

Women's health measures in two North Carolina regions sampled from the Basic Automated Birth Yearbook (BABY) datasets: experimental findings, methodological limits and future directions

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Summary

Purpose: To compare selected characteristics in two North Carolina counties to document women's health services at the geographical extremes of the state. **Methods:** Using aggregated 2004 data obtained from the North Carolina State Center for Health Statistics, obstetric and perinatal characteristics were experimentally analyzed for the westernmost and easternmost counties in North Carolina (Cherokee and Dare County, respectively). **Findings:** During the experiment period, 489 infants were delivered in Dare County (population 33,518), while 259 births were recorded in Cherokee County (population 25,289). Prenatal care was established by most women in both counties by the second gestational month. Women in Cherokee County were younger and less educated at delivery than women in Dare County, and smoking prevalence was higher in Cherokee County than in Dare County (31.3% vs 12.9%; $p < 0.01$). Cherokee County infants required assisted ventilation and other medical interventions more often than babies born in Dare County ($p < 0.01$) yet significantly fewer cesarean deliveries were performed in Cherokee County than Dare County (25.5% vs 35.2%; $p = 0.04$). **Conclusion:** This pilot study showed a significantly higher rate of tobacco use, and lower maternal education level in Cherokee County was associated with a higher incidence of multiple maternal complications and neonatal interventions compared to Dare County. Interestingly, the cesarean delivery rate was lower in Cherokee County despite these factors. We found $< 10\%$ of babies born in the study regions required any neonatal intervention. Early and almost universal access to prenatal care did not appear to be a problem at either site. Our preliminary comparison identified important limitations in this government-sponsored dataset that rendered logistic regression analysis methodologically impossible. Changes in process could improve surveillance based on patient-level data and facilitate multivariate analysis. Specific interventions to optimize women's health services form the basis of future experimental research, including larger regional populations.

Key words: Perinatal outcomes; Women's health; Rural; Appalachia.

Introduction

The rate of population growth in North Carolina over the past decade has magnified the public health challenges associated with provision of medical needs of individuals and families. This pilot experiment examined selected current obstetric and neonatal clinical features in North Carolina focusing on the Western and Eastern boundaries of the state, Cherokee and Dare Counties, respectively (Figure 1).

Materials and Methods

Data source

This report compares data derived from analysis of information submitted to the North Carolina Department of Health & Human Services, Division of State Health Statistics. Data were tabulated centrally based on formal entries on all birth certificates filed with the state from the two study counties in 2004. These data are compiled as the Basic Automated Birth Year-

book, providing a report stratified by county comprised of multiple cross-tabulations of various maternal and infant variables such as age, race, birth order, birth weight, and number of prenatal visits as well as medical conditions of both mother and newborn. As clinical information was not collected in a format permitting patient-specific comparisons for any parameters, it was not possible to perform logistic regression analyses.

For our study, live birth was defined as the complete expulsion or extraction from its mother of a product of conception irrespective of the duration of pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or any definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. Marital status for this population was determined as follows: 'An unmarried' mother was one who had never been legally married or who had been widowed or legally divorced from her husband for > 280 days. Birth weight for all infants was recorded in grams. A low-weight birth was defined as a live born infant weighing < 2500 g (*i.e.*, 5 pounds, 8 ounces or less) at birth, irrespective of gestational age. Maternal age was the reported age in completed years at the mother's last (most recent) birthday. Education of the mother was determined by the number of years of school completed at time of the birth.

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Figure 1. — North Carolina county map showing location of Cherokee (left shaded) and Dare (right shaded) Counties, representing the Western and Eastern extremes of the state, respectively.

Demographic and other non-clinical information was extracted from the most recent published reports from the U.S. Department of Commerce, Bureau of the Census. The Student's *t*-test was used to compare the two study populations, as appropriate.

Results

Table 1 summarizes recent federal census and geographic information for Cherokee and Dare County, North Carolina. Mean income was lower in Cherokee than Dare County, (median \$33,768 vs \$49,302, respectively), consistent with a significant difference in proportion of residents below the poverty line in these two respective areas (15.3% vs 8%; $p < 0.01$).

A total of 748 infants were delivered during the study period: 259 in Cherokee and 489 in Dare County. The number of medical practitioners providing prenatal and delivery services in the two counties during the study interval was quite dissimilar, with the hospital in Dare County having > 12 obstetricians on staff and the hospital in Cherokee County never having more than three (data not shown). Residents or other physicians-in-training did not work regularly in either location, although both counties maintained a public health clinic for individuals without health insurance. In Cherokee County, expectant mothers tended to be younger, less educated, and more likely to smoke (Figures 2-4). The incidence of maternal anemia, diabetes, and hypertension was higher in Cherokee County (Figure 5). Dare County women also were more likely to be unmarried and experience a sig-

Table 1. — Summary of demographic and geographic features in Cherokee and Dare County, North Carolina from U.S. Geologic Survey and 2004 U.S. Census information.

Cherokee		Dare
25,289	Population (2004)	33,518
14,099	Housing units (2002)	28,484
53.4	Population density (n/mi^2)	78.1
\$15,814	Mean income-individual (1999)	\$23,614
\$33,768	Median income-family (1999)	\$49,302
15.3	% < poverty (1999)	8
467	Total county area (mi^2)	1562
2.5	% of total county area, water	75.4
1979	Year hospital opened	2003
52	# hospital beds	19

nificantly lower rate of multiple medical problems in pregnancy (19.8% vs 54.4%; $p < 0.01$).

Not surprisingly, a significantly higher rate of smoking among pregnant Cherokee County women compared to pregnant Dare County women (31.3% vs 12.9%; $p < 0.01$) was associated with important differences in infant birth weight and a markedly increased need for assisted ventilation for infants after delivery in Cherokee County (Figure 6). As shown in Figure 7, the frequency of infants delivered in Cherokee County requiring multiple neonatal interventions was sharply higher (8.9% vs 3.9%; $p < 0.01$).

Our analysis also identified distinct differences in the mode of delivery at these two locations, with 35.2% of Dare County patients undergoing cesarean delivery compared to only 25.5% in Cherokee County ($p = 0.04$). Interestingly, stratification of cesarean deliveries by type (Figure 8) showed the repeat cesarean delivery rate to be higher in Cherokee County (12.4% in Cherokee County vs 11.5% in Dare County; $p = 0.05$). Additionally, utilization of operative vaginal delivery was significantly higher in Cherokee County than in Dare County (11.2% vs 9%; $p = 0.03$).

While this study found most women in both counties had begun their prenatal care by the second month of pregnancy, in Dare County > 25% of pregnant women had started prenatal care by the first gestational month. It was confirmed that both counties maintain a fulltime government-funded clinical program offering prenatal care and women's health services for those without health insurance. In 2004 few women from either county initiated prenatal care as late as the third month, and there were no recorded births in either study site resulting from pregnancy where prenatal care was entirely absent (Figure 9).

Discussion

Of North Carolina's 100 counties, no two are further apart geographically than Cherokee and Dare. As the total population of North Carolina has grown in the past decade (at a pace exceeding the U.S. average), these two counties have registered their own substantial gains as well.

Although at opposite ends of North Carolina and separated by more than 500 miles, Cherokee and Dare counties share some common characteristics. Neither county contains any large metropolitan center and both have only one hospital. Additionally, both counties are situated in rural areas with a generally low population density, both have a county health department that offers free women's health services including prenatal care, and both counties are contiguous with at least one neighboring county with no hospital at all. Ours is the first study to describe representative features of these two North Carolina areas with an emphasis on women's and infant health outcomes.

In general, these data show pregnant patients in Dare County to be older, better educated, and earlier in initiating prenatal care. Importantly, obstetric patients in Dare

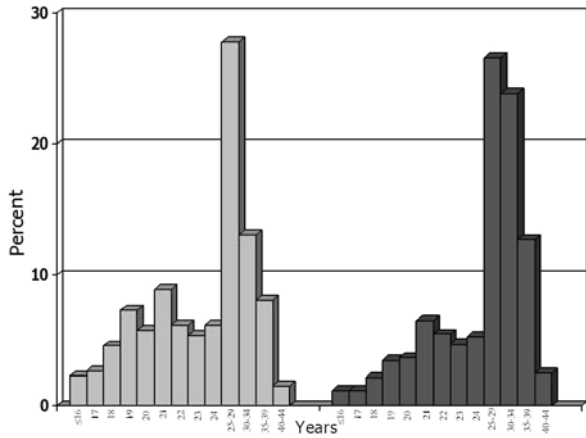


Fig. 2

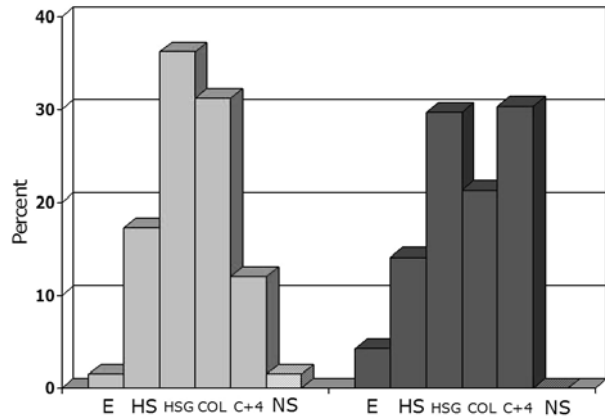


Fig. 3

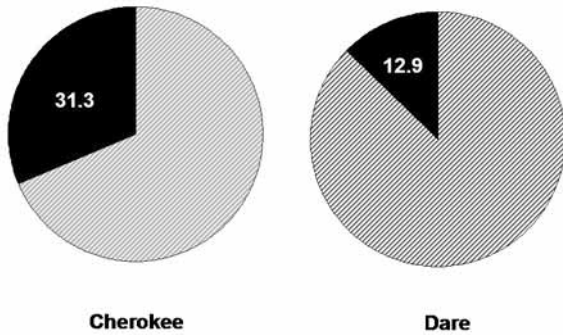


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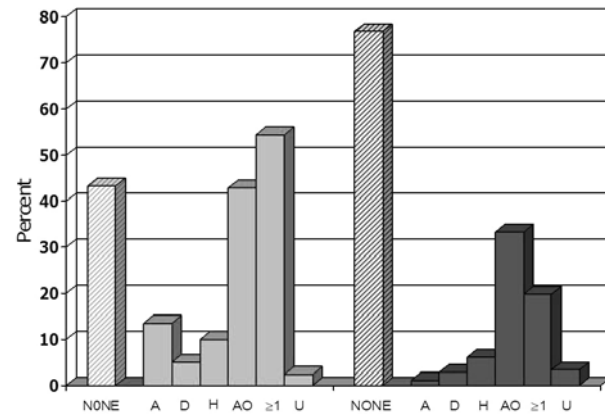


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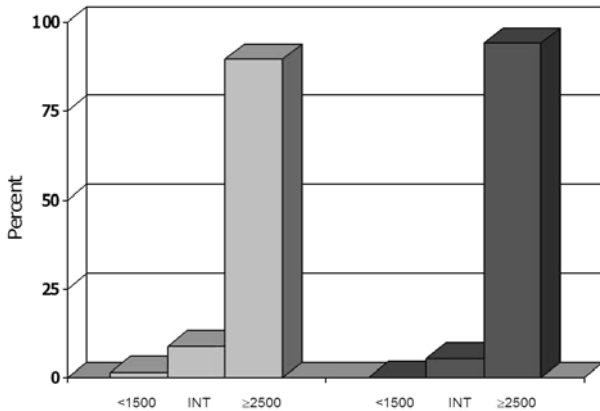


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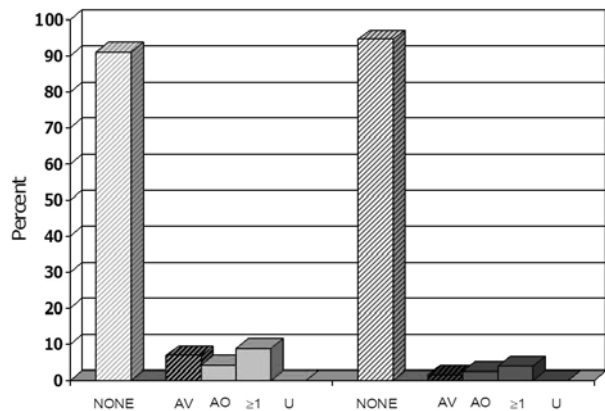


Fig. 7

Figure 2. — Comparison of age distributions of pregnant women from Cherokee County (left) and Dare County (right), North Carolina.

Figure 3. — Education (highest level completed) among pregnant women from Cherokee County (left) and Dare County (right), North Carolina. E = elementary, HS = high school, HSG = high school graduate, COL = college, C+4 = college graduate, NS = not specified.

Figure 4. — Comparison of smoking status (black = % smoking) among pregnant women from Cherokee County (left) and Dare County (right), North Carolina.

Figure 5. — Comparison of maternal medical complications among pregnant women from Cherokee County (left) and Dare County (right), North Carolina. A = anemia, D = diabetes, H = hypertension, AO = any other, ≥ 1 = one or more complicating condition, U = unspecified.

Figure 6. — Comparison of infant birth weight from pregnant women delivering in Cherokee County (left) and Dare County (right), North Carolina. < 1500 g, INT = 1500-2499 g, ≥ 2500 g.

Figure 7. — Comparison of neonatal interventions performed on newborns delivered in Cherokee County (left) and Dare County (right), North Carolina. AV = artificial ventilation, AO = any other, ≥ 1 = one or more intervention, U = unspecified.

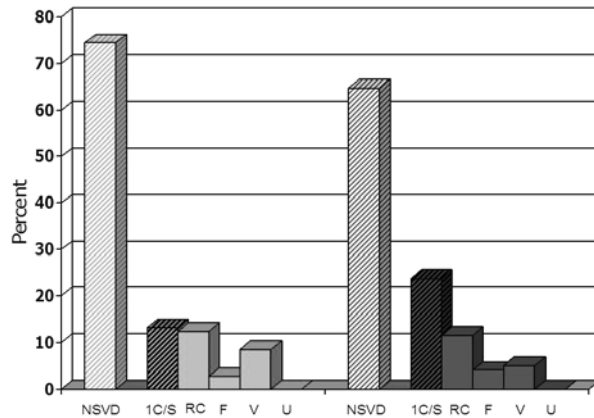


Fig. 8

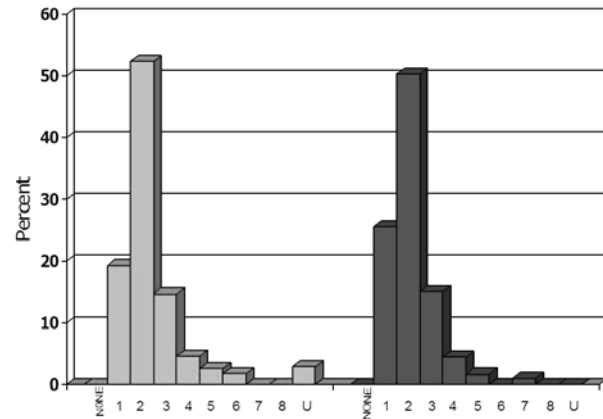


Fig. 9

Figure 8. — Comparison of method of delivery for pregnant women in Cherokee County (left) and Dare County (right), North Carolina. 1C/S = primary cesarean, RC = repeat cesarean, F = forcep, V = vacuum, U = unspecified.

Figure 9. — Comparison of time of initiation of first prenatal care (by gestational month) among pregnant women from Cherokee County (left) and Dare County (right), North Carolina. U = unspecified.

County were less likely to be smokers and their babies were less likely to require multiple neonatal interventions. Our observations parallel the findings of others [1, 2] who have noted an association between level of education and smoking status. Our analysis of these two North Carolina populations is in agreement with the confirmed deleterious impact of cigarette use during pregnancy and subsequent poor neonatal outcome [3, 4].

The rate of cesarean delivery in Dare County (35.2%) was significantly higher than in Cherokee County (25.5%) during a year (2004) when the national cesarean delivery rate was 29.1% [5]. While factors influencing cesarean delivery rate have been the focus of considerable study, there is little consensus on proper indications for this most frequently performed obstetrical surgery. It would be reasonable to expect a relatively high-risk obstetrical population to include an increased utilization of cesarean delivery, yet these data show a paradoxically lower cesarean rate in the location (Cherokee County) where women are more likely to have medical problems.

One explanation for this observation may be that, despite the higher prevalence of more complicated gestations in Cherokee County, the higher frequency of underweight babies delivered there leads to a lower cesarean delivery rate because cephalopelvic disproportion is encountered less often. The role of the relatively limited number of obstetricians in Cherokee County may also contribute to this finding, although the impact of this factor requires further study.

Measurement of the contributions of patient education level and affluence in the cesarean delivery equation represented an important challenge, and has frustrated epidemiologic efforts in other populations that sought to identify causes for cesarean delivery [5, 6]. The emerging concept of “cesarean delivery on maternal request” could also be a relevant factor, but as birth certificate data do not capture this as a recognized indication for cesarean delivery at present, the definitive answer remains elusive.

A comparison of operative vaginal delivery across the two regions was also performed, and important differences were identified. Choice of operative vaginal delivery method may be influenced by physician characteristics [7] including training and experience. For example, factors associated with operator preference for type of instrumental vaginal delivery (obstetrical forceps vs vacuum) has been studied previously [8, 9]. It may be that the number of physician providers in each county could contribute to the observed variance in operative vaginal delivery.

Our study anticipates further comparisons among larger groups in North Carolina, but was limited by several factors. The Basic Automated Birth Yearbook (BABY) databank (maintained by the North Carolina Department of Health & Human Services, Division of State Health Statistics) provides aggregate data only, and unfortunately is not presently configured for review of patient-level data. This rendered a more in-depth multivariate analysis of measured factors impossible and also made a robust statistical comparison between these two counties futile. The data also lacked sufficient detail to compare rate of multiple gestation, utilization of intrapartum anesthesia, frequency of maternal/neonatal blood transfusion, length of postpartum hospitalization, breastfeeding preference, or readmission within 48 hours of discharge. These parameters form the basis of further investigation at our institutions. Additionally, the source data could not identify how many pregnancies were established after ovulation induction, insemination, or advanced reproductive technologies. A higher *a priori* rate of primary cesarean delivery has been associated with antecedent infertility [10, 11] and could have impacted the cesarean delivery findings discussed above.

How could prenatal and perinatal care in these two North Carolina counties be improved? Having a database supporting a full range of statistical comparisons is vital for a definitive answer; at present this is not available in

North Carolina. Our descriptive study derived from aggregate data suggests that the rate of primary cesarean delivery in both counties (especially in Dare County) should be monitored and reduced. Institutional protocols are already in place to help achieve this objective. Furthermore, maternal tobacco use (particularly in Cherokee County) should be strongly discouraged and, if possible, eliminated. In this regard, the importance of antenatal smoking cessation counseling cannot be overstated. Previous investigators have demonstrated positive, enhanced clinical outcomes following implementation of a smoking cessation plan, particularly when initiated by the physician [12, 13]. With healthcare resources becoming acutely limited in these two counties and throughout North Carolina, cost savings resulting from such interventions would be especially welcome. Assessing the efficacy of these measures represents the aim of future studies.

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