CHANGING RATES OF LOW-RISK CESAREAN DELIVERIES IN THE U.S.: CLASSIFICATION, RACE/ETHNICITY AND OTHER FACTORS*

W. Parker Frisbie†
Sarah McKinnon†
Seung-Eun Song†
Robert A. Hummer†

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† The University of Texas at Austin

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Contact Information:
W. Parker Frisbie
Population Research
1 University Station, G1800
The University of Texas
Austin, TX 78512
Email: frisbie@prc.utexas.edu

ABSTRACT

Increasing rates of cesarean deliveries in the U.S., especially among low-risk women, continue to be of concern. Unfortunately, the call for additional research on C- section differentials by race/ethnicity has gone largely unheeded. Our objectives are to trace 1991-2002 trends in cesarean deliveries for low-risk women separately for first-birth and multiparous low-risk pregnancies among six race/ethnic groups using two sets of characteristics that have been used to categorize pregnancies as low-risk, and to model the risk of surgical deliveries for all women over time, using NCHS birth records. C-section rates increase over time for both first-birth and multiparous women for each race/ethnic group, and non-Hispanic black women consistently have the highest rates. However, the trajectory varies depending on the criteria employed to denote low-risk women. Regression models indicate that the likelihood of a cesarean is typically greater among minorities than that for non-Hispanic whites.

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INTRODUCTION

Pregnancy outcomes have long been of interest to demographers (Frisbie 2005). With a few important exceptions (e.g., Hopkins 2000; Potter et al. 2001), demographic attention has focused very heavily on infant mortality and birth outcomes (birth weight, gestational age, and fetal development), and left the topic of mode of delivery to epidemiological, public health, and/or medical researchers. Yet, as Menacker observed in a recent National Vital Statistics Report, "(l)owering the cesarean rate in the United States has been a goal for the past 25 years" (2005: 1). Lowering the C-section rate is important because of maternal and neonatal risks that attach to this procedure and the costs, both human and financial, when risk becomes reality. Among the maternal morbidities associated with surgical deliveries are uterine hemorrhage and injury to the urinary tract. The rate of rehospitalization of the mother is 80% higher for women who have a cesarean delivery as compared to a vaginal delivery (Mawson 2002), and "(s)carring of the uterus can lead to decreased fertility, miscarriage, ectopic pregnancy, placenta abruption, and placenta previa" (Mawson 2002:731). Moreover, "the maternal mortality rate associated with cesarean delivery is 3-7 times greater than that associated with vaginal delivery" (American College of Obstetricians and Gynecologists [ACOG] 2000: 5).

The infant mortality rate (IMR) is also higher following a cesarean, as compared to a vaginal delivery. But, of course, complications of pregnancy and delivery create both a higher risk of maternal and infant morbidity or death, and the need for cesarean delivery. Nevertheless, surgical delivery is associated with Respiratory Distress Syndrome (one of the leading causes of infant mortality) and, without the onset of labor "may contribute to transient tachypnea of the newborn, a condition that often requires intensive care treatment" (American College of Obstetricians and

Gynecologists [ACOG] 2000: 6). [1] A cesarean delivery may also lead to a "substantially increased need for and degree of resuscitation" and lower Apgar scores (Mawson 2002:731).

A third concern is that some research has found race/ethnic disparities in cesarean rates. It has been reported in a study of California birth records that, while unadjusted rates showed blacks to be at lower risk than whites of surgical delivery, in multivariate analysis "Black women were 24% more likely to undergo cesarean deliveries than were Whites" (Braverman et al. 1995). The same finding applied to U.S-born Latinas, although the disparity between the latter group and white women that emerged in the multivariate analysis was considerably less than that between blacks and whites.

The attempt to reduce cesarean rates which, overall, have been increasing in the United States for many years (Declercq, Menacker, and MacDorman 2006), has recently gained impetus for at least two reasons. First, the goals for the rate established in the *Healthy People 2010* report (U.S. Department of Health and Human Services [DHHS] 2000) will almost surely not come close to being realized. For first births, the target rate was set at 15%, but based on 2003 data, the actual rate was 24%. The target for repeat cesarean births (63%) was far exceeded in 2003 when the actual rate was close to 90% (Menacker 2005). Second, there appears to have been a reversal of progress. Menacker reports that, after many years of increases, the proportion of primiparas that were surgically delivered declined slightly, but monotonically, from 23.9% in 1990 to 21.2% in 1996. However, by 1997, the decline had ceased, and by 2003 the rate had risen to 27.1%. The same trend occurred for repeat cesareans with the latest officially reported rate being 89.4%. The percentages

[1] Tachypnea is the clinical term for "very rapid breathing" (*Steadman's Medical Dictionary* 1976:1400).

for all cesarean births were 22.7%, 20.7%, and 27.5% in 1990, 1996, and 2003, respectively (Menacker 2005: 3).

The primary indication for surgical delivery of first births in the U.S. is dystocia, "defined as difficult labor or childbirth," although in some instances a C-section is needed due to inefficient uterine contractions (ACOG 2000: 20). But this definition is very general in nature, and "difficult labor or childbirth" can result from many different conditions. Among the specific reasons for the decision to perform a cesarean delivery are malpresentation (e.g., breech birth), macrosomia (often defined as an infant weighing 4000 grams or more), and plural births (ACOG 2000; Menacker 2005).

Because the relative frequency of repeat C-sections is so high, and perhaps even more important, because "the highest variation occurs among nulliparous patients with term singleton fetuses with vertex presentations without other complications" (ACOG 2000: 1), recent research on this topic has concentrated on first births. In addition, there is a growing focus on "low-risk women"—i.e., women whose pregnancies are full-term (gestation of 37 weeks or more), not plural, and are characterized by vertex presentation (head of the fetus in a downward position). These three factors seem to be the most frequently used criteria for distinguishing low-risk women (e.g., see Declercq, Menacker and MacDorman 2006 and Menacker 2005); hence, we refer to them as "conventional" criteria.

A recent study (MacDorman et al. 2006) of the effect of cesarean deliveries on infant mortality used more stringent criteria for classification as low risk by additionally requiring that gestational age be 37-41 weeks, that the woman be without medical risks (such as diabetes, eclampsia, uterine bleeding, anemia, previous preterm births, etc.), and that there be no delivery complications. For multiparous women, one additional criterion was added, viz., no history of a

previous cesarean delivery (MacDorman et al. 2006). (The "no previous cesarean" requirement obviously does not apply in the case of first births.)

RESEARCH OBJECTIVES

Despite the growing concern over cesarean deliveries and the reversal of what appeared to be a temporal trend toward lower cesarean rates, we were able to find only two studies that examined the risk of surgical deliveries across race/ethnic groups over time. Research based on the National Hospital Discharge Survey (NHDS) examined cesarean deliveries for 1979-2004 (Joesch, Gossman, and Tanfer 2007). This is a very useful study, but the authors were able to distinguish only two race/ethnic groups: African Americans and Caucasians, plus an all other residual. Further, the outcome of interest in multivariate models was narrowly defined as a primary cesarean delivery prior to labor (a logical extension of earlier work on maternal requests for cesarean deliveries [Gossman, Joesch, and Tanfer 2006]).

A highly informative study by Braverman et al. (1995) modeled cesarean deliveries for several race/ethnic groups, but for only one state (California) for only one year. In most comparisons, they found that blacks were at a greater risk, and Hispanics and Asians (with a focus on the foreign-born) were at a lower risk, than whites of a surgical delivery. But this study did not take into account trends over time and did not include multiparous women. Also, it is unclear whether the findings for California are generalizable to the nation as a whole. Notably, Braverman et al. call for "further research that more directly examines …nonclinical characteristics—particularly race/ethnicity…" (1995: 630). Motivation for the present research is increased because, to our knowledge, no such studies have been forthcoming.

Accordingly, our general objective is to model the likelihood of cesarean deliveries for low-risk women for all births recorded in the U.S., by race/ethnicity, over a time period that includes the

decline, followed by an increase, in the likelihood of cesarean births. We place special emphasis on first births. However, consonant with much previous research, we compare findings for first births with those among multiparous women. More specifically, our aims include separately tracing trends in surgical delivery for first births and later births from 1991 through 2002 for six race/ethnic groups: non-Hispanic white (NHW), non-Hispanic black (NHB), Mexican origin, [2] Other Hispanic, non-Hispanic Asian and Pacific Islander (NHAPI), and non-Hispanic American Indian (NHAI). We attempt to account for as much variability as possible in the outcome variable and also to determine whether there are disparities in risk of cesarean section across the several race/ethnic groups, net of the effects of control variables.

DATA AND METHOD

Data

Our data set consists of all recorded births that occurred in the U.S., made available by the National Center for Health Statistics (NCHS) for the years 1991 through 2002. We use the birth records from the Linked Cohort Birth/Infant Death files for all years except the 1992-1994 period. No linked files were produced by NCHS for 1992-1994, so for that time period we use the NCHS Natality files. Although advance reports have appeared that include data for later years (e.g., Menacker 2005), as of this writing, we had not obtained and archived the files for years beyond 2002. The data contain millions of births for each year, (thereby allowing multivariate analysis of small race/ethnic groups), along with information on the variables needed to designate low-risk births, and a set of covariates thought to impact the risk of cesarean deliveries. Infants recorded as weighing less than 500 grams are omitted because of the concern that many of these cases represent misclassified stillbirths or errors in recording birth weight. Unfortunately, the files contain no data

[2] We use the term "Mexican origin" to refer to persons who are U.S.-born Mexican Americans, as well as those who are Mexican immigrants.

on whether the woman had health insurance, and the only indicator of socioeconomic status available on birth certificates is maternal education.

Methods

We conduct parallel analyses that use different schemes for identifying low-risk pregnancies. In one analysis, we employ the three criteria used by Menacker (2005), viz., singleton birth, full term pregnancy (37+ weeks), and no malpresentation. In the second, and more stringent, classification, the criteria are singleton births, with gestation of 37-41 weeks, birth weight less than 4000 grams, and no malpresentation among women with no medical risks and who experience no complications of delivery. For both classifications, we add the requirement of no previous cesarean deliveries for multiparous women. Application of the latter criterion means that the rates we compute for multiparous women will be much lower than those found in official governmental reports.

Cases are categorized according to maternal race/ethnicity (Rogers 1989). Births to women not classified as one of the six race/ethnic groups listed above are excluded. Measurement of the control variables, which include maternal age, marital status, nativity, maternal education, prenatal care, and maternal smoking, is straightforward for the most part (as can be seen in the regression tables). But note that prenatal care (PNC) is measured by application of Kotelchuck's Access to Prenatal Care Utilization (APNCU) index (Kotelchuck 1994a, 1994b), which takes into account gestational age and adds a category for women who have more than the number of PNC visits recommended by the American College of Obstetricians and Gynecologists. The latter, "adequate plus," category contains a disproportionately large number of problem pregnancies. The distributions of the control variables are not shown in this paper, but are available upon request.

First, we follow trends for low-risk pregnancies over time and by race/ethnicity for both first-birth and multiparous mothers, with the rates of cesarean delivery calculated separately based on the

two methods of identifying low-risk births. Then, in order to more rigorously assess race/ethnic effects and to determine whether there are any differences that may exist by race/ethnicity or by use of different strategies for defining low-risk births, we conduct a set of multivariate logistic regressions for all women who gave birth in this country from 1991 through 2002, with results presented in the form of odds ratios. The risks for first-birth and multiparous women are modeled separately. In the two sets of regressions, the baseline model contains only race/ethnicity as a predictor, following which other covariates are added progressively. The second model adds a temporal dimension by including the time periods 1991-1993, 1994-1996, 1997-1999, and 2000-2002. The three conventional criteria for identifying low-risk births are added in Model 3. Model 4 increments the model by including additional criteria for low-risk births used by MacDorman et al. (2006). The full model adds a set of control variables (listed above) that are often used in crosstabulations in studies of cesarean deliveries. The outcome for the two sets of regressions is a dichotomy, with non-surgical births coded 0 and cesarean births coded 1.

Fortunately, the amount of missing data is quite small for the items needed to define low-risk births. For example, in 1991, the percent missing ranges from one-tenth of one percent for birth weight to 3.03% for maternal medical conditions among NHW women. The amount of missing data declines over time—the percent of cases with missing data for NHWs ranges from 0.03% to 0.79% for birth weight and maternal medical conditions, respectively, in 2002. The greatest amount of missing data occurs for the Mexican origin population. In 1991, the range is from one-tenth of one percent (birth weight) to 6.0% for maternal morbidities. However, by 1992, information on the latter variable was missing for only 3.9% of women of Mexican origin, and improvement continued for all groups. However, two control variables, viz. maternal education and smoking, present a problem. California does not report information on whether the mother smoked, and a number of other states

do not report (or do not fully report) data on smoking for certain years during the time period selected for the analysis. For example, New York State also does not report maternal smoking, but data on this covariate are available for New York City. Compared to smoking, there is relatively little missing data on maternal education. Still, the percent of birth certificates lacking information on education is slightly over 6% for NHAPI and NHAI women in 1991 (after which coverage is much improved). Inasmuch as maternal education is the only measure of socioeconomic status (SES) available to us, we believe the missing data issue also needs to be addressed directly for this variable. Our approach was to include a category for missing data for both smoking and education—a strategy that has proven useful in earlier research (Frisbie, Forbes, and Hummer 1998; Singh and Yu 1996).

Because our data set consists of virtually all births, the conventional reason for use of tests of statistical significance, i.e., assessing the probability of error in generalizing from a sample to a population, has little relevance. Hence, the greatest emphasis is placed on the direction and magnitude of the estimated odds ratios. Nonetheless, tests of significance retain utility "in order to rule out the simple 'chance processes' alternative" (Blalock 1979: 242).

DESCRIPTIVE RESULTS

Tables 1 and 2 both use the three conventional criteria for denoting low-risk women. Table 1 shows the percentage of cesarean deliveries for first births, and Table 2 presents analogous percentages for multiparous women. Several notable results emerge from comparisons within and between Tables 1 and 2. The greatest difference between the two tables is that the percentages of deliveries by cesarean section are four to five times higher among women giving birth for the first

time. [3] Second, even though we collapsed the years from 1991 through 2002 into four three-year categories, the curvilinear trend demonstrated by Menacker based on single years is easily discernable. For example, among NHWs in Table 1, the percentage of cesarean deliveries dropped from 20.61% during the first time period to 18.42% in 1994-96, then rose slightly to 18.48% in 1997-1999, and increased again to 21.38% in the latest time period. Among NHBs, the cesarean rate in 1991-93 was 22.39%, then declined to roughly 21% in the two middle time periods, but rose to 24.31% in 2000-2002. Indeed, a curvilinear trend is observable for first-birth, low-risk women for every race/ethnic group. It is also the case that the rate of cesarean births was higher in 2000-2002 than in 1991-1993 for every race/ethnic group. Differentials exist across the race/ethnic groups in Table 1, but all differences are small to moderate. Blacks, without exception, have the highest rates for every time period, and NHAIs always have the lowest rates. The largest disparity is seen in the latest time period in which the difference is over five percent between NHBs (24.31%) and NHAIs (18.97%). The rates for the other race/ethnic groups are fairly similar within each time period, with differences typically being on the order of one percent.

Although the rates are much lower, exactly the same temporal patterns are evident for multiparous women (Table 2) as for mothers giving birth for the first time (Table 1). That is, the percentage of cesarean deliveries first declines and then increases over time. And, once again, the percentages were higher in the latest time period than at the earliest time period for every race/ethnic group. NHBs again always have the highest rates and, with one very minor exception, NHAIs have the lowest rates of cesareans. The exception occurs in 1994-1996 for multiparous women, when NHWs (3.84%) and NHAIs (3.74%) are in a virtual tie for the lowest rates.

[3] Note that when C- section rates are computed for all women (as opposed to low-risk women), the differentials between first-birth and multiparous women are much less regardless of whether computations are carried out by race/ethnicity or for all women giving birth.

--Tables 1 and 2 about here--

Application of the more stringent criteria (Tables 3 and 4) produces results that are different in at least two ways—one expected and one not anticipated. Not surprisingly, the percentages of cesarean deliveries are much lower, especially for first-birth women (Table 3), as compared to their counterparts in Table 1. When we add the additional criteria for an expectant mother to be placed in the low-risk category, by (operational) definition, cesarean deliveries become much less likely. The same pattern holds for multiparous women in Table 4 as compared to their counterparts in Table 2, although the relatively low percentages of C-sections in this group of women means that the differentials between the rates in Table 2 and Table 4 are smaller.

The curvilinear time trend disappears when the additional criteria for low risk are added. Over time, for every race/ethnic group, there is a monotonic increase in the percentage of cesarean deliveries in Tables 3 and 4. Thus, based on simple cross-tabulations, conclusions concerning temporal trends are different when low-risk is operationalized using different classification schemes. On the other hand, the race/ethnic patterns (although not the magnitudes) of variation by race/ethnicity are quite similar in Tables 3 and 4 to those observed in Tables 1 and 2. Among multiparous women, for all time periods, NHBs have the highest rates and NHAIs have the lowest rates of surgical deliveries among both first-birth and multiparous women. NHW women have lower rates than do the other three minorities, which are rather tightly bunched in the middle ground.

--Tables 3 and 4 about here--

In summary, it is clear that cesarean rates have continued to rise in the U.S. Although the curvilinearity observed for single years appears only in Tables 1 and 2, this should not be taken as evidence that the conventional classification is superior. After all, we collapsed the 12 years of data into four time periods, and the downward inflection was, in any event, fairly small. Also, the

percentage of low-risk births delivered by cesarean section declined by only a little over two percent between from 1991 to 1996, while the increase from 1996 to 2002 was 6.4% (Menacker 2005). Cesarean rates were consistently highest for NHB women and consistently lowest for NHAI women. It remains to be seen whether the descriptive findings persist in the multivariate analysis.

MULTIVARIATE ANALYSIS

Tables 5 and 6 present odds ratios (ORs) showing the relative risk of cesarean deliveries for all women giving birth for the first time and for multiparous women, respectively. Each table contains five models with variables (or blocks of variables) added progressively as described in the Methods Section. Heretofore, we have referred to conventional and more stringent criteria used to categorize women as low-risk. Inasmuch as the logistic regression encompasses all women who gave birth from 1991 through 2002, a semantic problem arises. In the regressions, the "low risk criteria" are expected to be very strong predictors of the mode of delivery, and are analyzed as risk factors in exactly the same way as the control variables. Therefore, in discussing the multivariate results, we use the term "proximate risk factors" to designate the variables employed in the descriptive analysis to designate low-risk women. The controls are viewed as exogenous risk factors and are referred to simply as control variables.

First-Birth Women

Among first-birth women, the baseline model shows that Mexican origin, NHAPI, and NHAI women are less likely to have a surgical delivery, compared to NHW women (Table 5). The risk for Other Hispanic women is identical to that of NHW women, while NHB women are slightly more at risk (OR = 1.034). When time period is added in Model 2, only slight changes in the estimates for the race/ethnic groups occur. Note, however, that the ORs for time period pick up the curvilinear trend seen in the descriptive data. That is, the risks of a cesarean for first-birth women in the two

middle time periods are less than 1.0, while the OR for 2000-2002 is greater than one. This pattern persists in all models.

The three conventional proximate risk factors are added to the equation in Model 3. Each is associated with an increase in the likelihood of a C-section. As was to be expected, malpresentation has far and away the strongest impact. Once again, the changes in the ORs for the race/ethnic variable are relatively small, although the risk for NHB women increases modestly (OR = 1.141), and the risk becomes slightly greater among Other Hispanic women, relative to their NHW counterparts. [4] Each of the more stringent proximate risk factors (added in Model 4) increments the likelihood of a cesarean delivery. Notably, the ORs for four of the race/ethnic groups increase and are greater than 1.0 in Model 4. To illustrate, NHB women are about 24% (OR = 1.243) more apt to have a cesarean delivery in Model 4 as compared to an OR of 1.141 in Model 3. The likelihood of a C-section for NHAI women is lower in Model 4 than it is in all previous models.

--Table 5 about here--

In the full model that includes all the control variables (Model 5), the risk of a cesarean for NHBs increases substantially (OR = 1.558). This result coincides with Braverman et al. (1995) who found that, with controls, the risk of a cesarean was greater for NHB women than for NHW women (based on 1991 California records). In our data, we also observed relatively small increases in risk among Mexican origin, Other Hispanic, and NHAI women (although the OR for the latter group remains below unity), while the risk declines a bit for NHAPI women. Over time, the decrease, followed by a rebound, in the risk of surgical delivery remains clearly evident. The magnitude of the odds ratios associated with conventional and stringent proximate risks show little change in Model 5 compared to Model 4, although there is a minor change in the effect of preterm birth. In Model 4,

[4] Race/ethnic comparisons are always relative to NHW women. Thus, with few exceptions, phrases such as "relative to NHW women" or "compared to NHW women" are not repeated.

this variable is associated with a four percent greater risk of a cesarean delivery. In Model 5, the effect of preterm birth was not significant (OR = 0.998).

Lower levels of education, birth in the U.S., older maternal age, and smoking increase the likelihood of a C-section. That the same is true of the estimate for women receiving adequate plus PNC is unsurprising inasmuch as this category typically denotes problem pregnancies. Unmarried women and those with less than adequate PNC are less apt to deliver by cesarean section. The odds ratios associated with the control variables are small (with the exception of older maternal age). This is as one would anticipate because, by and large, the controls influence the outcome of interest only indirectly—i.e., through the more proximate risks, which have already been taken into account before the controls enter the equation.

Perhaps the most striking finding from Table 6 is that, when control variables are added in Model 5, the risk of a cesarean delivery increases for four of the race/ethnic minorities. To illustrate, the OR among NHB women increases from 1.243 in Model 4 to 1.558 in Model 5. The risk for NHAI women also evidences a sharp increase. In Model 4, this group of women is about 23% less apt to deliver by C-section, as compared to NHW women. In Model 5, the risk for NHAI women is only three percent lower. These findings are consonant with the study by Braverman et al. (1995) of the effects of sociodemographic factors among first-birth women giving birth to singletons. Thus, the results in Table 5 suggest that the findings of Braverman and colleagues for California are generalizable to the entire U.S.

Multiparous Women

There are a number of similarities in the results for first-birth and multiparous women. However, the results for the latter group of women differ in a few, but nonetheless important, respects (Table 6). In Model 1 of Table 6, it is once again the case that race/ethnic effects are small,

and that Mexican Origin, NHAPI, and NHAI women are less apt to have a surgical delivery--with NHAI women again estimated to be at a lower risk than any other group. However, the chance of a cesarean section among Other Hispanic women slightly exceeds that of NHB women. Just as among first-birth women, (but differing from the descriptive analysis), a curvilinear pattern in the risk of cesareans over time emerges for multiparous women (Model 2). Once again, the addition of the time period variable has little effect on the race/ethnic odds ratios. Other similarities in Table 6, as compared to Table 5, are that each of the conventional proximate risks is related to an increase in the risk of cesarean delivery (Model 3), and when the stringent proximate risks enter the equation, the effects of the conventional proximate risks are amplified (Models 4). Given the fact that nearly 90% of women who have had a C-section delivery for a previous birth have a repeat C-section for a subsequent birth, the huge OR associated with previous cesarean delivery is not surprising.

--Table 6 about here--

In Table 6, just as in Table 5, it is in Model 4 that we first see a substantial upturn in the risk of a surgical delivery for all race/ethnic groups, save for NHAI women. But when the control variables are added, only among NHB and NHAI women does a further increase in the odds occur. In fact, the risk of a cesarean delivery, which was about 9% greater (OR = 1.089) for NHAPI women in Model 4 of Table 6, is reversed such that the risk is smaller (OR =0.951) than that for their NHW counterparts (Model 5, Table 6). Also, the directions of the effects of some of the controls change in the regression for multiparous women. Among the latter, being unmarried is slightly positively, rather than moderately negatively, related to the risk of a C-section. The direction of the effect of nativity is also reversed. In this case, the greater chance of a C-section for a woman born in the U.S. seen among first-births is reversed to become lower among U.S.-born multiparous mothers. But the

magnitudes of the odds ratios for the control variables continue to be rather small in Table 6, again with the exception of the risk for older women (OR = 1.568).

DISCUSSION AND CONCLUSIONS

Before turning to the conclusions that can be derived from our study, it may be useful to address the question of why the risk of cesareans increases among first-birth minority women when controls for sociodemographic variables on which these minorities are disadvantaged are introduced. [5] For example, NHBs have lower average educational levels, a much higher proportion of births to unmarried women, and less access to PNC than do NHWs (Echevarria and Frisbie 2001; Weeks 1999: 388). Braverman et al. in their study of first births in California also report that the rates of C-sections "increased with maternal age and with years of schooling and were higher for married women…" (1995:627). In addition, "Women with late or no prenatal care had a lower likelihood of cesarean delivery. This finding may be explained by a diminished or absent likelihood of scheduled cesarean deliveries among the late/no care group…." (Braverman et al. 1995: 629; emphasis added). Alternative explanations are possible. One has to do with socioeconomic status (SES), which cannot be said to be adequately controlled by the inclusion of the education variable. It would be much more preferable if our data set contained information on income, wealth, and other indicators of SES. Nevertheless, young, unmarried women are more apt to be poor and thus less likely to be able to pay for a surgical delivery (unless, of course, they are mired in poverty to such an extent that they qualify for Medicaid). In addition, more highly educated, married women may well be more able to afford the costs of a cesarean, and thus may more often request the procedure. If so, it is certainly plausible that, when such requests are granted, the procedure is more likely to be scheduled. But, perhaps the most likely explanation is that all control variables were entered into the

[5] This issue does not pertain to NHAPIs, who in many ways have a more advantaged risk profile than NHWs (see Weeks 1999: 388).

models after the risk factors central to this analysis, so that the impact of the controls is net of the effects of variables already in the equation. In any event, our findings are generally consistent with the research by Braverman et al. (1995) and suggest that the results of that earlier study are generalizable to first-birth women in the U.S. as a whole. [6]

Turning now to conclusions that can be derived from our study, the findings are consistent with all previous research in showing that the rate of cesarean deliveries among low-risk pregnancies increased between 1991 and 2002. In the descriptive analysis, we also showed that these results obtain regardless of whether time trends are traced for first-birth or for multiparous women. However, the trajectory of the time trend varies, depending on whether conventional or more stringent criteria are used to categorize low-risk women, at least when the outcome data are grouped into three four-year time periods. When the three conventional criteria are employed, the rate of cesareans first decreases, and then rises again. Using the more stringent criteria to define low risk, the trend in the crosstabulations is one of monotonic increase. Regardless of the categorization scheme used, the rate is higher at the end of 1991-2002 time period than at the beginning for each of the six race/ethnic groups.

However, in the regression analysis, the time period variable showed that the risk of a C-section for both first birth and multiparous women first declined and then increased. This curvilinear pattern persisted in all models, including the model with full controls.

It will be recalled that one of our central aims was to ascertain whether the risk of a surgical delivery varied by race/ethnicity. The short answer from the logistic regressions is "Yes." More specifically, NHB women, almost without exception, were at the highest risk, and NHAI women

[6] It is interesting that the chance of a cesarean delivery is slightly greater among multiparous women who are married. We can think of no explanation for this finding, but the effect is so small (OR = 1.036) that it is very unlikely to distort the conclusions reached regarding the core objectives of this research.

(without exception) had the lowest risk, for both first-birth and multiparous women. From Model 1 through Model 3 in both sets of regressions, Mexican American, Other Hispanic, and NHAPI women have risks of C-sections that are very similar to, and often less than, the risk for their NHW counterparts. But beginning in Model 4 (which added the more stringent proximate risk factors), and especially in Model 5 (which adds a set of sociodemographic controls) these three groups are always at higher risk. The likelihood of a cesarean delivery also rises for NHAI women in Models 4 and 5, but in all cases, the risk of a cesarean delivery remains lower than that for NHW women. The smaller likelihood of C-sections among NHAI women may be at least partially due to the use of the Indian Health Service (IHS) or to different culturally based attitudes toward surgical deliveries. However, these interpretations are merely speculative (and a topic for future research), as we have no information on delivery protocols of physicians serving in the IHS or on attitudes toward C-sections among American Indians.

A policy concern, expressed by several authors, and given extensive attention in *Evaluation of Cesarean Delivery* by the American College of Obstetrician and Gynecologists (ACOG 2005), has been that cesarean sections are too often performed before all procedures that would allow a safe vaginal delivery are employed. A different, but related concern, is that a non-negligible proportion of women with low or no risk of delivery complications request a cesarean delivery (Gossman, Joesch, and Tanfer 2007). [7] We in no way wish to question the legitimacy of these issues, but the evidence in the present research bearing on the question of whether unnecessary C-sections are more often performed on minority women is decidedly mixed. It is true that both the descriptive analysis and logistic regressions show that cesareans are more likely to occur among NHB than among NHW women. Nevertheless, the fact remains that NHAI women, who are close to NHB women in regard

[7] Maternal requests for cesarean deliveries have declined since 1998 (Gossman, Joesch, and Tanfer 2007), and thus may be of less concern today than previously.

to the degree of social disadvantage (Weeks 1999), typically have the lowest rates (descriptive analysis) and risks (regression analysis) of cesareans compared to all other race/ethnic groups, including NHWs. Other minority women are at somewhat greater risks of C-sections when more stringent risk factors, and especially when control variables, are added (Models 4 and 5). But it is well to remember that controls for risk factors indicate what would exist if all groups were equal with respect to the covariates in the equation, while the baseline model shows what exists in reality.

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Table 1. Percent Distribution of Cesarean Births Over Time For Low-Risk (Standard Classification)† First-Birth Women by Race/Ethnicity and Time Period: U.S. 1991-2002

Time Period	NHW	NHB	MEXICAN ORIGIN	OTHER HISP.	NHAPI	NHAI	TOTAL
1991-1993	20.61	22.39	19.59	21.62	20.03	17.75	20.77
1994-1996	18.42	21.34	17.54	19.52	18.41	16.65	18.77
1997-1999	18.48	21.26	17.59	19.70	18.90	16.99	18.83
2000-2002	21.38	24.31	19.76	22.36	21.79	18.97	21.61
	n=10,180,691	n=2,201,133	n=1,862,434	n=871,180	n=750,844	n=126,674	n=15,992,956

SOURCE: NCHS Linked CohortBirth/Infant Death Files(1991 and 1995-2002) and Natality Files(1992-1994)
† Low Risk: singleton, gestation 37 weeks+; no malpresentation

Table 2. Percentage Distributions of Cesarean Births Over Time For Low-Risk* Multiparous Women by Race/Ethnicity and Time Period: U.S., 1991-2002

Time Period	NHW	NHB	MEXICAN ORIGIN	OTHER HISP.	NHAPI	NHAI	TOTAL
1991-1993	4.27	6.39	4.96	5.62	4.22	3.97	4.75
1994-1996	3.84	6.13	4.57	5.38	3.95	3.74	4.35
1997-1999	3.99	6.38	4.72	5.46	4.27	4.00	4.54
2000-2002	5.01	7.65	5.53	6.63	5.19	4.79	5.58
	n=12,317,041	n=2,995,597	n=2,748,183	n=1,112,425	n=773,892	n=209,964	n=20,157,102

SOURCE: See Table 1
† Low Risk: singleton, gestation 37 weeks+; no malpresentation; no previous cesarean delivery

Table 3. Percent Distribution of Cesarean Births Over Time For Low-Risk (Stringent Classification)† First-Birth Women by Race/Ethnicity and Time Period: U.S. 1991-2002

Time Period	NHW	NHB	MEXICAN ORIGIN	OTHER HISP.	NHAPI	NHAI	TOTAL
991-1993	4.92	7.14	6.50	6.77	5.89	3.58	5.55
994-1996	5.15	7.52	6.71	6.80	6.71	4.25	5.85
997-1999	6.04	8.48	7.56	7.79	7.63	4.80	6.77
000-2002	8.29	11.02	9.80	9.89	9.46	6.45	9.06
	n=4,240,587	n=948,873	n=974,382	n=394,327	n=384,357	n=45,556	n=6,988,082

SOURCE: See Table 1

† Low Risk: singleton, gestation 37-41 weeks, no malpresentation, birth weight < 4000 grams, among women with no medical risks, and no delivery complications.

Table 4. Percent Distributions of Cesarean Births Over Time For Low-Risk (Stringent Classification)† Multiparous Women by Race/Ethnicity and Time Period: U.S., 1991-2002

Time Period	NHW	NHB	MEXICAN ORIGIN	OTHER HISP.	NHAPI	NHAI	TOTAL
991-1993	1.27	2.22	1.77	1.86	1.45	0.86	1.52
994-1996	1.30	2.34	1.81	1.95	1.64	1.06	1.58
997-1999	1.62	2.80	2.21	2.31	2.05	1.37	1.94
000-2002	2.34	3.63	2.95	3.15	2.57	1.79	2.69
	n=5,806,391	n=1,423,640	n=1,533,490	n=556,459	n=449,979	n=80,488	n=9,850,447

SOURCE: See Table 1

† Low Risk: singleton, gestation 37-41 weeks, no malpresentation, birth weight < 4000 grams, among women with nomedical risks, no delivery complications, and no previous cesarean delivery.

Table 5. Risk of Cesarean Delivery for First-Birth Women: U.S., 1991-2002

	Model 1	Model 2	Model 3	Model 4	Model 5
Race/Ethnicity [NHW]					
NHB	1.034***	1.033***	1.141***	1.243***	1.558***
Mexican Origin	0.824***	0.816***	0.882***	1.086***	1.185***
Other Hisp.	1.000	0.994*	1.062***	1.133***	1.265***
NHAPI	0.957***	0.949***	0.995	1.139***	1.045***
NHAI	0.822***	0.820***	0.859***	0.767***	0.973***
Time Period [1991-1993]					
1994-1996		0.914***	0.902***	0.883***	0.884***
1997-1999		0.929***	0.913***	0.881***	0.881***
2000-2002		1.096***	1.095***	1.084***	1.095***
Conventional Risks					
Plural Birth [Singleton Birth]			3.909***	4.858***	4.184***
Preterm [Full Term]			1.095***	1.039***	0.998
Malpresentation [None]			31.712***	63.639***	64.866***
Stringent Risks					
Gest. 42+ weeks [Gest. < 42 weeks]				1.194***	1.310***
Birth Wgt. ≥ 4000 g. [Birth Wgt. < 4000 g.]				2.520***	2.467***
Medical Risk [None]				1.278***	1.280***
Delivery Complications [None]				6.190***	6.258***
Maternal Age [20-34]					
≤19					0.620***
≥35					1.914***
Marital Status [Married]					
Unmarried					0.878***
Maternal Educ. [13+ years]					
12 years					1.018***
< 12 years					1.072***
Missing					0.854***
Nativity [Foreign-born]					
U.S.-born					1.041***
Prenatal Care [Adequate]					
None/Inadequate					0.859***
Intermediate					0.957***
Adequate Plus					1.168***
Smoking [No]					
Yes					1.026***
Missing					1.309***

SOURCE: See Table 1

[ ] indicate reference category. * p≤.05; ** p≤.01; *** p≤ .001

Model 1 is the baseline model. Model 2 adds time period.

Model 3 adds conventional risks criteria. Model 4 adds more stringent risk criteria.

Model 5 adds all other covariates.

Table 6. Risk of Cesarean Delivery for Multiparous Women: U.S., 1991-2002

	Model 1	Model 2	Model 3	Model 4	Model 5
Race/Ethnicity [NHW]					
NHB	1.064***	1.063***	1.064***	1.349***	1.457***
Mexican Origin	0.931***	0.916***	0.963***	1.235***	1.131***
Other Hisp.	1.084***	1.076***	1.118***	1.312***	1.275***
NHAPI	0.850***	0.842***	0.864***	1.089***	0.951***
NHAI	0.831***	0.827***	0.821***	0.844***	0.928***
Time Period [1991-1993)					
1994-1996		0.942***	0.929***	0.917***	0.903***
1997-1999		0.982***	0.958***	0.957***	0.941***
2000-2002		1.212***	1.201***	1.203***	1.203***
Conventional Risks					
Plural Birth (Singleton Birth]			3.268***	7.482***	6.998***
Preterm [Full Term}			1.41***	1.864***	1.703***
Malpresentation [None]			16.16***	50.203***	51.415***
Stringent Risks					
Gest. 42+ weeks [Gest. < 42 weeks]				1.061***	1.186***
Birth Wgt. ≥ 4000 g. [Birth Wgt. < 4000 g.]				1.675***	1.659***
Medical Risk [None]				1.191***	1.179***
Delivery Complications [None]				4.061***	4.146***
Previous C-Section [None]				>999***	>999***
Maternal Age [20-34]					
≤19					0.723***
≥35					1.568***
Marital Status [Married]					
Unmarried					1.036***
Maternal Educ. [13+ years]					
12 years					1.020***
< 12 years					1.097***
Missing					0.888***
Nativity [Foreign-born]					
U.S.-born					0.924***
Prenatal Care [Adequate]					
None/Inadequate					0.799***
Intermediate					0.911***
Adequate Plus					1.300***
Smoking [No]					
Yes					1.078***
Missing					1.345***

SOURCE: See Table 1

[ ] indicate reference category. * p≤.05; ** p≤.01; *** p≤ .001

Model 1 is the baseline model. Model 2 adds time period.

Model 3 adds conventional risks criteria. Model 4 adds more stringent risk criteria.

Model 5 adds all other covariates.