PREDICTORS OF CESAREAN SECTION DELIVERY AMONG COLLEGE-EDUCATED BLACK AND WHITE WOMEN, DAVIDSON COUNTY, TENNESSEE, 1990-1994

Alicia O. Scott-Wright, MD, MPH, MTM&H, Tiffany Monique Flanagan, MD, and Ronald Matthew Wrona, PhD
Nashville, TN and Raleigh, NC

Cesarean section delivery increases the cost, morbidity, and mortality of childbirth. Cesarean section rates vary nationwide with the highest rates occurring in the southern United States. The Department of Health and Human Services has published year 2000 objectives that include a 15% reduction in the cesarean section rate. This study identified factors contributing to cesarean section delivery among a cohort of college-educated black and white women in Davidson County, TN. Logistic regression models were applied to Linked Infant Birth and Death certificate data from 1990-1994. Data on singleton first births for 606 black women and 3661 white women completing 16 years of education were analyzed. College-educated African Americans were at a significantly higher risk of cesarean section delivery than whites. This difference could not be accounted for by controlling for all other variables. The geographic differences in cesarean section rates in this country may be the result of varying in provider practice styles, perceptions, or attitudes. Improving the health of women and children will require establishing a system of maternity care that is comprehensive, case-managed, culturally appropriate, and available to all women. (J Natl Med Assoc. 1999;91:273-277.)

Key words: cesarean section ◆ college-educated mothers ◆ race

Cesarean section delivery increases the cost[1] of childbirth as well as the morbidity and mortality of mothers and babies.[2-5] The US Department of Health and Human Services has published objectives designed to improve the health of US citizens. These objectives include a

From the Department of Family and Preventive Medicine, Meharry Medical College, Nashville, TN, and the Department of Obstetrics and Gynecology, Wake Medical Center, Raleigh, NC. Requests for reprints should be addressed to Dr Alicia O. Scott-Wright, Health Resources and Services Administration, Office of Data and Information Management, 5600 Fishers Ln, Rockville, MD 20857.

reduction of the cesarean section delivery rate to no more than 15% by the year 2000.[6] Recent reports indicate that the US cesarean section rate has increased from 4.5% in 1965[7] to 21.8% in 1993.[8] According to the National Center for Health Statistics, abdominal delivery rates vary nationwide, with the highest cesarean section rates occurring in the southern United States.[9]

Epidemiologic studies have shown statistically significant associations between cesarean section delivery and older maternal age,[10-14] first births,[6,7] insurance coverage,[15-18] and births occurring in for-profit or nonteaching hospitals.[7,15] Research has identified higher cesarean section delivery rates among African-American mothers,[7,15,19,20] while other studies have not shown racial disparities in cesarean section rates.[11,21] The literature also indicates that women with higher education have lower

risk pregnancies but are at higher risk for abdominal deliveries.[22,23]

In 1989, Tennessee adopted revisions to its birth certificate recommended by the National Center for Health Statistics. These revisions consisted of a new checkbox format of collecting information for public health for the state of Tennessee. Data collected in the checkbox format includes maternal medical risk factors, labor and delivery complications, abnormal conditions of the newborn, obstetric procedures, delivery method, congenital anomalies of the newborn, maternal or infant transfer prior to or after delivery, maternal weight gain, and maternal use of alcohol, tobacco, or illicit drugs.

This study analyzes Linked Infant Birth and Death certificate data for the largest county in Tennessee and identifies factors that contribute to cesarean section delivery among a cohort of nulliparous college-educated women. Because of wide variations in cesarean section rates by geographic region, strategies to minimize operative deliveries should be guided by information gathered at the level at which these programs will be implemented.

MATERIALS AND METHODS

Linked Infant Birth and Death Files for Davidson County, TN were used to determine predictors of cesarean section delivery for infants of college-educated black and white women. Data on singleton first births from 1990-1994 were combined in this analysis. All information about the mother and infant were drawn from infant birth/death certificates. Records of mother-infant pairs in which mothers were at least 20 years of age, completed at least 16 years of education, delivered an infant in Davidson County, TN during the study period, had a recorded race of white or black, had a recorded method of delivery as either primary cesarean section or primary vaginal delivery, and reported no previous pregnancies were included. Records of mother-infant pairs were excluded if the infant was born <20 weeks of gestation, weighing <500 g or >6000 g, of twin or multiple births, or with lethal congenital anomalies. Mother-infants pairs also were excluded if either was transferred to or from another institution during the perinatal period.

Adjusted-odds ratios (OR) for cesarean section versus vaginal deliveries were calculated by stepwise logistic regression analyses using SAS software (SAS Inc, Cary, NC).[24] In logistic regression analyses, records were excluded if data were missing on any variable in the specific model under consideration. Ninety-five percent confidence intervals (CI) were computed,

and statistical significance was assessed. Infant mortality rates were calculated as the number of deaths of children aged <1 year per 1000 live births.

The following risk factors entered the modeling process as dichotomous variables: infant gender (male or female), maternal race (white or black), maternal age (20-29 years or ≥30 years), marital status (married or unmarried to father), tobacco use during pregnancy (yes or no), alcohol use during pregnancy (yes or no), trimester prenatal care began (first trimester or later than first trimester), newborn with a clinical estimate of gestational age <37 completed weeks (yes or no), and newborn weighing < 2500 g at birth (yes or no).

Both maternal medical risks and labor and delivery complications were included in statistical analyses as dichotomous variables as follows: maternal risk factors for the pregnancy, ie, anemia, cardiac, lung, or renal disease, active genital herpes, hydramnios, oligohydramnios, hemoglobinopathy, hypertension–chronic or pregnancy–induced, eclampsia, previous preterm, large or small for gestational age infant, Rh sensitization, uterine bleeding, all others (any factor present or all factors absent), complications of labor and deliver, ie, febrile mother, presence of moderate-to-heavy meconium, premature rupture of membranes, abruptio placenta, placenta previa, other excessive bleeding, precipitous labor, prolonged labor, dysfunctional labor, breech, malpresentation, cephalopelvic disproportion, cord prolapse, anesthetic complications, fetal distress, and all others (any factor present or all factors absent).

To allow for linear or nonlinear associations with cesarean section, the following risk factors entered the modeling process both as continuous variables and as stratified nonlinear variables: maternal and paternal age and years of education, clinical estimate of gestational age, and birthweight.

Poorly ascertained factors, ie, weight gain during pregnancy or maternal illicit drug use during pregnancy, or factors with unclear associations to cesarean section versus vaginal delivery, ie, abnormal conditions of the newborn, congenital anomalies, or obstetric procedures, were not included in these analyses.

RESULTS

After excluding records with missing data on maternal years of education, age, parity, or race, as well as records coding lethal congenital anomalies and transfers between hospitals (<3% of records excluded), there were 4267 first-born singleton infants to black or white women at least 20 years of age and completing at least 16 years of education. Singleton first births in this

college-educated subsample represented 44.5% of all births to college-educated black or white women in Davidson County during the five-year study.

Characteristics of the study population by maternal race based on Davidson County, TN linked birth and death files from 1990-1994 are summarized in Table 1. Mean maternal years of schooling were 16.3 (SD=0.52) years. Mean maternal age was 29.1 (SD=3.99) years. There were differences between the 606 black and 3661 white mothers in the subsample. Compared with white mothers, black mothers were more likely to be younger, unmarried, and to begin prenatal care after the first trimester. African-American women had significantly more complications during labor and delivery, delivered almost four times more newborns weighing <2500 g, and were more than twice as likely to give birth to an infant of low gestational age (<37 weeks) compared with white women. The unadjusted infant mortality rate was 18 per 1000 for blacks and 1 per 1000 for whites. Unadjusted cesarean section rates differed markedly by race (31% for blacks versus 21.3% for whites).

Unadjusted rates for maternal medical risk factors were not significantly different (18.2% for blacks and 15.4% for whites). Tobacco and alcohol use during pregnancy was also comparable but too small for further statistical analyses.

Data on the father's age, race, and number of completed years of education was available on 97%, 96.2%, and 97% of records, respectively. Mean paternal age was 31.15 (SD=5.24) years; 99.2% of men were married to women of the same race. Mean paternal years of schooling completed was 15.57 (SD=1.7). Paternal age and years of education completed were not significantly different between blacks and whites. Paternal age, race, and education when added to the logistic model contributed insignificant coefficient parameter estimates. These variables were eliminated from the final logistic model.

Table 2 provides odds ratios for cesarean section versus vaginal delivery after adjustment for educational level beyond college, maternal race, maternal age, marital status, infant gender, trimester prenatal care began, presence of any maternal medical risk, presence of any complication of labor and delivery, presence of low birthweight infant (<2500 g), presence of low gestational age infant (<37 weeks gestation), and infant survival outcome after one year.

Significant independent predictors of cesarean section were: presence of any complication of labor and delivery (OR=19.31; 95% CI=15.87-23.47), presence of any maternal medical risks (OR=1.89; 95% CI=1.50-2.38),

Table 1. Selected Characteristics of Nulliparous College-Educated Black and White Mothers, Davidson County, Tennessee, 1990-1994, by Maternal Race*

Characteristic	% Black	% White
Maternal age (yr)		
20-24	22.2	9.2
25-34	67.2	80.8
≥35	10.6	10.0
Marital status		
Married	64.2	95.7
Unmarried	35.8	4.3
Any tobacco use?		
Yes	2.0	2.3
No	98.0	97.7
Any alcohol use?		
Yes	0.0	0.2
No	100.0	99.8
Trimester prenatal care began		
First trimester	92.2	98.3
After first trimester	7.8	1.7
Any maternal medical risks?		
Yes	18.2	15.4
No	81.8	84.6
Any complications of labor and delivery?		
Yes	41.7	34.4
No	58.3	65.6
Newborn <2500 g?		
Yes	13.2	3.7
No	86.8	96.3
Newborn <37 weeks gestation?		
Yes	13.3	6.4
No	86.7	93.6
Infant survived first year of life?		
Yes	98.2	99.9
No	1.8	0.1
Vaginal delivery?		
Yes	69.0	78.7
No	31.0	21.3

*Total births=4267; black births=606; and white births=3661.

African-American mother (OR=1.78; 95% CI=1.36-2.32), and maternal age ≥30 years (OR=1.31; 95% CI=1.10-1.56).

DISCUSSION

In this study population, college-educated African-American mothers were at a significantly higher risk of cesarean section delivery than white mothers. This find-

Table 2. Adjusted Odds Ratios for Cesarean Section Among Nulliparous College-Educated Black and White Mothers, Davidson County, 1990-1994

Characteristic	Odds Ratio* (95% CI)
Maternal race	
Black	1.78 (1.36-2.32)
White†	1.00
Maternal age (yr)	
20-29†	1.00
≥30	1.31 (1.10-1.56)
Marital status	
Married†	1.00
Unmarried	1.33 (0.95-1.87)
Trimester prenatal care began	
First trimester†	1.00
Later than first trimester	1.68 (0.93-3.03)
Any maternal medical risks?	
Yes	1.89 (1.50-2.38)
No†	1.00
Any complications of labor and delivery?	
Yes	19.31 (15.87-23.47)
No†	1.00
Newborn <2500 g?	
Yes	1.04 (0.66-1.65)
No†	1.00
Newborn <37 weeks gestation?	
Yes	1.08 (0.72-1.61)
No†	1.00
Infant survived first year of life?	
Yes†	1.00
No	1.54 (0.42-5.61)

*The odds ratios for cesarean section were adjusted for all other variables in the model.
†Reference stratum.

ing could not be accounted for by differences in level of educational achievement beyond college, marital status, parity, infant gender, birthweight or gestational age of the infant, trimester prenatal care began, or by the other significant independent predictors of cesarean delivery, presence of any complication during labor and delivery, presence of any maternal medical risk factor, and maternal age >30 years.

Although this study does not identify causal associations between race and abdominal delivery, it raises concerns that nonclinical factors may influence decisions to perform cesarean sections and that black race may be such a nonclinical factor. The wide geographic

differences in cesarean section delivery rates in this country may actually be the result of variances in provider practice styles, perceptions, or attitudes. Goyert et al,[24] using multivariate statistical analyses to assess determinants of cesarean birth in a population of affluent low-risk women, found that only nulliparity was more important than the identity of the physician in determining the delivery method. Epidemiologic studies also have found that the practice patterns of nurse midwives favorably influence vaginal delivery over operative delivery.[25,26]

High maternal educational attainment has been associated with healthy lifestyle choices.[27,28] In choosing our study population, we theorized that college-educated expectant mothers were motivated consumers who could be targeted for prevention/intervention programs that address the paradox of high cesarean section delivery rates among women at low medical risk. Standardized report cards using validated race-specific adjusted cesarean section rates for local providers and hospitals should be available to consumers. This dissemination of information may encourage providers to adopt those practice patterns that result in lower cesarean section rates without declines in the health of women and their babies.

There are limitations in using birth-certificate data. Piper et al[29] compared data obtained from 1989 Tennessee birth certificates with data from a case-control study in which hospital medical records of mothers and infants reviewed by trained abstracters. This validation study concluded that the coding of descriptive demographic data, birthweight, gestational age within one week, trimester prenatal care began, tobacco use during pregnancy, and delivery method whether primary vaginal or primary cesarean was generally reliable and accurate.

Concordance rates between birth certificate and medical record data ranged from 65% for the variable trimester prenatal care began to >95% for descriptive demographic data and primary method of delivery. Coded information on complications of labor and delivery and maternal medical risks was found to be underreported, particularly when more than one complication or maternal risk was present. Since specific maternal medical risk factors and complications of labor and delivery were not mutually exclusive and were judged to be underreported, we did not estimate the contribution of each subcategory to cesarean delivery.

The wide racial disparity in unadjusted infant mortality rates (infant survival outcome in one year, Table 1) bears mention. We[30] previously found preterm deliv-

ery significantly contributed to infant mortality in college-educated mothers in Tennessee.

CONCLUSION

This analysis of birth certificate data demonstrates that the presence of any complication of labor and delivery, any maternal medical risk factor, older maternal age, and black race were significant independent predictors of primary cesarean section among nulliparous college-educated women in Davidson County, TN. Continued efforts are necessary to improve the accurate reporting of maternal medical risks and complications of labor and delivery on birth certificate data so that specific subcategories contributing to cesarean delivery may be identified. Geographic variations in cesarean section delivery rates may be a result of differences in provider practice patterns. Improving the health of women and children will require establishing a system of maternity care that is comprehensive, case-managed, culturally appropriate, and available to all women. Open channels of communication between prospective mothers and providers including a discussion of race-specific cesarean section rates should form the cornerstone for programs aimed at decreasing cesarean section delivery in Davidson County, TN.

Literature Cited

1. Mushinski M. Average charges for uncomplicated cesarean and vaginal deliveries: United States, 1993. *Statistical Bulletin.* 1994;75:27-36.
2. National Institutes of Health Consensus Development Task Force. NIH Consensus Development Task Force statement on cesarean childbirth. *Am J Obstet Gynecol.* 1981;139:902-909.
3. Bashore RA, Phillips WH, Brinkman CR. A comparison of the morbidity of forceps and cesarean delivery. *Am J Obstet Gynecol.* 1990;162:1428-1435.
4. Miler JM. Maternal and neonatal morbidity and mortality in cesarean section. *Obstet Gynecol Clin North Am.* 1988;15:629-638.
5. Bryan H, Hawrylshyn P, Hogg-Johnson S, et al. Perinatal factors associated with the respiratory distress syndrome. *Am J Obstet Gynecol.* 1990;162:476-481.
6. Public Health Service. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives-Full Report with Commentary.* Washington, DC: Government Printing Office; 1991. DHHS publication PHS 91-50212.
7. Pacek PJ, Taffel S, Moien M. Cesarean section delivery rates: United States, 1981. *Am J Public Health.* 1983;73:861-862.
8. Centers for Disease Control and Prevention. Rates of cesarean section delivery-United States, 1993. *Morb Mortal Wkly Rep.* 1995;44:303-307.
9. Clarke SC, Taffel SM. State variation in rates of cesarean and VBAC delivery: 1989 and 1993. *Statistical Bulletin.* 1996;77:28-36.
10. Gould JB, Davey B, Stafford RS. Socioeconomic differences in rates of cesarean section. *N Engl J Med.* 1989;321:233-239.
11. Williams RL, Chen P. Controlling the rise in cesarean section rates by the dissemination of information from vital records. *Am J Public Health.* 1983;73:863-867.
12. Peipert JF, Bracken MB. Maternal age: an independent risk factor for cesarean delivery. *Obstet Gynecol.* 1990;81:200-205.
13. Gordon D, Milberg J, Daling J, Hickok D. Advanced maternal age as a risk factor for cesarean delivery. *Obstet Gynecol.* 1991;77:493-497.
14. Turcot L, Marcoux S, Fraser WD, the Canadian Early Amniotomy Study Group. Multivariate analysis of risk factors for operative delivery. *Am J Obstet Gynecol.* 1997;176:395-402.
15. Stafford RS, Sullivan SD, Gardner LB. Trends in cesarean section use in California, 1983-1990. *Am J Obstet Gynecol.* 1993;168:1297-1302.
16. Stafford RS. Cesarean section use and source of payment: an analysis of California hospital discharge abstracts. *Am J Public Health.* 1990;80:313-315.
17. Zahniser SC, Kendrick JS, Franks AL, Saftlas AF. Trends in obstetric operative procedures, 1980-1987. *Am J Public Health.* 1992;82:1340-1344.
18. Stafford RS. The impact of nonclinical factors on repeat cesarean section. *JAMA.* 1991;265:59-63.
19. Braverman P, Egerter S, Edmonston F, Verdon M. Racial/ethnic differences in the likelihood of cesarean delivery, California. *Am J Public Health.* 1995;85:625-630.
20. Thom MH, Chan KK, Studd JW. Outcome of normal and dysfunctional labor in different racial groups. *Am J Obstet Gynecol.* 1979;135:495-498.
21. Irwin DE, Savik DA, Bowes WA, St Andre KA. Race, age and cesarean delivery in a military population. *Obstet Gynecol.* 1996;88:530-533.
22. Taffel SM. Cesarean delivery in the United States, 1990. *Vital Health Stat 21.* 1994:51:1-24.
23. King DE, Lahiri K. Socioeconomic factors and the odds of vaginal delivery after cesarean delivery. *JAMA.* 1994;272:524-529.
24. Goyert GL, Bottoms SF, Treadwell MC, Nehra PC. The physician factor in cesarean section birth rates. *N Engl J Med.* 1989;320:706-709.
25. Butler J, Abrams B, Parker J, Roberts JM, Laros RK. Supportive nurse-midwife care is associated with a reduced incidence of cesarean section. *Am J Obstet Gynecol.* 1993;168:1407-1413.
26. Davis LG, Riedmann GL, Sapiro M, Minogue JP, Kazer RR. Cesarean section rates in low-risk private patients managed by certified nurse-midwives and obstetricians. *J Nurse Midwifery.* 1994;39:91-97.
27. Berger MC, Leigh JP. Schooling self-selection and health. *Journal of Human Resources.* 1989;24:433-455.
28. Kenkel DS. Health behavior, health knowledge, and schooling. *Journal of Political Economy.* 1991;99:287-305.
29. Piper JM, Mitchel EF, Snowden M, Hall C, Adams M, Taylor P. Validation of 1989 Tennessee birth certificates using maternal and newborn hospital records. *Am J Epidemiol.* 1993;137:758-768.
30. Scott-Wright AO, Wrona RM, Flanagan TM. Predictors of infant mortality among college-educated black and white women, Davidson County, Tennessee, 1990-1994. *J Natl Med Assoc.* 1998;90:477-483.