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PERINATAL MORTALITY IN NORTH CAROLINA: RISK FACTOR ANALYSIS BY RACE

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ABSTRACT

Perinatal mortality continues to be a public health problem in North Carolina. In 1992, there were 1,655 perinatal deaths among North Carolina residents. Blacks comprised only 29 percent of the deliveries, but 48 percent of all perinatal deaths occurred among blacks. Furthermore, the rate of perinatal mortality for blacks was 23.9 per 1,000 deliveries, while for whites it was 10.3 per 1,000 deliveries. The reasons for these discrepancies are not fully understood.

This study examines how the risk factors associated with perinatal mortality vary according to race. By using odds ratios and logistic regression, the strongest predictors of perinatal mortality are compared for blacks and whites. The risk factors considered include sociodemographic factors, medical risk factors, and complications of labor that were reported on the birth and fetal death certificates.

Results indicate that black women had a higher prevalence of several characteristics associated with perinatal mortality. Furthermore, while the medical risk of a previous preterm or small for gestational age infant, and the complications of labor influenced perinatal mortality strongly for both blacks and whites, several of the sociodemographic variables affected blacks and whites differently. Maternal age 35 or more and maternal age under 18 were the strongest predictors of perinatal mortality in blacks. However, for whites, birth order 5 or more and marital status had the strongest association; and maternal age 35 or more had no association with perinatal mortality.

The findings of the study are discussed, as well as strategies for reducing perinatal mortality in North Carolina.

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INTRODUCTION

In 1992, for North Carolina residents, there were 1,655 perinatal deaths. For this study, the perinatal period was defined as including both fetal deaths (stillbirths of 20 or more weeks gestation) and neonatal deaths (live births through the first 28 days of life). Forty-eight percent of these deaths occurred among blacks, while only 29 percent of deliveries were to black women.

The rate of perinatal mortality for blacks was 23.9 per 1,000 deliveries (live births and fetal deaths), and for whites it was 10.3 per 1,000 deliveries. While it is well-known that blacks experience higher perinatal mortality rates than whites, it is less clear how risk factors vary according to race. Race can be a substitute for multiple risk factors, and controlling for demographic factors does not entirely eliminate the differences in perinatal mortality observed between the races.¹ This study found that if whites and blacks are considered separately, the strongest predictors of perinatal mortality are not the same in both groups. Furthermore, the prevalence of the most common risk factors differs between whites and blacks.

Previous research has identified several risk factors for perinatal mortality.^{2,3} The risk factors examined in this study fall into 3 broad categories – sociodemographic, medical risk factors, and complications of labor.

Sociodemographic risk factors include:

- race⁴
- delivery of a male infant⁵
- maternal age under 18⁶
- maternal age 35 or more⁷
- education under 12 years⁸
- being unmarried²
- receiving late or no prenatal care⁹
- weight gain less than 15 pounds¹⁰
- first birth or fifth or more birth¹¹
- tobacco use during pregnancy.¹²

Medical risk factors include:

- anemia⁹
- diabetes^{13,14}
- pregnancy-induced hypertension^{15,16}
- a previous preterm or small for gestational age infant.¹⁷

Complications of labor include:

- abruptio placenta¹⁸
- cord prolapse¹⁹
- placenta previa²⁰
- premature rupture of membranes.²¹

The objective of this exploratory study was to determine which of the above factors were the strongest predictors of perinatal mortality for whites and for blacks. It was assumed that certain risk factors indicate risk for one race, but not for the other; also certain high risk behaviors may be more common in one race than in the other, or affect one group more than the other. For example, blacks giving birth are more likely to be unmarried, anemic, of higher birth order (fifth birth or more), less educated, and under age 18. All of these factors are associated with a higher risk of perinatal mortality.

METHODS

This study was based on live births linked to neonatal deaths (less than 28 days), and fetal deaths (20 or more weeks gestation), occurring to North Carolina residents in 1992. The 1992 birth certificate data files, linked infant death data files, and fetal death data files were used to construct the file for analysis. Any live births that resulted in a post-neonatal death (28 days to one year of age) were excluded, as were all multiple births. Only white and black deliveries were included in this study; the 3% of deliveries to other races were excluded. There were 98,999 deliveries in the study; 1,428 of these were perinatal deaths (846 fetal deaths and 582 neonatal deaths). The remaining 97,571 were single, live births who survived to at least one year of age. The study population was comprised of 70% white deliveries and 30% black deliveries.

The first stage of analysis was to examine the differences in prevalence of factors reported on the birth certificate comparing blacks and whites. The percent of perinatal deaths and the percent of the survivors (excluding postneonatal deaths) having a specified risk factor were calculated.

Crude (unadjusted) odds ratios were calculated to determine the association between a factor and the risk for perinatal mortality. The odds ratio is an estimate of the risk of perinatal mortality for mothers who have a specified characteristic (exposed) compared to the risk among mothers who do not have that characteristic (unexposed). An odds ratio greater than 1 indicates increased risk. The SAS Frequency Procedure with the Cochran-Mantel-Haenszel (CMH) statistics option was used to calculate these odds ratios.²² Since the sample size was large and the occurrence of perinatal death was sufficiently rare in the population, the odds ratio is a close approximation of the risk ratio.

In the next stage of analysis, logistic regression was used to estimate odds ratios for perinatal mortality for blacks and whites by adjusting for the sociodemographic variables race, sex of the infant, maternal age under 18, maternal age 35 or more, education, beginning care after the first trimester, birth order of 1, birth order 5 or more, marital status, and tobacco use, and the medical risk of a previous preterm or small for gestational age infant. Estimates are of the “independent” effect of each risk factor in the model. The SAS Logistic Procedure was used.²² For efficiency, this part of the analyses used an approach in which all of the black and white perinatal deaths (n=1,428) and a 10 percent random sample (n=11,284) of the black and white survivors (again excluding multiple births and births resulting in a postneonatal death) were selected to perform logistic regression. The subsample of survivors was very similar in demographic makeup to the survivors in the full dataset

(the prevalence of all factors in the subsample was within 1% of the prevalence of that factor in the full dataset).

Logistic regression was used to develop a model for predicting perinatal mortality for blacks and for whites. “Complications of labor” were added one at a time to the sociodemographic model to determine their association with perinatal mortality.

In order to check for multicollinearity (high correlation between the independent variables in the regression model), Pearson correlation coefficients were calculated between all independent variables using the SAS Correlation Procedure.²² All of the correlations were less than |0.5|, so it was determined that multicollinearity was not a problem.

RESULTS

As shown in Table 1, black women had a higher prevalence of the following characteristics:

- age under 18
- education under 12 years
- being unmarried
- beginning prenatal care after the first trimester or not receiving any care
- gaining less than 15 pounds during pregnancy
- having a birth order of 5 or more
- being anemic
- having a previous preterm or small for gestational age infant
- experiencing abruptio placenta or premature rupture of membranes.

These factors have all been identified as being associated with perinatal death. As expected, whites had a higher prevalence of tobacco use. They were also more likely to be 35 or more years of age, delivering their first infant, and to have diabetes.

Table 1 shows the percentage of perinatal deaths and survivors (excluding postneonatal deaths) that had a specified risk factor. In general, the percentage of perinatal deaths having the specified risk factor was larger than the percentage of survivors having the risk factor. For whites and blacks, the most noticeable gap between perinatal deaths and survivors was for weight gain less than 15 pounds. However, as it will be discussed later, this risk factor may be affected by gestational age.

Table 2 shows crude or unadjusted odds ratios for perinatal mortality and their respective 95% confidence intervals. For whites, weight gain had the largest crude odds ratio. However, as discussed below, there is some confounding with gestational age. Five or more births, not being married, age under 18, tobacco use, education, and beginning care after the first trimester also had relatively large odds ratios among the sociodemographic variables.

Risk Factors:	White		Black	
	Perinatal Deaths¹	Survivors²	Perinatal Deaths¹	Survivors²
Sociodemographic Factors:				
Male infant	53.8	51.3	54.5	50.8
Age under 18 years	6.3	3.9	12.7	10.6
Age 35 or more years	8.2	8.3	7.2	5.3
Education under 12 years	25.1	19.1	29.9	28.5
Not married	24.3	16.2	72.1	66.8
Began care late or no care	19.0	14.3	37.7	35.4
Weight gain under 15 pounds	35.8	6.3	50.0	13.4
Birth order of 1	39.1	37.3	32.4	30.6
Birth order 5 or more	9.3	5.2	11.7	9.8
Used tobacco	27.5	20.3	17.7	14.8
Medical Risks:				
Maternal anemia	2.2	1.9	3.1	3.4
Maternal diabetes	3.5	3.7	2.4	2.8
Maternal hypertension	3.8	4.5	3.7	4.3
Previous preterm or SGA infant	2.4	1.0	4.1	1.7
Complications of Labor:				
Abruptio placenta	9.7	0.6	8.2	0.8
Cord prolapse	2.2	0.2	1.8	0.2
Placenta previa	2.2	0.5	1.7	0.5
Premature rupture of membranes	11.8	3.4	15.0	4.4
Number of Deliveries	716	68,517	712	29,054
¹ Percentage of perinatal deaths having specified characteristic ² Percentage of live births surviving at least one year having specified characteristic <i>Source: 1992 N.C. Resident Live Births and Fetal Deaths</i>				

It is also noteworthy that maternal age 35 or more had the smallest odds ratio of the sociodemographic risk factors for whites. A previous preterm or small for gestational age infant had the largest odds ratio of the medical risk factors. All of the complications of labor had relatively large odds ratios; abruptio placenta was the largest.

For blacks, weight gain also had the largest odds ratio of the sociodemographic variables. Maternal age 35 or more had a relatively large odds ratio among the sociodemographic variables. As for whites, the medical risk factors had small odds ratios except for a previous preterm or small for gestational age infant. Furthermore, all of the complications of labor had large odds ratios, and abruptio placenta was the largest.

TABLE 2
Crude Odds Ratios for Risk Factors of Perinatal Mortality

Risk Factors:	White Odds Ratios¹ and 95% Confidence Intervals	Black Odds Ratios¹ and 95% Confidence Intervals
Sociodemographic Factors:		
Male infant	1.11 (0.95 - 1.28)	1.16 (1.00 - 1.35)
Age under 18 ²	1.66 (1.23 - 2.24)	1.26 (1.01 - 1.58)
Age 35 or more ²	1.01 (0.77 - 1.33)	1.44 (1.08 - 1.92)
Education under 12 years	1.42 (1.20 - 1.69)	1.07 (0.91 - 1.26)
Not married	1.67 (1.41 - 1.98)	1.28 (1.09 - 1.51)
Began care late or no care ³	1.41 (1.16 - 1.70)	1.10 (0.94 - 1.29)
Weight gain under 15 pounds	8.30 (7.21 - 9.56)	6.49 (5.61 - 7.52)
Birth order 1 ⁴	1.17 (1.00 - 1.37)	1.13 (0.96 - 1.33)
Birth order 5 or more ⁴	1.99 (1.54 - 2.59)	1.26 (0.99 - 1.61)
Used tobacco	1.49 (1.27 - 1.76)	1.24 (1.02 - 1.51)
Medical Risks:		
Maternal anemia	1.21 (0.73 - 1.99)	0.90 (0.59 - 1.38)
Maternal diabetes	0.95 (0.64 - 1.42)	0.86 (0.53 - 1.40)
Maternal hypertension	0.84 (0.57 - 1.23)	0.86 (0.58 - 1.27)
Previous preterm or SGA infant	2.33 (1.46 - 3.74)	2.47 (1.71 - 3.57)
Complications of Labor:		
Abruptio placenta	16.90 (13.90 - 20.54)	11.76 (9.27 - 14.90)
Cord prolapse	9.83 (6.45 - 14.99)	7.98 (4.82 - 13.20)
Placenta previa	4.64 (2.93 - 7.36)	3.75 (2.15 - 6.53)
Premature rupture of membranes	3.73 (3.01 - 4.63)	3.85 (3.15 - 4.70)
Number of Deliveries	69,233	29,766

¹The referent group is generally the opposite category of the risk factor shown, except where otherwise stated.

²Referent group - mothers aged 18-34

³Referent group - began care during first trimester

⁴Referent group - birth order 2-4

Source: 1992 N.C. Resident Live Births and Fetal Deaths

Table 3 shows the adjusted odds ratios for perinatal mortality, obtained by using logistic regression. The same group of variables was selected for blacks and whites so that comparisons could be made between the races. The first model used included the sociodemographic and medical risk factors that were believed to be associated with perinatal mortality based on the crude odds ratios:

- sex
- maternal age under 18
- maternal age 35 or more
- education
- marital status

- beginning care after the first trimester
- first or five or more births
- tobacco use
- a previous preterm or small for gestational age infant.

Weight gain was not used because of its association with gestational age. Anemia, diabetes, and hypertension were not used since they were not associated with perinatal mortality based on the crude odds ratios. It should also be noted that birth order of 1 did not have a very large odds ratio for blacks or whites in the crude associations, however, it was

TABLE 3
Adjusted Odds Ratios for Risk Factors of Perinatal Mortality

Risk Factors:	White Adjusted Odds Ratios¹ and 95% Confidence Intervals	Black Adjusted Odds Ratios¹ and 95% Confidence Intervals
Sociodemographic Factors:		
Male infant	1.18 (1.00 - 1.38)	1.23 (1.04 - 1.47)
Age under 18 ²	1.26 (0.87 - 1.85)	1.47 (1.05 - 2.05)
Age 35 or more ²	0.92 (0.68 - 1.25)	1.56 (1.10 - 2.21)
Education under 12 years	1.13 (0.91 - 1.41)	0.86 (0.68 - 1.08)
Not married	1.37 (1.10 - 1.70)	1.18 (0.96 - 1.44)
Began care late or no care ³	1.13 (0.90 - 1.41)	1.00 (0.83 - 1.20)
Birth order 1 ⁴	1.11 (0.93 - 1.33)	1.11 (0.91 - 1.36)
Birth order 5 or more ⁴	1.94 (1.44 - 2.62)	1.34 (1.00 - 1.79)
Used tobacco	1.28 (1.06 - 1.56)	1.23 (0.97 - 1.56)
Medical Risks:		
Previous preterm or SGA infant	2.16 (1.24 - 3.77)	2.23 (1.36 - 3.64)
Complications of Labor:		
Abruptio placenta	16.20 (10.88 - 24.11)	8.82 (5.37 - 14.49)
Cord prolapse	4.49 (2.31 - 8.71)	9.34 (3.46 - 25.25)
Placenta previa	4.93 (2.62 - 9.29)	7.23 (2.93 - 17.88)
Premature rupture of membranes	3.82 (2.90 - 5.04)	3.21 (2.45 - 4.20)
Number of Deliveries	7,659	3,625

¹The referent group is generally the opposite category of the risk factor shown, except where otherwise stated.

²Referent group - mothers aged 18-34

³Referent group - began care during first trimester

⁴Referent group - birth order 2-4

Source: 1992 N.C. Perinatal Deaths and a 10 Percent Sample of Live Births

included in this model because the complementary category, birth order 5 or more, had a fairly large odds ratio. Then the “complications of labor” were added one at a time to this model to see how they were associated with perinatal mortality.

For whites, birth order 5 or more, marital status, tobacco use, and age under 18 had the largest adjusted odds ratios for the sociodemographic variables. For blacks, age 35 or more, age under 18, and birth order 5 or more had relatively large odds ratios. In both whites and blacks, a previous preterm or small for gestational age infant and all four complications of labor had relatively large odds ratios. Interestingly, maternal age 35 or more had the largest odds ratio of the sociodemographic variables for blacks, but for whites, it was the smallest. This suggests that the association between perinatal mortality and age varies by race. The Breslow-Day test for homogeneity revealed that an interaction between race and age is likely (p-value= 0.028).

The risk factors maternal age under 18, maternal age 35 or more, marital status, and birth order 5 or more influenced black and white perinatal mortality differently. The prevalence of these behaviors also varied between whites and blacks.

DISCUSSION

The size of the study population was very large (n=98,999). Large sample sizes often result in many significant variables. Thus, for this study it was preferable to consider the size of the odds ratios rather than to simply consider significance as the sole basis for interpreting the results.

This study examines perinatal mortality rather than fetal or neonatal mortality alone. The reason for this choice was to avoid bias due to problems of definition. The definition of fetal death is death prior to birth. This report includes fetal deaths of 20 or more weeks gestation. A neonatal death is a “death of a live born child under 28 days of age”. Bias could result due to confusion as to whether the death occurred prior to birth or just after birth. By

using perinatal mortality, which includes both fetal and neonatal deaths, this bias is avoided.

When conducting a study such as this, it is important to note the quality of the data. In 1988, North Carolina began using a new birth certificate. In 1992, Buescher et al., conducted a study to determine the accuracy of the data on the birth certificate as compared to data in maternal hospital records.²³ Results indicated that reporting was very accurate (>90% agreement) for birth weight, Apgar score, and method of delivery; fair to good (60-90% agreement) for tobacco use, prenatal care, weight gain during pregnancy, obstetrical procedures, and events of labor and delivery; and poor (<60% agreement) for medical history and alcohol use.

This study found that medical history factors anemia, hypertension, and diabetes were not associated with perinatal mortality. This finding could be related to the quality of reporting of these items on the birth certificate. These variables were not included in the model that adjusted for risk factors. It should be mentioned that there are three items on the birth certificate relating to hypertension: “hypertension, chronic,” “hypertension, pregnancy-associated,” and “eclampsia.” For this study, only pregnancy-associated hypertension was considered.

“Complications of labor” were included individually in the logistic regression model with the sociodemographic variables. As expected, these variables were highly predictive of perinatal mortality for whites and blacks. Each of the complications examined were serious conditions that would normally be easy to identify.

Prenatal care is a difficult factor to assess. This study elected not to use a variable based on the “number of prenatal care visits.” Preterm delivery reduces the number of prenatal visits and because such a delivery is at higher risk this would bias the results.²⁴ Whether care began during the first trimester may reduce the confounding with gestational age but it is not free from bias. “Trimester care began” had a relatively large crude odds ratio,

but when adjusting for other sociodemographic factors, the odds ratio was much smaller. Women who began care very late in their pregnancy may bias the results. Since these women were able to complete most of their pregnancy without needing medical attention, they may be less likely to experience a perinatal death.

Weight gain is also a difficult factor to examine. Since perinatal deaths are often associated with pre-term delivery, mothers who delivered prematurely would not have as much time to gain 15 pounds. Thus it was decided not to consider weight gain in the logistic regression model in order to avoid confounding with gestational age.

Recent studies have discussed the importance of older maternal age as a risk factor for perinatal mortality among blacks. This study found maternal age over 35 to be one of the strongest non-medical risk factors for blacks (crude odds ratio 1.44). For whites, maternal age 35 or more was not associated with perinatal mortality. Furthermore, when other sociodemographic characteristics were adjusted for by logistic regression, maternal age over 35 became an even stronger risk factor for blacks (odds ratio 1.56)

A recent study of racial differences in North Carolina infant mortality by Family Health International and the Governor's Commission on the Reduction of Infant Mortality outlines several possible areas to consider when examining why older black women have an increased risk. The authors suggest that medical risks such as hypertension and diabetes, as well as complications due to poor nutritional and general health status compound with age. Also, older women have more opportunity to develop sexually transmitted diseases and reproductive tract infections. Finally, they suggest that psychosocial stress may increase with age

and further worsen medical risks. Along with an increase in psychosocial stress, social support for blacks may decrease with age, as younger women may have more available support.²⁵ All of these factors may increase the risk of perinatal death for older black women.

Clearly, babies born to black women have a higher risk for perinatal death. This study shows that the strongest predictors of perinatal death are not identical for whites and blacks. But how can this information be translated into reductions in mortality for all women? There is no easy solution to the problem of perinatal mortality. Improvements such as better prenatal care provide only the first step. Many of the risk factors are related to socioeconomic status and there are no simple solutions to removing these barriers. Effort needs to be made to improve the socioeconomic status of all women, which increases their chances for a positive outcome. Women with higher socioeconomic status often decrease their risk by altering their behavior. For example, by staying in school, a woman may avoid getting pregnant until she has passed her teenage years. More education would perhaps enable her to develop a stronger economic base and better parenting skills. A good job would also help her to afford better nutrition and proper prenatal care. Among black women, special effort needs to be made to decrease the percentage of unmarried women giving birth. Improvements in the overall health and economic status of blacks may help improve the birth outcomes of women over age 35. Among whites, special effort needs to be made to decrease tobacco use during pregnancy. Such efforts will benefit women of all races.

The problem of perinatal mortality cannot be easily solved. Continuing research and intervention programs will help mortality rates for all races decline, and more babies grow up healthy.

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