outcomes.

Therefore, these findings have useful implications for program planning in public health nursing. Pre-conception or prepregnancy care can play an important role in diagnosing and managing maternal chronic diseases, as well as other physical and mental risk factors that can affect pregnancy outcomes. Public health nurses are closely involved in providing health care to women throughout the lifespan and these findings can inform their practice. In Mississippi, public health nurses currently participate in a number of programs focusing on women’s and infants’ health, such as the Family Planning Program, Maternity Services, and Prenatal High Risk Management/Infant Services System. Programs such as these are an opportunity for public health nurses to promote healthy choices and behaviors to facilitate the best outcomes for mothers and infants. To further advance our understanding of the effectiveness of public health interventions, public health nurses

are involved in the Closing the Gap on Infant Mortality: African American-Focused Risk Reduction (CTG) program. In two pilot communities in the state, the CTG program works to replicate the success of interventions shown to improve pregnancy outcomes in other geographic locations.

A few limitations of the analysis were identified. The study was limited to data included on birth and death certificates, which only list some maternal morbidities and confounding factors. Therefore, the study was unable to control for the severity of the selected maternal chronic medical conditions. There is also no record of maternal use of medications or other methods of managing symptoms, a factor relevant to the severity and confounding morbidity associated with most maternal chronic conditions. Finally, the Mississippi birth certificate does not contain information on the source of payment for delivery, and so we were unable to account for maternal socioeconomic status in the model. Insufficient data sources also prevented investigation of any relationships between birth outcomes and the environment.

The study underscores the importance of increasing access to preconception care and treating women throughout the lifespan. Appropriate training for women's health care providers in recognizing and understanding the effects of chronic disease in women would also be valuable. The study also stresses the need for preventive health care as a tool for reducing African American disparities in infant and adult mortality and morbidity, a particularly serious and growing problem in Mississippi. Generally speaking, healthier mothers have healthier babies and policy development geared at improving the health of mothers could improve outcomes for Mississippi infants and their families.

Conclusions

PTB, LBW, and infant mortality were found to be more prevalent among African American mothers, and mothers with cardiac disease, chronic hypertension, and diabetes. Maternal chronic hypertension and diabetes were significantly associated with at least one of the three negative birth outcomes regardless of mother's race. Maternal cardiac disease was only significantly associated with African American mothers on PTB and LBW in Mississippi. This information is of vital significance to public health nurses who play a pivotal role in promoting good health practices before and during pregnancy.

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