Racial and Ethnic Disparities in Infant Mortality in North Carolina, 2008-2009

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BACKGROUND This study was designed to investigate whether racial and ethnic disparities in infant mortality still exist in North Carolina and to examine predictors of infant mortality using the North Carolina Vital Statistics Dataverse.

METHODS This was a retrospective, cross-sectional, observational study that included all 257,543 births in North Carolina in 2008-2009. Infant mortality was assessed based on birth records included in the database. Infant births and deaths were summarized by demographic and maternal/infant characteristics. A multivariate logistic regression model was constructed to jointly assess predictors of infant mortality.

RESULTS The overall infant mortality rate in North Carolina was 0.8%. Adjusting for confounders through the construction and assessment of a multivariate logistic regression model, statistically significant associations were found between infant mortality and each of the following: maternal race (both black and ‘other’ versus white), infant sex, both premature and preterm gestation (versus full term), birth weight (both low and high versus normal), maternal education (both less than high school graduate and more than high school versus college graduate), prenatal care (both intermediate and inadequate versus adequate), and maternal tobacco use.

LIMITATIONS Maternal race was limited to white, black, and other. Data on socioeconomic status, maternal medical risk factors, and quality of prenatal care were not available. At the time of the analysis, data for years beyond 2009 were limited.

CONCLUSIONS Racial disparities in infant mortality persist in North Carolina; specifically, infants of nonwhite mothers have a higher mortality rate than do infants of white mothers. Other factors that continue to play a significant role in infant mortality in North Carolina include preterm and prematurity births, male infant sex, low birth weight, maternal education less than college graduate, maternal tobacco use, and less than adequate prenatal care.
the period 2008–2009 (the most recent data available at the time the analysis was conducted) while examining the influence of commonly studied risk factors of infant mortality such as gestational age, maternal age, low birth weight, and prenatal care.

**Methods**

This study utilized the North Carolina Vital Statistics Dataverse (NCVSD), which contains vital statistics such as births, fetal deaths, deaths, birth/infant deaths, marriages, and divorces [8]. Two databases from the NCVSD were used; we combined the dataset for infant mortality (defined here as a death occurring in the first year of life) with the dataset for all infant births in North Carolina. Both datasets included information on the parents of each infant, such as age, education level, marital status, prenatal medical care received [9], and information on the mother’s reproductive history, including number of previous pregnancies and live births [8]. There was no identifying information in either of the 2 linked datasets, so the study was exempted from review by Campbell University’s institutional review board.

This study used the aforementioned NCVSD databases for 2008 and 2009. Because newly revised birth certificates were being gradually adopted across the state in 2010, data from that year were not included. Birth certificates are a significant source of data for the databases; since the new birth certificate was adopted at different times throughout the state, the 2010 database contains many missing data points in variables that would have been of interest for this study.

Data was available for each of the following variables of interest, which were grouped as indicated: maternal race (white versus black versus ‘other’), maternal ethnicity (Hispanic/Latina versus non-Hispanic/Latina), gestational age (≤32 weeks versus 33–36 weeks versus 37–42 weeks versus ≥43 weeks), maternal age (≤19 years versus 20–34 years versus ≥35 years), maternal education (less than high school graduate versus high school graduate and/or some college or college graduate versus post-graduate), marital status (not married versus married), maternal tobacco use (yes versus no), infant sex (male versus female), birth weight (low [<5.5 lbs.] versus normal [5.5–8.15 lbs.] versus high [≥8.15 lbs.]), prenatal care (inadequate versus intermediate versus adequate), and type of attendant (medical doctor [MD] versus doctor of osteopathy [DO] versus midwife versus other).

As an initial model filter, only variables with an individual overall chi-square P-value less than .2 were included in a multivariate logistic regression model to determine significant predictors of interest for infant mortality, adjusting for covariates of interest. Both forward and backwards stepwise multivariate logistic models were also constructed. The consistency of results across the 3 models adds evidence to the robustness of the results reported here. Odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for each level of each variable included in the model are reported relative to each variable’s reference group. Given the exploratory and retrospective nature of this study, no adjustment for multiple comparisons was made.

**Results**

Demographic and maternal/infant characteristics for births and deaths are shown in Table 1. A total of 257,543 births and 2,000 deaths were included in the analysis. The

| Characteristic         | Number of infants (%) | Infant mortality N (%) |
|------------------------|-----------------------|------------------------|
| Maternal race          |                       |                        |
| Other                  | 12,543 (4.9)          | 92 (0.73)              |
| Black                  | 61,767 (24.0)         | 873 (4.1)              |
| White                  | 183,233 (71.2)        | 1,035 (0.56)           |
| Mother’s age (mean ± SD) |                       |                        |
| ≤19 years              | 270 ± 6.12            |                        |
| 20–34 years            | 29,632 (11.5)         | 319 (1.08)             |
| ≥35 years              | 195,055 (75.7)        | 1,446 (0.74)           |
| Maternal ethnicity     |                       |                        |
| Hispanic or Latina     | 41,776 (16.2)         | 245 (0.59)             |
| Not Hispanic or Latina | 215,553 (83.8)        | 1,748 (0.55)           |
| Marital status         |                       |                        |
| Not married            | 108,554 (42.2)        | 1,183 (1.09)           |
| Married                | 148,927 (57.8)        | 816 (0.55)             |
| Mother’s education level |                       |                        |
| Less than high school graduate | 56,262 (21.9) | 560 (1.00)             |
| High school graduate or some college | 130,593 (50.7) | 1,121 (0.86)           |
| College graduate       | 42,951 (16.7)         | 188 (0.44)             |
| Post-graduate          | 27,737 (10.8)         | 131 (0.47)             |
| Maternal tobacco use   |                       |                        |
| Yes                    | 26,596 (10.3)         | 317 (1.19)             |
| No                     | 230,500 (89.7)        | 1,653 (0.72)           |
| Sex of infant          |                       |                        |
| Female                 | 125,535 (48.7)        | 877 (0.70)             |
| Male                   | 152,005 (51.3)        | 1,121 (0.85)           |
| Gestation (mean ± SD)  |                       |                        |
| ≤32 weeks              | 38.5 ± 3.22           |                        |
| 33–36 weeks            | 6,557 (2.6)           | 1,199 (18.29)          |
| ≥37–42 weeks           | 20,911 (8.1)          | 196 (0.94)             |
| ≥43 weeks              | 229,920 (89.3)        | 596 (0.26)             |
| Birth weight (mean ± SD) |                       |                        |
| High (>8.15 lbs.)      | 7,2 ± 1.36            |                        |
| Low (<5.5 lbs.)        | 20,328 (7.9)          | 20 (0.10)              |
| Normal (5.5–8.15 lbs.) | 36,475 (14.7)         | 1,477 (4.05)           |
| Prenatal care          |                       |                        |
| Inadequate             | 7,607 (3.0)           | 156 (2.05)             |
| Intermediate           | 28,540 (11.1)         | 366 (1.28)             |
| Adequate               | 221,396 (86.0)        | 1,428 (0.67)           |
| Provider type          |                       |                        |
| Other                  | 1,110 (0.4)           | 12 (1.08)              |
| Midwife                | 27,019 (10.5)         | 113 (0.42)             |
| DO                     | 3,443 (1.3)           | 30 (0.87)              |
| MD                     | 225,279 (87.7)        | 1,840 (0.82)           |
| Overall infant mortality |                       |                        |
| Yes                    | 2,000 (0.8)           |                        |
| No                     | 255,543 (99.2)        |                        |

a Totals for any variables that do not sum to the column total are due to missing characteristic variable data.

b Percent in each category for each variable.
The majority of the maternal population consisted of white mothers (71%), with black and other being the minority racial groups (24% and 5%, respectively). The majority of mothers were of non-Hispanic/Latina ethnicity (84%). The mean maternal age was 27 years, with the majority of mothers being in the 20–34 year age group (76%); over half of mothers were married at the time they gave birth (58%). Approximately half of the mothers were high school graduates (but did not attend or complete college), and 10% of the mothers were smokers. Most of the infants received adequate care (86%), were of normal birth weight (85%), and were delivered at full term (89%). The majority of the maternal population received care from an MD (88%).

Overall, 0.8% of the infants born in 2008–2009 in North Carolina died within the first year following birth. On a percentage basis, the rate of infant deaths occurring to black mothers (1.41%) was nearly twice the rate of infant deaths for mothers in the ‘other’ race group (0.73%) and approaching 3 times the rate for white mothers (0.56%). A higher percentage of infant deaths occurred among mothers 19 years of age or younger (1.08%) than among mothers 20–34 years of age (0.74%) or among those 35 years of age or older (0.71%). Non-Hispanic/Latina mothers were found to have a higher rate of infant mortality (0.81%) compared to Hispanic/Latina mothers (0.59%). Mothers who were not married at the time of their child’s birth were found to have nearly twice the rate of infant mortality (1.09%) compared to married mothers (0.55%). In terms of maternal education, mothers with less than a high school education had the highest rate of infant mortality (1.00%). Finally, mothers who were smokers were more likely to experience infant mortality (1.19%) compared to nonsmokers (0.72%).

Male infants were found to have a slightly higher rate of mortality (0.85%) than female infants (0.72%), and infants with a low birth weight were found to have a more than 16-fold increase in infant mortality compared to those with a normal birth weight (4.05% versus 0.24%, respectively). However, mortality was lower in infants with a high birth weight than in those with a normal birth weight (0.10% versus 0.24%, respectively). Premature infants had a far higher rate of infant mortality (18.29%) than infants born at 33–36 weeks (0.94%) or those born at 37–42 weeks (0.26%). No infant deaths were recorded among infants with a gestational age of 43 weeks or greater, most likely due to the small number of infants in that category. Not surprisingly, infants receiving inadequate prenatal care, as measured by the Kessner Index [9], were found to have the highest rate of infant mortality (2.05%) compared to those receiving intermediate or adequate care (1.28% and 0.67%, respectively). When care was delivered by a provider in the ‘other’ category, infants demonstrated the highest rate of mortality (1.08%) compared to those whose mothers received care from midwives (0.42%), DOs (0.87%), or MDs (0.82%).

Table 2 displays the results of the multivariate logistic regression model that included all covariates of interest (all overall chi-square test P-values were <0.2). Adjusting for the covariates of interest included in the model, the odds of infant mortality were found to be significantly higher in the black maternal race group compared to the white maternal race group (OR, 1.35; 95% CI, 1.20–1.51) as well as in the ‘other’ maternal race group compared to the white maternal race group (OR, 1.27; 95% CI, 1.01–1.59). The odds of infant mortality were found to be significantly higher in mothers who were high school graduates or had some college education compared to those who were college graduates (OR, 1.35; 95% CI, 1.14–1.60). Similarly, the odds of infant mortality were significantly higher for mothers who did not finish high school compared to those who were college graduates (OR, 1.60; 95% CI, 1.31–1.95). No difference in the odds of infant mortality was noted between mothers with a post-graduate education and those with a college education.

Mothers using tobacco were found to have significantly higher odds of infant mortality than those who did not use tobacco (OR, 1.19; 95% CI, 1.04–1.37). Odds of infant mortality were also higher among infants with low birth weight compared to those with normal birth weight (OR, 3.14; 95% CI, 2.64–3.73). High birth weight infants were found to have significantly lower odds of mortality compared to normal birth weight infants (OR, 0.48; 95% CI, 0.31–0.74).

| Variables | Adjusted odds ratio (95% Wald confidence limits) |
|-----------|--------------------------------------------------|
| Maternal race (other versus white) | 1.27 (1.01, 1.59) |
| Maternal race (black versus white) | 1.35 (1.20, 1.51) |
| Maternal age (0–34 years versus 37–42 years) | 0.95 (0.82, 1.11) |
| Maternal age (≥35 years versus 37–42 years) | 1.08 (0.83, 1.24) |
| Maternal ethnicity (Hispanic/Latina versus non-Hispanic/Latina) | 0.98 (0.83, 1.15) |
| Marital status (not married versus married) | 1.11 (0.99, 1.24) |
| Maternal education (post-graduate versus college graduate) | 0.94 (0.74, 1.20) |
| Maternal education (high school or some college versus college graduate) | 1.35 (1.14, 1.60) |
| Maternal education (less than high school versus college graduate) | 1.60 (1.31, 1.95) |
| Maternal tobacco use (yes versus no) | 1.19 (1.04, 1.37) |
| Sex of infant (female versus male) | 0.80 (0.73, 0.88) |
| Gestation (33–36 weeks versus 37–42 weeks) | 2.61 (0.16, 42.94) |
| Gestation (33–36 weeks versus 37–42 weeks) | 1.61 (1.32, 1.96) |
| Gestation (32 weeks versus 37–42 weeks) | 27.84 (23.50, 32.98) |
| Birth weight (low [<5.5 lbs.] versus normal [5.5–8.15 lbs.]) | 3.14 (2.64, 3.73) |
| Birth weight (high [≥8.15 lbs.] versus normal [5.5–8.15 lbs.]) | 0.48 (0.31, 0.74) |
| Prenatal care (inadequate versus adequate) | 1.41 (1.17, 1.71) |
| Prenatal care (intermediate versus adequate) | 1.39 (1.22, 1.58) |
| Provider type (other versus MD) | 1.49 (0.74, 3.01) |
| Provider type (midwife versus MD) | 0.95 (0.77, 1.16) |
| Provider type (DO versus MD) | 1.10 (0.74, 1.62) |

*The reference group is listed last in each row. Note. DO, doctor of osteopathy; MD, medical doctor.
as were female infants compared to male infants (OR, 0.80; 95% CI, 0.73–0.88). Compared to full term births, a gestational duration of 33–36 weeks (OR, 1.61; 95% CI, 1.32–1.96) or 32 weeks or less (OR, 27.84; 95% CI, 23.50–32.98) was found to result in significantly higher odds of infant mortality. However, no difference in the odds of infant mortality was noted between mothers with a gestational duration of 43 weeks or longer compared to those with a gestational duration of 37–42 weeks. Finally, when prenatal care was measured by the Kessner scale [9], both inadequate prenatal care (OR, 1.41; 95% CI, 1.17–1.71) and intermediate prenatal care (OR, 1.39; 95% CI, 1.22–1.58) were found to result in significantly higher odds of infant mortality compared to adequate prenatal care. After adjusting for the covariates of interest, maternal age, ethnicity, marital status, and provider type showed no disparities in the odds of infant mortality.

Discussion

This retrospective analysis found that racial disparities in infant mortality persisted through the most recent years of data included in this study (2008–2009). These findings unfortunately remain consistent with prior studies and disparity trends found in previous years [5, 6]. After adjusting for confounders, several factors continue to play a significant role in infant mortality in North Carolina: preterm and premature births, infant sex and birth weight, black and ‘other’ maternal race, maternal education less than college graduate, maternal tobacco use, and less than adequate prenatal care.

A prior study by Kitsantas and Gaffney based on North Carolina infant mortality data from 1999–2007 [6] found black maternal race to be associated with post-neonatal mortality but not neonatal mortality. The current study did not distinguish between neonatal and post-neonatal infant mortality. Other more recent studies have confirmed this pattern of higher rates of infant mortality associated with black/African American maternal race [5, 10, 11]. The current study was unique in its analysis of infant mortality and ‘other’ maternal race, as none of the aforementioned studies examined any race beyond white and black/African American. ‘Other’ race was identified as other non-white, American Indian, Chinese, Japanese, Hawaiian, Filipino, and other Asian. Biracial mothers likely identified with ‘other’ race. Healthy People 2010 and 2020 initiatives have focused on maternal and infant health in efforts to reduce disparities in infant mortality. The consistency of our results with prior research are further evidence that more public health education efforts are needed in such areas as smoking cessation for pregnant women and the importance of prenatal care. The aforementioned risk factors continue to be associated with infant mortality, and although they may not be preventable in every pregnancy, additional awareness can help minimize future infant deaths in the first year of life. Obstetricians, gynecologists, and other health care practitioners should educate pregnant women on these factors and the associated risks of infant mortality.

An interesting finding was that female infants were significantly less likely to die than were male infants, even after adjusting for covariates of interest. This finding was consistent with the Kitsantas and Gaffney [6] study, which found neonatal or post-neonatal mortality to be 20%–30% more likely in male infants. A study by Drevenstedt and colleagues studied male infant mortality over 300 years and found that male infants were more likely than females to die in the first year of life. The study attributes the higher mortality rate in males to higher birth weight, which can lead to complicated deliveries, as well as the risk of premature birth. In addition, the study also suggested that males have weaker immune systems [15].

Limitations

The study was not without limitations. Given the available data, we were unable to distinguish between neonatal and post-neonatal mortality. Also, maternal races other than white and African American were combined into one category, and data on combined infant race/ethnicity were not available in the dataset studied. Socioeconomic data were also unavailable, and there was no measurement of the quality of prenatal care received; the Kessner scale [9] is based on the number of prenatal visits and does not assess the quality of care received at those visits. Data for the year 2010, which were the most recent data available at the time the analysis was conducted, were not included due to newly
revised birth certificates being gradually adopted across the state that year. The newly revised birth certificates collect more data, such as medical risk factors; however, due to older versions of birth certificates not collecting this information, medical risk factors were not available for all the years studied. A 1.5-year delay in the availability of infant mortality data currently exists, limiting the availability of the more recent data for study. Finally, this study only included data from 1 state (North Carolina), so these results are not generalizable to the entire US population.

Conclusion

The findings of this study show that racial and other disparities in infant mortality persist in North Carolina. Public health efforts should aim to educate all women of childbearing age (with special emphasis on expectant mothers) on the benefits of adequate prenatal care and avoidance of tobacco during pregnancy. In addition, support should be made available for mothers of premature, preterm, or low birth weight infants. Additional research is needed in this area to further evaluate infant mortality in North Carolina as more recent years of data become available. 

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Potential conflicts of interest. All authors have no relevant conflicts of interest.

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