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Title Page
Master of Public Health Research Project

Predictors of primary elective Cesarean delivery among apparently healthy pregnant women in Virginia

by

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Abstract

Objectives. The purpose of this cross-sectional study was to evaluate whether certain maternal variables were associated with the performance of a primary cesarean delivery rather than a spontaneous vaginal delivery among apparently healthy pregnant women in the Commonwealth of Virginia.

Methods. This study utilized the 2004 Virginia Statistics File for Live Births which contained 103,830 records. From this dataset, the following groups of women were excluded: multiparous women, women who had had a previous delivery by any method, women with medical and obstetric problems, women with any labor and delivery complications, women with premature births and women with multiple gestations. The resulting study population only included ostensibly healthy women who had no medical and/or obstetric indication for a primary cesarean delivery. The main outcome variable was the performance of a primary cesarean delivery and the independent variables included maternal race, age, location of residence in the state, educational level, method of payment, birth attendant and number of prenatal visits. Descriptive statistics were first calculated and subsequently univariate and multiple logistic regression analyses were performed to calculate crude and adjusted odds ratios for each variable.

Results. The study population included 18,873 live births. The following maternal variables were statistically significantly associated with an increased likelihood of having a primary cesarean section: black race (adjusted odds ratio (OR) 1.58, 95% confidence interval (CI) 1.42, 1.76, p-value <0.01), increasing age (for women aged 25-29 adjusted OR 1.50, 95% CI 1.33, 1.69, p-value <0.01; for women aged 40 and older adjusted OR 3.81, 95% CI 2.76, 5.26, p-value <0.01), residence in Central (adjusted OR 1.80, 95% CI 1.58, 2.04, p-value <0.01), Eastern (adjusted OR 1.27, 95% CI 1.12, 1.44, p-value <0.01) or Northwest (adjusted OR 1.40, 95% CI 1.22, 1.61, p-value <0.01) Virginia, having private insurance (adjusted OR 1.22, 95% CI 1.09, 1.37, p-value <0.01) and having between 16 and 25 prenatal visits (for women with 16-20 prenatal visits adjusted OR 1.33, 95% CI 1.11, 1.58, p-value <0.01; for women with 21-25 visits adjusted OR 2.43, 95% CI 1.47, 4.02, p-value <0.01). Women without health insurance (adjusted OR 0.75, 95% CI 0.58, 0.98, p-value <0.05) and those under the care of a nurse midwife (adjusted OR 0.06, 95% CI 0.04, 0.10, p-value <0.01) or osteopathic physician (adjusted OR 0.52, 95% CI 0.28, 0.97, p-value <0.05) were less likely to have a primary cesarean delivery.

Conclusions. Specific maternal variables are associated with an increased likelihood of having a primary cesarean section in the absence of an overt medical or obstetric indication (i.e. an elective cesarean section) among women in the Commonwealth of Virginia. These results have important public health implications for patients, obstetric care providers and the healthcare system. Pregnant women need to be fully informed about the risks and benefits of cesarean delivery. Furthermore, ethical issues regarding the provision of elective cesarean sections need to continue to be explored as should the monetary costs of this procedure to our healthcare system.

Introduction

Cesarean section has become an increasingly popular delivery method for women to have their children over the past 30 years. This trend has not only occurred in the United States (U.S.), but also in other countries around the world. In the U.S., there was a rapid increase in the rate of cesarean delivery (CD) in the 1970s and early 1980s and then a decline from the late 1980s until 1996.[1] Since 1996, however, the rate of CD in the U.S. has climbed continuously. In 2004, the overall rate of CD in the U.S. was 29.1%, the highest ever reported.[1] This translates into approximately 1.2 million live births in the U.S. delivered by cesarean section annually.

Under the general heading of CD, there are a number of subheadings (Figure 1). CD can be either "primary" or "repeat." A primary CD is a woman's first CD and one in which a decision has been made in advance that the delivery will be by cesarean section, ideally without a trial of labor. Over the last 10 years, there has been a significant increase in the rate of primary CD—in 1996 the rate was 14.6% whereas in 2006 the rate had climbed to 20.6%.[2] A repeat CD is a cesarean section on a woman who has had a previous CD. Cesarean sections can also be "elective" (i.e. done for no medical and/or obstetric reason) or "non-elective" (i.e. done as a result of a medical and/or obstetric indication). Elective cesarean sections are also sometimes referred to as elective "prophylactic" cesarean deliveries. This term is defined as a cesarean delivery done at 39-40 weeks of gestation for the preservation of health or the prevention of injury either to mother or child or both.[3]

A cesarean section may be done for a variety of reasons—both for maternal and fetal medical indications. The four most common medical indications for a CD account for about 70% of its use—these include non-progression of labor, non-reassuring fetal

status, women who have had a previous CD or hysterotomy and fetal malpresentation (i.e. a breech or transverse lie).[4] Less common medical indications include abnormal placentation (such as placenta previa), some multiple gestations, mechanical obstruction to vaginal birth and other medical reasons.

Cesarean sections may also be done for non-medical reasons (i.e. an elective CD). Recently, the concept of "maternal section on request" has become an increasing and controversial phenomenon in the field of obstetrics. According to the National Institutes of Health (NIH), a cesarean section on maternal request is defined as a CD for a singleton pregnancy by the mother's request at term in the absence of any medical indication for the procedure.[1] It is estimated that in the U.S. and other countries between 4-18% of all CDs are done based on maternal request, however, a more precise estimate is difficult to quantify.[1] In the U.S., it has also been shown that the rate of primary CD in mothers with "no indicated risk" for a cesarean section increased from 3.3% in 1991 to 5.5% of all live births in 2001, with higher rates in older first-time mothers.[1] According to one study, women in the U.S. with "no indicated risk" had a 49% increase in the odds of having a CD from 1996 to 2001.[2] Indeed, the topic of performing CDs on low-risk women has gained even more importance since it was addressed in the Healthy People 2010 guidelines. Objective 16-9a seeks to reduce the rate of CD among low-risk women giving birth for the first time from 18% (the 1998 baseline) to 15%.[5]

The growing interest in both CD in general and the subset of CD on maternal request is not just limited to the U.S. In Canada, the overall rate of cesarean sections increased from 18% in 1994-1995 to 22.1% in 2000-2001.[1] In other countries, rates of CD on maternal request have also increased. In Italy, the rate of CD on maternal request was 9% in 2000 compared to 4.5% in 1996; in Sweden the rate was 15.8% in 1999

compared to 8.9% in 1994; in Taiwan the rate was 3.5% in 2001 compared with 2% in 1997; and in Norway 7.6% of all CDs performed are done based on maternal request.[1] Two things are evident from these data—first, there is a wide spectrum of reasons for a CD, from the medically necessary all the way to simple patient choice; second, that the trends of CD in general and that of CD on maternal request appear to be increasing.

In order to understand more completely the issue of CD, we must look into the specific risks and benefits of this procedure compared to vaginal delivery. There are both maternal and fetal outcomes that favor either vaginal delivery or CD—each of these will be discussed individually. One major limitation of research in this area is that there is no randomized prospective study that compares the maternal and neonatal risks and benefits of spontaneous vaginal delivery versus cesarean section.

Cesarean delivery is considered major abdominal surgery and carries the risk of morbidity and mortality to the mother. In general, the major causes of maternal mortality associated with pregnancy include thromboembolism, hypertension, hemorrhage and infection.[6] For elective CD, the maternal mortality rate has been estimated to be 1.7-3.4/100,000 women. For emergency cesarean deliveries, the mortality rate is as high as 12/100,000 women.[6] Data from the United Kingdom (U.K.) from 1997-1999 showed the following mortality rates by method of delivery—vaginal delivery carried a mortality rate of 1.69 deaths/100,000 deliveries, emergency cesarean delivery 20.29/100,000 deliveries and elective CDs 3.85/100,000 deliveries.[7]

However, the data on maternal mortality associated with CD are conflicting. Some previous studies have shown that the risk of maternal death with CD is several times that of vaginal delivery. In addition, a recent case-control study from France on postpartum maternal mortality from CD concluded that CD in general was associated

with a significantly increased risk of maternal death with an adjusted odds ratio of 3.6 (95% CI 2.15, 6.19) compared to vaginal delivery.[8] For term deliveries (38 weeks of gestation or more), the risk of maternal death associated with CD was 3.3 (OR 3.31, 95% CI 1.89, 5.78) times higher than for vaginal delivery. In this study, CD was also associated with a significantly increased risk of death from complications of anesthesia, venous thromboembolism and infection. However, two studies, one from England and one from Israel, showed a lower maternal mortality rate associated with scheduled CD compared to vaginal delivery.[9]

There are also important issues with regard to maternal morbidity that need to be taken into account when considering CD. Potential complications of CD include thromboembolism, hemorrhage and the need for blood transfusion, admission to an intensive care unit, surgical injury to intraabdominal and/or pelvic structures, infection, complications of anesthesia and the need for re-operation to address complications. While the data are not complete on the rate of each of these risks, some information is available. The most common maternal morbidity after either vaginal or cesarean delivery is endometritis. In one study, the incidence of this ranged from 10-50% after CD compared to 2.6% after vaginal delivery.[6] The risk of surgical injury to intraabdominal and/or pelvic structures is estimated at 2%; the risk of blood transfusion is estimated at 1-6% and the risk of severe ileus post surgery is estimated at 1%.[6] These complications would not be expected to occur with vaginal delivery. Cesarean delivery, either planned or unplanned, has also been associated with a longer hospital stay compared to vaginal delivery[1] as well as a longer post-operative recovery time.[10]

Another important issue regarding CD is the impact of having a first CD on subsequent pregnancies and deliveries. After a first CD, a woman has three options with

regard to future pregnancies—a repeat CD, a vaginal birth after cesarean (VBAC) or a failed trial of labor with an emergency CD. Although it has been reported that the rate of successful VBACs is 60-80%, in the U.S. the rate of VBACs has gradually been decreasing over time.[6] The net result of this is that a woman who has a cesarean delivery for any reason is often destined to have only future cesarean deliveries should she desire more children. This might not be an issue except for the fact that previous cesarean sections have been associated with a number of increased risks in subsequent pregnancies including uterine rupture, placenta previa, placenta accreta, placental abruption and ectopic pregnancy.[9]

A recent retrospective cohort study examined the risks of placenta previa and placental abruption in women who had at least one previous CD.[11] In general, placenta previa occurs in approximately 1 in 200 deliveries and is a leading cause of vaginal bleeding in the latter stages of pregnancy. Placenta previa is also associated with increased risks of both maternal and neonatal morbidity and mortality. Placental abruption occurs in about 1% of pregnancies and is known to recur in subsequent pregnancies. In this study, the authors found that women with a previous CD had a 50% higher chance of having placenta previa in their 2nd pregnancy (relative risk 1.5, 95% CI 1.3, 1.8). For women who had had two previous cesareans, the risk of previa was doubled in their third pregnancy (relative risk 2.0, 95% CI 1.3, 3.0). Regarding placental abruption, the risk of this complication was 30% higher among women in their 2nd pregnancy if they had had a prior CD compared to those women having had a vaginal delivery (relative risk 1.3, 95% CI 1.2, 1.5). The authors concluded there is a dose-response relationship between the number of prior CDs and the risk of placenta previa.

Other studies have shown similar findings with regard to number of prior CDs and the subsequent risk of placenta previa.[1]

With regard to placenta accreta, the incidence of this condition between 1960-1970 was about 1/19,000 deliveries.[12] By 2005, the incidence had increased to 1/533 pregnancies. The maternal mortality rate from this condition is as high as 7%. This increase in incidence has come during a time of significant growth in the number of cesarean sections. One practitioner stated that placenta accreta "is rapidly becoming the most dreaded complication facing the obstetrician."[12] Most cases of placenta accreta are related to prior CD. Taken together, all of these possible maternal morbidities should be considered when a woman decides to undergo a first cesarean section.

Despite the potential maternal risks that accompany CD, there are some possible maternal benefits associated with it. The most important potential benefit that has been cited in multiple sources is protection of the mother's pelvic floor. Cesarean section avoids trauma to the pelvic floor that might result in urinary incontinence, fecal incontinence and pelvic organ prolapse.[9] However, the "protective" effect of CD on the development of urinary incontinence has not been conclusively established.[6] The other frequently cited benefit of elective cesarean delivery is that it avoids an emergent CD that might occur with a failed trial of labor, for example. Emergency CD is associated with higher morbidity and mortality than elective CD.[9] Other advantages of CD include providing a known endpoint for the pregnancy which allows for planning related to issues of work, childcare, etc., the avoidance of postterm pregnancy and a more "controlled" birth setting.

There are also potential neonatal complications that accompany CD. With regard to neonatal mortality, there does not appear to be a consensus on whether CD has any

effect on this. Over the last decade, there has been a gradual reduction in the perinatal mortality rate which some have attributed to the increased use of CD. However, other data have shown a correlation between a lower rate of CD and a lower rate of perinatal mortality.[6] In its conference statement, the National Institutes of Health stated there was not enough evidence to favor either mode of delivery (cesarean or vaginal) with regard to the outcome of neonatal mortality.[1]

The primary neonatal morbidity associated with CD relates to respiratory disease. Specifically, transient tachypnea of the newborn and respiratory distress syndrome occur more frequently in infants born by CD than by planned vaginal delivery.[1] Another potential neonatal problem associated with CD is iatrogenic prematurity if the fetus is delivered before full-term gestation. This has been associated with newborn respiratory problems, hypothermia and hypoglycemia.[1] Other potential complications of CD are fetal trauma or fetal laceration, though the latter is reported to be uncommon.[9]

Just as with maternal outcomes, there are some possible benefits to the fetus of elective CD. One main advantage of elective CD is that the fetus is delivered at a specified gestational age, thus any complications that might occur after this time can potentially be avoided. The rate of intrapartum fetal death at 39 weeks gestation and beyond is estimated to be 2/1000. Thus, if an infant is delivered at 39 weeks it is possible that these deaths could be avoided.[9] In addition, neonatal complications such as meconium aspiration have been reported to increase after 39 weeks gestation—again, these might be avoidable with a planned CD at 39 weeks.[9]

Other arguments are also made in favor of elective CD. It has been noted that the rates of birth injuries, such as fractures and nerve injuries, are lower with CD compared to vaginal delivery.[1,9] It has also been noted that infants born by vaginal delivery have a

higher incidence of infections that those born by planned CD.[1] Furthermore, the scheduling of cesarean deliveries is advantageous in terms of scheduling appropriate medical staff that should be present. Scheduled CDs also helps to alleviate healthcare provider fatigue which itself has been associated with neonatal morbidity.[9]

Aside from the medical and obstetric reasons to perform an elective CD, there are a number of non-clinical maternal factors such as age, race, educational level, income and others that influence the decision about whether to have an elective cesarean section. Similar to the situation with regard to the medical risks and benefits of CD, there are conflicting data regarding the association of maternal factors and having a CD. Kabir and others examined national U.S. data with regard to racial differences in the performance of cesarean sections.[13] In this cross-sectional study using data from 2001, they found that black women were more likely to have an unnecessary CD compared to white or Hispanic women. This finding was corroborated in another study that examined birth certificate data in Louisiana. While it showed that white women were more likely to have a primary CD overall compared to nonwhites (adjusted OR 1.19, 95% CI 1.16, 1.21, p-value <0.0001), white women were less likely to have an unnecessary primary CD (adjusted OR 0.89, 95% CI 0.85, 0.93, p-value <0.0001).[14] With regard to overall rates of CD, another study showed that non-Hispanic whites had the highest rate of primary CD at 20.6%, while black women had a somewhat lower rate at 18.9%.[15]

Kabir's study of women in Louisiana showed that increased maternal age ($\geq$ 35 years old) was associated with an increased likelihood of primary CD overall (adjusted OR 1.13, 95% CI 1.10, 1.16, p-value <0.0001).[14] In the study using national U.S. birth data, it was also noted that women 35 years of age or older had an increased chance of having a potentially unnecessary CD compared to younger women.[13] Similarly, a study

from England reported a similar finding in that there was a steady increase in the rate of elective cesarean sections with increasing maternal age.[16] Another important finding from this study was that there was also an increase in the rate of emergency cesarean delivery with increasing maternal age. This may have important implications with regard to the method of delivery for an older woman.

The data regarding maternal economic circumstances or affluence and its relationship to method of delivery are somewhat conflicting. A study from 1989 by Gould *et al.* showed that women in the U.S. living in higher median family income census tracts had a higher prevalence of primary CD compared to women in lower-income families.[15] Similarly, women living in the most affluent areas of England were significantly more likely to have an elective CD compared to less affluent women (adjusted OR 1.3, 95% CI 1.1, 1.4).[17] However, the study using 2001 national U.S. birth data showed that in a multiple logistic regression model, ZIP code income was not associated with having a potentially unnecessary cesarean delivery.[13] Another study from England showed that women living in the poorest areas of the country were less likely to have an elective CD, but it failed to show an association between increasing affluence and having an elective CD.[16]

The study on birth certificate data from Louisiana also examined the relationship between maternal education and mode of delivery. Mothers with a high school education or greater were more likely to have a primary cesarean delivery in general (adjusted OR 1.28, 95% CI 1.26, 1.31, p-value <0.0001).[14] However, these same women were less likely to have a potentially unnecessary CD (adjusted OR 0.93, 95% CI 0.89, 0.97, p-value <0.002). In their study examining singleton first-birth live births from California, Braveman and others found that women with less than a high school education were

somewhat less likely to have a primary cesarean delivery compared to college-educated women. Women with a 9th grade education or less had a statistically significant adjusted OR of 0.92 (95% CI 0.88, 0.97) and women with a 10-11th grade education also had a statistically significant adjusted OR of 0.94 (95% CI 0.89, 0.98).[18]

Overall, the data on the association between maternal characteristics and the performance of a CD are inconsistent. Some studies have shown that whites are more likely to have a CD while others have shown the same for black women. Similar differences are present when examining the variable of maternal income. Women with less education appear to have slightly fewer primary CDs than those women who are more educated. The most consistent finding is that older women are more likely to have a CD.

Another pertinent issue regarding elective cesarean delivery is the ethics involved in doing this surgical procedure. Elective cesarean delivery, particularly that driven primarily by maternal request ("section on request") presents an inherent ethical dilemma for the healthcare provider—usually an allopathic physician. On one hand, the physician has an obligation to protect the patient and not to perform any services that are medically unwarranted. However, the physician must also respect the autonomy of the patient and take her wishes into account regarding the mode of delivery. This situation is made even more difficult for several reasons. First, mothers may have unrealistic expectations concerning CD compared to vaginal delivery. As one author put it, physicians and patients may believe that "cesarean delivery is a fast, safe and convenient way to have a baby."[19] Unfortunately, the reality is more complicated than this. Second, the risks and benefits of elective CD compared to spontaneous vaginal delivery have not been precisely quantified. Third, there are no randomized controlled trials that directly

compare elective CD with spontaneous vaginal delivery in terms of maternal and neonatal outcomes, risks and benefits.

Not surprisingly, there are a variety of opinions regarding the ethics of performing an elective CD. According to the American College of Obstetrics and Gynecology (ACOG), if a CD is more beneficial to the patient than a vaginal delivery then the practitioner is ethically justified in performing surgery.[10] In their article from 2003, Minkoff and Chervenak felt that physicians should "accede to an informed patient's request for such a delivery [an elective cesarean delivery]" based on the medical evidence available at that time.[9] In contrast, the International Federation of Gynecology and Obstetrics (FIGO) states that performing a CD electively is not ethically justified.[6] Grisaru and Samueloff also take the position that elective CD should not be offerred.[6] In its conference statement, the National Institutes of Health takes a more neutral position stating that a healthcare provider should engage in "nondirective" counseling if a woman requests information on elective CD. The NIH paper also states that the decision about mode of delivery should be shared between the provider and the patient and that the risks and benefits of each mode of delivery (cesarean vs. vaginal) be conveyed to the mother and individualized to fit her situation best.[1]

As is evident from the discussion above, the decision about whether to have a primary elective CD or a spontaneous vaginal delivery is a complex one from both a medical and ethical standpoint. There are also numerous non-medical maternal factors that influence this decision. From reviewing the literature, there is currently no data available on what maternal factors among women in the Commonwealth of Virginia are associated with having a primary elective cesarean section or a primary vaginal delivery. This information would add to the knowledge base about this subject in general, but more

importantly, would hopefully act as a catalyst to ensure that women in Virginia are well informed about the decision to have a primary elective CD.

Methods

The purpose of this cross sectional study was to determine if there was an association between specific maternal variables and the likelihood of having a primary elective cesarean delivery. To answer this question we used a data set containing all of the live birth data in the Commonwealth of Virginia for 2004. This data set contains 103,830 records and comes from the Virginia Department of Health's Vital Statistics Department. Virginia law requires that a birth certificate be filed within 7 days of every live birth. The data requested on the form is provided by different individuals. Non-medical data such as maternal social and demographic information is supplied by the mother, father or another designated informant if the parents are unable to provide the requested information. Medical and obstetric information is provided by the physician or other birth attendant or the labor and delivery nurse.

For the purposes of this study, the initial data set was limited to only specific live births in order to remove certain factors that might confound the association between maternal variables and the odds of having a cesarean delivery—this is shown in Figure 2. The following groups of women were sequentially excluded from the initial data set: multiparous women (N=59,796), women having a repeat delivery of any kind (N=254), women with any medical or obstetric problems and those with labor and delivery complications (N=21,190) and those having multiple births and premature infants (N=3,717). Therefore, the remaining data set used for analysis contains 18,873 records. This data set includes only the "healthiest" primiparous women in Virginia for which ostensibly there would be no medical or obstetric indication for a primary cesarean section, based on the information available.

In this study, the main outcome variable was the performance of a primary cesarean delivery. This was treated as a binary variable. The independent variables were all treated as categorical variables and included maternal race, maternal age, maternal residence within the Commonwealth of Virginia, maternal education level, method of payment, birth attendant and number of prenatal visits. One of the limitations of the dataset is that is does not include maternal or household income. Using 2000 U.S. Census data,[20] the mean of the 1999 median household income was calculated for each of the five regions of the state, but this data was not used in either the univariate or multiple logistic regression analyses since it was not specific to the individual mother. While this may not be the optimal way to measure income, this is the data that was available for evaluation. Appendix 1 shows the different counties and cities that comprised the different regions of the Commonwealth.

The statistical analysis used for the study was as follows. Frequencies were run on the total number of primary cesarean deliveries and primary vaginal deliveries and crosstabs were used for univariate comparisons with the variables used in the study. Primary cesarean delivery prevalence and 95% confidence intervals (95% CI) were calculated for each variable. Univariate logistic regression was used to calculate the crude odds ratio (OR) and 95% CI for each variable to estimate the likelihood of having a primary cesarean section. When calculating odds ratios, each variable category had a reference level that was set at 1.0. Reference levels were chosen mainly to conform to the methodology used in other similar studies so as to compare results more directly. For the variable of maternal age, a Chi-square test for trend was also calculated. Multiple logistic regression analysis was used to calculate adjusted odds ratios for each variable found to be significant in the univariate analysis. For the statistical analysis, we set our

alpha at 0.05. SPSS Version 14.0 was used for all statistical analyses with the exception of the Chi-square test for trend for which Epi-Info Version 3.3.2 was utilized.

Results

In the entire dataset (N=103,830 live births), there were 20,669 (19.9%) primary cesarean deliveries and 11,195 (10.8%) repeat cesarean deliveries for a total cesarean delivery percentage of 30.7 (data not shown). By comparison, in 2004, the total U.S. cesarean delivery rate was 29.1%. Looking only at the population of interest (N=18,873) the breakdown of method of delivery was as follows: 15,770 (83.6%) women had a primary vaginal delivery while 3,103 (16.4%) had a primary cesarean section. The rate of primary cesarean delivery in apparently healthy women in Virginia was slightly higher than the Healthy People 2010 goal of 15%.

Table 1 presents descriptive statistics and frequencies regarding the study population. Within each variable category are the frequency counts, the associated percentages and the amount of unknown or missing data. White women comprised 72.8% of the study population while black women represented 18.5%. Among women having a primary vaginal birth, 73.5% were white while 17.7% were black. However, among women having a primary CD, 69.0% were white compared to 22.7% who were black.

With regard to age, the greatest number of women in this study were between the ages of 20-24 (Table 1). This was followed by women aged 25-29. In general, as women became older they had fewer pregnancies, but the percentages of women having primary CDs were higher than those having primary vaginal deliveries.

The greatest number of deliveries occurred in Northern Virginia followed by Eastern Virginia and then Central Virginia (Table 1). Among women having a primary CD, 21.5% resided in Central Virginia; among women having a primary vaginal delivery, 14.6% lived in Central Virginia. Conversely, 15.7% of women having a primary vaginal

birth resided in Southwest Virginia while 12.3% of women having a primary CD lived in this area (Table 1).

There were some differences in maternal education level with respect to having a primary cesarean or vaginal delivery (Table 1). Overall, most women (52.4%) in this cohort had a college education. Among women in the primary vaginal delivery group, 46.8% had a high school education or less compared to 39.4% in the primary CD group. Fifty eight percent of women in the primary CD group were college educated compared to 51% in the primary vaginal delivery group.

The majority of women used private insurance as their method of payment for obstetric services (Table 1). In the primary CD group, 71.8% of women had private insurance compared to 65.3% in the primary vaginal delivery group. Medicaid was the second most common insurer and covered 20.3% of women in the primary cesarean group and 26.0% of women in the primary vaginal birth group.

Almost all women were under the care of an allopathic physician (91.7%) (Table 1). However, in the primary cesarean group 98.3% used an allopathic physician as their birth attendant compared to 90.4% in the primary vaginal delivery group. Other healthcare providers, such as nurse midwives or osteopathic physicians, provided little care to this group of women.

The majority of women (63.9%) had 11 to 15 prenatal visits during their pregnancy (Table 1). However, 8.3% of women in the primary CD group had 16 or more prenatal visits compared to 6.5% of women in the primary vaginal birth group.

Table 2 presents data on the prevalence rates and 95% confidence intervals (95% CI) of women undergoing a primary CD. Black women had the highest prevalence of primary CD at 20.2% (95% CI 18.87, 21.54) followed by Asian and then white women.

The prevalence of primary cesarean section increased steadily with age, ranging from 11.8% (95% CI 10.7, 12.86) in women 19 years of age or less to 34.7% (95% CI 28.45, 40.89) in women 40 or older. Women residing in Central Virginia had the highest prevalence of primary CD at 22.5% (95% CI 21.0, 24.0) while women in Southwest Virginia had the lowest prevalence at 13.3% (95% CI 12.1, 14.6). There was an increase in the prevalence rate of primary CD with increasing education—those women with less than a high school education had a prevalence rate of 11.2% (95% CI 8.92, 13.45) while college educated women had a prevalence rate of 18.3% (95% CI 17.51, 19.04). As might be anticipated, patients with private insurance had the highest prevalence at 17.8% (95% CI 17.12, 18.46) while self-pay patients had the lowest at 9.9% (95% CI 7.83, 11.88). Women under the care of an allopathic physician had the highest prevalence rate for primary CD at 17.6% (95% CI 17.05, 18.18) while women who received care from an osteopathic physician had a prevalence rate of 9.9% (95% CI 4.80, 15.04). With regard to prenatal visits, there was a steady increase in the prevalence rate of having a primary CD with increasing prenatal visits up to 25 visits. Women who received no prenatal care had a prevalence rate of 10.6% (95% CI 4.94, 16.30), women who had between 21-25 prenatal visits had a rate of 31.0% (95% CI 21.31, 40.76), but women with 26 or more prenatal visits had a rate of 26.7% (95% CI 10.84, 42.49).

Univariate logistic regression analysis was conducted and the resulting odds ratios, 95% CIs and p-values for each variable are presented in Table 3. Within each variable category, one variable was selected as a reference level and has been labeled as such. Black women had a highly statistically significant increased odds ratio (OR) of 1.37 (95% CI 1.25, 1.51, p-value <0.01) of having a primary CD compared to white women (the reference group). With respect to maternal age, being young (19 years of

age or less) was protective against having a primary CD with an OR of 0.87 (95% CI 0.77, 0.99, p-value 0.04). Other than this age group, increasing age was associated with an increased odds ratio of having a primary CD. Women aged 25-29 had a 37% increase in the likelihood of having a primary CD compared to women aged 20-24 (the reference group) with an OR of 1.37 (95% CI 1.23, 1.52, p-value <0.01). Women aged 40 and older had an OR of 3.47 (95% CI 2.61, 4.61, p-value <0.01). A Chi-square test for linear trend was calculated using the unadjusted age data and found to be highly statistically significant (χ^2 265.13, p-value <0.0001). That is, the odds of having a primary CD increased with increasing maternal age.

Using Northern Virginia as the reference group, women living in Central Virginia had a 59% increased likelihood of having a primary CD with an OR of 1.59 (95% CI 1.42, 1.77, p-value <0.01) (Table 3). Living in Southwest Virginia was protective against having a primary CD with an OR of 0.84 (95% CI 0.74, 0.96, p-value 0.01). Having less than a high school education was also protective against having a primary CD with an OR of 0.74 (95% CI 0.59, 0.94, p-value 0.01). Conversely, women with a college education were 32% more likely to have a primary CD with an odds ratio of 1.32 (95% CI 1.22, 1.43, p-value <0.01).

Insurance status and birth attendant were also associated with having a primary cesarean delivery (Table 3). Women without insurance (self-pay category) were less likely to have a primary CD (OR 0.71; 95% CI 0.56, 0.91, p-value <0.01) while women with private insurance were significantly more likely to have this procedure with an OR of 1.41 (95% CI 1.28, 1.55, p-value <0.01). Using allopathic physicians as the referent group, women with a nurse midwife as their birth attendant were much less likely to have

a primary CD (OR 0.06; 95% CI 0.04, 0.10, p-value <0.01) as were women who had an osteopathic physician as their birth attendant (OR 0.52; 95% CI 0.29, 0.92, p-value 0.02).

In the category of number of prenatal visits, 2 subcategories were associated with statistically significant increases in the odds ratios of having a primary CD—those women with 16-20 and 21-25 prenatal visits (Table 3). Respectively, these odds ratios were 1.43 (95% CI 1.21, 1.68, p-value <0.01) and 2.28 (95% CI 1.44, 3.60, p-value <0.01).

Table 4 presents the adjusted odds ratios calculated using multiple logistic regression analysis. Black women continued to have a significantly higher likelihood of having a primary CD with an adjusted OR of 1.58 (95% CI 1.42, 1.76, p-value <0.01). With regard to age, the youngest category of women (less than or equal to 19 years old) had a lower likelihood of having a primary cesarean section, but it was no longer statistically significant. As in the crude analysis, increasing age was statistically significantly associated with increased odds of having a primary CD in the adjusted analysis. Regarding maternal residence, women in Central Virginia still had a higher likelihood of having a primary CD. Women in Eastern and Northwest Virginia also had a significantly higher odds ratio of having a primary CD compared to women in Northern Virginia (the referent group). Living in Southwest Virginia was no longer "protective" against having a primary CD compared to the referent group in the adjusted analysis.

After controlling for all variables, there were also changes in the relationship between maternal education level and primary CD (Table 4). In the crude analysis, lower levels of education were associated with fewer primary CDs while more education was associated with more primary CDs. In the adjusted analysis, neither category of educational level was significantly associated with the performance of a primary CD. As

opposed to maternal education, the adjusted analysis continued to show that having private health insurance was associated with an increased odds of having a primary CD (adjusted OR 1.22; 95% CI 1.09, 1.37, p-value <0.01) while having no insurance was significantly associated with a lower likelihood of having this procedure (adjusted OR 0.75; 95% CI 0.58, 0.98, p-value <0.05).

Lastly, the adjusted analysis showed that having a nurse midwife or an osteopathic physician continued to be protective against having a primary CD (Table 4). Having either 16-20 or 21-25 prenatal visits remained significantly associated with an increased likelihood of having a primary cesarean section. With regard to the multiple logistic regression analysis, the model fit was assessed with the Hosmer and Lemeshow (Goodness of Fit) Test. There was no evidence for a significant lack of fit (χ^2 7.53, df 8, p-value 0.48).

Table 5 shows the mean of the median income for each of the five regions of the state as reported by the U.S. Census Bureau. There was no correlation between prevalence of CD and region income. Northern Virginia household income was the highest, while Southwest Virginia had the lowest. There was a substantial difference between the two—almost $40,000. While women living in Northern Virginia had the highest household income they were the fourth highest in terms of prevalence of primary CD. Women in Central Virginia, who had the highest prevalence rate, had an intermediate household income of about $39,000. Women with the lowest household income, those in Southwest Virginia, also had the lowest prevalence of primary CD.

Since black women had the highest prevalence of primary CDs, this group was studied in more depth by further examination of the available data (data not shown in table format). Out of 3,103 primary cesarean sections performed in this cohort, 705 were

on black women. Frequency tables were run on these women using the variables of maternal age, maternal education, maternal residence and number of prenatal visits. The most notable findings were that 70.8% of black women lived in two geographic areas of the state—Central Virginia (35.2%) and Eastern Virginia (35.6%). There was a notable drop off in the black female population in other areas of the state—16.9% in Northern Virginia, 8.4% in Northwest Virginia and 4.0% in Southwest Virginia. Approximately 92% of black mothers were less than or equal to 34 years of age, 54.5% had a high school education, 42.6% had a college education and most (58.3%) had between 11-15 prenatal visits during their pregnancy.

Discussion and Conclusions

This study examined the 2004 Virginia Live Birth Dataset to determine whether certain maternal variables were associated with apparently healthy women undergoing a first-birth primary cesarean delivery. Women selected for this study had no identifiable indication for a CD, thus the presumption was that these were "elective" procedures by default. This assumption appears reasonable and similar methodology has been used in other studies though the terminology may be a bit different. The study by Menacker in 2005 looking at CD rates used the term "low-risk woman" which was defined as a woman with a full-term (at least 37 weeks gestation), singleton pregnancy with a vertex fetal presentation.[21] In their study examining primary CDs in the U.S., Declercq *et al.* described women as having "no indicated risk" for a CD. The definition of this term was a singleton birth of full-term gestation ($\geq$ 37 weeks gestation) with a vertex presentation in a mother who had no medical risk factors and no complications of labor and delivery recorded on the birth certificate.[22] All of these studies—the one presented here and the other two cited—appear to be looking at women with essentially the same characteristics.

In this study population, the rate of elective CD for primiparous mothers was 16.4%, 1.4% above the Healthy People 2010 goal. In 2004, there were 3,103 primary cesarean deliveries in Virginia. Using the Healthy People 2010 goal for comparison, the rate of 16.4% translated into 272 excess elective cesarean deliveries in Virginia in 2004. On a national basis, it has been clearly noted that rates of first-birth "low-risk" CDs have been steadily increasing as have rates of repeat CDs in "low-risk" women.[21] Complementary to this, rates of VBACs overall and those performed in "low-risk" women have been decreasing. The net effect is that the rates of primary CDs and overall CDs have increased over the last 10 years, moving beyond the Healthy People 2010 goal.

If this trend occurs in Virginia, the number of potentially unnecessary or elective CDs will increase.

This study indicated that certain maternal characteristics were associated with an increased likelihood of having a primary elective CD. Black women had the highest prevalence of primary elective CDs (20.2%) and a 58% increased likelihood of having a primary elective CD compared to white women (adjusted OR 1.58, 95% CI 1.42, 1.76, p-value < 0.01). This finding has also been noted in other studies. In their study looking at national U.S. birth data from 1991-2001, Declercq and others found that non-Hispanic black women with "no indicated risk" were 80% more likely to have a primary CD compared to white women (adjusted OR 1.80).[22] Menacker used the same U.S. national data, but extended the observation period from 1990-2003. This study noted that in 2003 the prevalence of first-birth CD in "low-risk" black women was 26.6% compared to 23.3% in non-Hispanic whites.[21] In their study of unnecessary cesarean deliveries in Louisiana, Kabir and others noted that white women were less likely to have an unnecessary primary CD (adjusted OR 0.89) compared to non-whites.[14] Kabir's study of 2001 national inpatient birth data also showed that black women had a higher chance of having an unneeded CD compared to white women. In this study, 14.4% of black women had potentially unnecessary CDs compared to 10.4% of white women.[13]

Maternal residence within certain regions of the state was also associated with having a primary elective CD. Using Northern Virginia as the reference group, women residing in Central Virginia had the highest likelihood of having a primary elective CD (adjusted OR 1.80), followed by those in Northwest Virginia (adjusted OR 1.40) and then those in Eastern Virginia (adjusted OR 1.27). These data may have some association with the distribution of black women in the state. In the study population, 35.2% of black

women resided in Central Virginia while 35.6% lived in Eastern Virginia. Since the data show that black women are significantly more likely to have primary elective CDs, this may help to explain why healthy women in these areas of the state are more likely to have a primary CD. Since this was a cross sectional study only an association can be postulated, not a cause and effect relationship.

There was also an association between increasing maternal age and an increase in the odds of having a primary elective CD. This data is very much in line with that from other studies. Declercq's study showed a steady increase in the adjusted odds ratio of a woman with "no indicated risk" having a primary CD with increasing age.[22] In that study, like this one, women aged 20-24 were the reference group. In Declercq's study, women aged 25-29 had an adjusted OR of 1.65, those aged 30-34 had an adjusted OR of 2.30, those aged 35-39 had an adjusted OR of 3.58 and those 40 and older had an adjusted OR of 5.42. In general, these ORs are slightly higher than those in the current study, but the trend is the same. Kabir's study came to a similar conclusion—women older than 35 years of age had a higher percentage of possibly unnecessary CDs compared to younger women (11.9% vs. 10.9%).[13] In England, Barley and others studied U.K. data from 2001-2002 and noted there was a steady increase in both the prevalence of elective CDs and emergency CDs with increasing age of the mother.[16]

One hypothesis for these data relates to the fact that as women get older they tend to have more complications related to pregnancy. Even though age by itself is not considered an indication for a CD, in the practice of obstetrics there appears to be a continuum of indications for a CD. As noted earlier, some obstetricians view an elective CD as a preventive measure in order to avoid performing an emergency CD if there are

problems with labor and delivery. The result is that as a woman gets older, she is more likely to have a CD even in the absence of a solid medical or obstetric indication.

Medical malpractice issues may also play a role when it comes to the decision of how to treat an older pregnant woman who is inherently at higher risk of pregnancy complications. As Resnik noted, obstetricians practice in a "zero tolerance" medical and legal environment where the expectation is that every delivery will be perfect.[12] It seems reasonable to assume that a physician practicing in such a climate will want to have as much control over the situation as possible in order to minimize risk—this may translate into a "controlled" CD rather than a spontaneous vaginal delivery.

Turning to maternal education, in the univariate analysis lower maternal educational level was protective against having a primary elective CD whereas higher educational achievement had a positive association with primary elective CDs. However, the adjusted analysis showed no relationship between level of maternal education and having a primary elective CD. This result adds further confusion to what has previously been reported in the literature. Declercq's study showed a small increase (8%) in the likelihood of having a primary "no indicated risk" CD among women with $\geq$ 13 years of education (adjusted OR 1.08).[22] Conversely, Kabir's study of birth certificate data from a single state with high CD rates, Louisiana, showed that women with $\geq$ 12 years of education were less likely to have an unnecessary primary CD (adjusted OR 0.93).[14]

With regard to maternal method of payment, the results appear to make logical sense. In both the univariate and multiple logistic regression analyses, mothers with private insurance were more likely to have a primary elective CD while patients with no insurance (self pay) were less likely to have one. This result is similar to that found by Aron and others in their study from 2000. These investigators performed a retrospective

cohort study on the effect of race and health insurance status on the performance of a primary CD using data from 21 hospitals in the Cleveland, Ohio area.[23] The insurance makeup of their study population (66% with private insurance, 30% with government insurance and 4% uninsured) was very similar to the insurance mix in this study (66.4% private insurance, 25.1% Medicaid, 4.4% uninsured and 4.1% unknown or missing data). The authors found that the rate of CD was highest among women with private insurance (17%) compared to 10.7% in those without insurance. In their logistic regression model, the adjusted OR of having a CD among women without health insurance was 0.65 (95% CI 0.41, 1.03, p-value 0.067), however this value was not statistically significant. In addition, since the cost of a cesarean section is more than that of a vaginal delivery, it seems reasonable to conclude that a mother might choose the less expensive mode of delivery, particularly given the notion that the CD might not be medically necessary to begin with. The obstetric provider might also have a role in this decision by steering the uninsured patient toward a less expensive birthing method.

There appears to be a clear association between having an allopathic physician as the birth attendant and the performance of a cesarean section. In general, allopathic physicians provided the vast majority of obstetric care to the study cohort—91.7% of women were under the care of an allopathic physician. In the primary cesarean section group (3,050 women), 98.3% of care was provided by an allopathic physician. Having a nurse midwife or an osteopathic physician as the birth attendant was associated with a significantly lower likelihood of having a primary elective section.

Other authors have examined physician factors in relation to cesarean deliveries. A study published in 1989 by Goyert and others investigated physicians' medical practice styles on the rate of CDs. They found substantial variability in the rate of CD by

physician, ranging from 19.1% to 42.3%.[24] However, while the individual physician's practice styles varied, the authors found no clear differences in neonatal outcomes. A similar study conducted by DeMott and Sandmire looked at obstetricians practicing in Green Bay, Wisconsin. These physicians also had widely different rates of CD, ranging from 5.6% to 19.7%.[25] Similar to the finding in Goyert's study, the higher CD rates did not translate into better neonatal outcomes. Coco and others looked into the effect of the specialty of the attending physician (family physicians vs. obstetricians) on CD rates in a single community hospital in Pennsylvania.[26] They found that when family practitioners were the attending physician the total CD rate went from 16.7% to 11.1% (a 34% decrease). Similarly, the repeat CD rate declined from 8.5% to 2.9%. Mitler *et al.* studied physician gender and its relationship to the performance of a CD at Yale-New Haven Hospital in Connecticut. Using multivariate logistic regression analysis, they reported that male physicians were significantly more likely to perform this procedure than their female colleagues (adjusted OR 1.38, 95% CI 1.00, 1.88, p-value < 0.05).[27] Unfortunately, we did not have the data to examine physician factors for this study.

An association was noted between higher numbers of prenatal visits (16-20 and 21-25) and an increase in the odds of having a primary elective cesarean delivery. In this study, the majority of women (N=12,056; 63.9%) had between 11-15 prenatal visits. One possible explanation for the findings in this study may be that women with more prenatal visits had complications during their pregnancy that were not captured by the 2004 Virginia Live Birth Dataset—this would explain both the increased number of prenatal visits and the performance of a cesarean delivery. Therefore, these women may actually have had a medical and/or obstetric indication for a CD and did not have elective sections.

The current study has both internal and external validity. The issue of possible confounding was addressed in two ways. First, we used restriction to remove possible confounding variables and second, multiple logistic regression analysis was used to adjust for confounding. With regard to bias, it is possible that it could exist, but it is difficult to determine given that this study analyzes an existing dataset. One type of bias that appears to be present is misclassification bias as demonstrated in Figure 2. When multiparous women were excluded, this should have excluded not only the 59,796 women that were removed from the dataset, but also the 254 women that had a VBAC, repeat vaginal delivery or repeat cesarean section. However, as shown in Figure 2, these 254 women were removed from the dataset by specifically excluding any kind of repeat delivery, thus these women were obviously misclassified as being nulliparous.

Another source of misclassification bias likely exists with regard to the medical and obstetric complications captured on the Commonwealth of Virginia—Certificate of Live Birth form (Appendix 2). The list of medical/obstetric conditions on this form is not exhaustive, therefore some women who had conditions that might warrant a CD may have been misclassified as having "none" since their particular medical problem was not on the form. In a dataset this large it is also probable that other items were miscoded or misclassified, but the extent of this is unknown.

With respect to external validity or generalizability, this study has strengths and limitations. One clear asset of this study is that it utilizes a very complete database, the entire 2004 Virginia Live Birth Dataset. However, while the study is obviously generalizable to Virginia and other states with similar population and/or demographic characteristics, it might not be applicable to other locations or populations of women. Furthermore, the cross sectional design of this study allows us to look only at 2004 birth

data—it is possible that the data will change over time and the current study results and conclusions may not be as applicable. However, this limitation is inherent in any cross sectional study.

There are other strengths in the present study. One strong point is the study's large data set of 18,873 apparently healthy women in Virginia. This study also makes the reasonable assumption that primary cesarean sections on these women represent elective sections since women with a known or recorded medical and/or obstetric indication for a CD have been removed. There is also little missing data among the variables examined. Most of the variables had about 1% or less missing data. The variable of maternal education level had 2.0% missing or unknown data and the method of payment variable had 4.1% missing/unknown data.

This study also has some inherent limitations. First, we are only able to use the variables captured by the dataset. Variables that would have been interesting and likely pertinent to examine include maternal income data, birth attendant demographic information and others. In addition, this dataset does not contain information about which CDs were done on the basis of patient request. This is a topic of much interest currently and one where it would be helpful to have more data.

The issue of primary elective CD is at the forefront of obstetric practice and more research needs to be done in this area. A prospective observational cohort study comparing cesarean delivery and vaginal delivery in terms of maternal and fetal outcomes, risks and benefits would be a welcome addition to the knowledge base in this area. This study could also incorporate more variables such as physician demographic information, physician attitudes toward CD versus vaginal delivery, rural versus urban location, neonatal outcomes and other variables.

This study also has potential impact regarding public health issues. One issue at the core of the discussion about primary elective CD is that women are fully informed about both the maternal and neonatal risks and benefits, as we know them, of this procedure. One possible public health intervention would be to target an educational campaign at women who are more likely to have a primary elective CD. This would include black women, older women, and those living in Central or Eastern Virginia. Such an educational effort would attempt to inform women of the aforementioned risks and benefits of CD and should also include physicians to make sure they are up to date with current medical information on this issue. A second public health issue is the ethics involved in performing elective CDs. Currently, this is a hotly debated issue and rightfully so. Cesarean delivery is major abdominal surgery and not to be taken lightly. Therefore, it would seem important to keep this debate going and not to become complacent with regard to the increasing rate of CD in the U.S. As more information becomes available regarding the risks and benefits of CD, the ethics involved in doing this procedure may change accordingly. Finally, there is a substantial monetary cost to our healthcare system associated with performing cesareans instead of allowing spontaneous vaginal delivery. According to Resnik, the 1.2 million cesarean sections that are done annually conservatively translate into a cost to the healthcare system of about $15-16 billion per year.[12] With the current dynamic in obstetric practice—that is, an increasing rate of primary CD, an increasing rate of repeat CD and a decreasing rate of VBACs—the overall CD rate seems only destined to increase. Thus, the associated healthcare costs will continue to rise. This is another reason that would seem to warrant serious discussion about CD in general and particularly elective CD since it creates potentially unnecessary healthcare costs. In conclusion, the goals of public health efforts

in this area are to protect the health of both mother and fetus by encouraging the responsible use of CD and to save healthcare system money by discouraging the use of unnecessary CDs.

Tables

Table 1 - Descriptive Statistics and Frequencies of Women in Virginia Undergoing Primary Cesarean Section vs. Primary Vaginal Birth, 2004

	Total (N=18,873)		Primary C-Section (N=3,103)		Primary Vaginal Birth (N=15,770)	
Variable	**N**	**%**	**N**	**%**	**N**	**%**
Maternal race						
White	13738	72.8	2142	69.0	11596	73.5
Black	3489	18.5	705	22.7	2784	17.7
Asian	1070	5.7	173	5.6	897	5.7
Other	555	2.9	81	2.6	474	3.0
Unknown/Missing	21	0.1	2	0.1	19	0.1
Maternal age						
19 and younger	3438	18.2	405	13.1	3033	19.2
20-24	5690	30.1	755	24.3	4935	31.3
25-29	4933	26.1	853	27.5	4080	25.9
30-34	3409	18.1	698	22.5	2711	17.2
35-39	1177	6.2	314	10.1	863	5.5
40 and older	225	1.2	78	2.5	147	0.9
Unknown/Missing	1	0.0	0	0.0	1	0.0
Maternal residence						
Central Virginia Region	2969	15.7	668	21.5	2301	14.6
Eastern Virginia Region	4839	25.6	758	24.4	4081	25.9
Northern Virginia Region	5653	30.0	875	28.2	4778	30.3
Northwest Virginia Region	2558	13.6	421	13.6	2137	13.6
Southwest Virginia Region	2854	15.1	381	12.3	2473	15.7
Unknown/Missing	0	0				
Maternal Education Level						
Elem and Middle School	742	3.9	83	2.7	659	4.2
High School	7864	41.7	1140	36.7	6724	42.6
College	9893	52.4	1808	58.3	8085	51.3
Unknown/Missing	374	2.0	72	2.3	302	1.9
Method of payment						
Medicaid	4731	25.1	629	20.3	4102	26.0
Private insurance	12531	66.4	2229	71.8	10302	65.3
Self pay	832	4.4	82	2.6	750	4.8
Unknown/Missing	779	4.1	163	5.3	616	3.9
Birth Attendant						
Physician	17313	91.7	3050	98.3	14263	90.4
Midwife	0	0.0	0	0.0	0	0.0
Nurse Midwife	1306	6.9	17	0.5	1289	8.2
Other attendant	67	0.4	7	0.2	60	0.4
D.O.	131	0.7	13	0.4	118	0.7
Unknown/Missing	56	0.3	16	0.5	40	0.3
Number of prenatal visits						
None	113	0.6	12	0.4	101	0.6
1 to 5	434	2.3	62	2.0	372	2.4
6 to 10	4979	26.4	784	25.3	4195	26.6
11 to 15	12056	63.9	1987	64.0	10069	63.8
16 to 20	911	4.8	200	6.4	711	4.5
21 to 25	87	0.5	27	0.9	60	0.4
26 or more	30	0.2	8	0.3	22	0.1
Unknown/Missing	263	1.4	23	0.7	240	1.5

Table 2 - Prevalence of Women Undergoing Primary Cesarean Section with Singleton Births of at Least 38 Weeks Gestation in Virginia, 2004

Variable	Total (N)	Primary C-Section (N)	Prevalence (%)	95% CI LL	95% CI UL
Maternal race					
White	13738	2142	15.6	14.99	16.20
Black	3489	705	20.2	18.87	21.54
Asian	1070	173	16.2	13.96	18.37
Other	555	81	14.6	11.66	17.53
Unknown/Missing	21 (<1%)				
Maternal age					
19 and younger	3438	405	11.8	10.70	12.86
20-24	5690	755	13.3	12.39	14.15
25-29	4933	853	17.3	16.24	18.35
30-34	3409	698	20.5	19.12	21.83
35-39	1177	314	26.7	24.15	29.20
40 and older	225	78	34.7	28.45	40.89
Unknown/Missing	1 (<1%)				
Maternal residence					
Central Virginia Region	2969	668	22.5	21.00	24.00
Eastern Virginia Region	4839	758	15.7	14.64	16.69
Northern Virginia Region	5653	875	15.5	14.54	16.42
Northwest Virginia Region	2558	421	16.5	15.02	17.90
Southwest Virginia Region	2854	381	13.3	12.10	14.60
Unknown/Missing	0 (0.0%)				
Maternal Education Level					
Elem and Middle School	742	83	11.2	8.92	13.45
High School	7864	1140	14.5	13.72	15.27
College	9893	1808	18.3	17.51	19.04
Unknown/Missing	374 (2.0%)				
Method of payment					
Medicaid	4731	629	13.3	12.33	14.26
Private insurance	12531	2229	17.8	17.12	18.46
Self pay	832	82	9.9	7.83	11.88
Unknown/Missing	779 (4.1%)				
Birth Attendant					
Physician	17313	3050	17.6	17.05	18.18
Midwife	0	0	0.0		
Nurse Midwife	1306	17	1.3	0.69	1.92
Other attendant	67	7	10.4	3.12	17.77
D.O.	131	13	9.9	4.80	15.04
Unknown/Missing	56 (<1%)				
Number of prenatal visits					
None	113	12	10.6	4.94	16.30
1 to 5	434	62	14.3	10.99	17.58
6 to 10	4979	784	15.7	14.73	16.76
11 to 15	12056	1987	16.5	15.82	17.14
16 to 20	911	200	22.0	19.27	24.64
21 to 25	87	27	31.0	21.31	40.76
26 or more	30	8	26.7	10.84	42.49
Unknown/Missing	263 (1.4%)				

Table 3 - Odds Ratio of Primary Cesarean Section Among Pregnant Women in Virginia with Singleton Births of at Least 38 Weeks Gestation, 2004

Variable	Primary C-Section (N)	Total (N)	OR	95% CI LL	95% CI UL	p-value
Maternal race						
White	2142	13738	referent			
Black	705	3489	1.37	1.25	1.51	<0.01
Asian	173	1070	1.04	0.88	1.24	0.62
Other	81	555	0.93	0.73	1.18	0.53
Maternal age						
19 and younger	405	3438	0.87	0.77	0.99	0.04
20-24	755	5690	referent			
25-29	853	4933	1.37	1.23	1.52	<0.01
30-34	698	3409	1.68	1.50	1.88	<0.01
35-39	314	1177	2.38	2.05	2.76	<0.01
40 and older	78	225	3.47	2.61	4.61	<0.01
Maternal residence						
Central Virginia Region	668	2969	1.59	1.42	1.77	<0.01
Eastern Virginia Region	758	4839	1.01	0.91	1.13	0.79
Northern Virginia Region	875	5653	referent			
Northwest Virginia Region	421	2558	1.08	0.95	1.22	0.26
Southwest Virginia Region	381	2854	0.84	0.74	0.96	0.01
Maternal Education Level						
Elementary and Middle School	83	742	0.74	0.59	0.94	0.01
High School	1140	7864	referent			
College	1808	9893	1.32	1.22	1.43	<0.01
Method of payment						
Medicaid	629	4731	referent			
Private insurance	2229	12531	1.41	1.28	1.55	<0.01
Self pay	82	832	0.71	0.56	0.91	<0.01
Birth Attendant						
Physician	3050	17313	referent			
Nurse Midwife	17	1306	0.06	0.04	0.10	<0.01
Other attendant	7	67	0.55	0.25	1.20	0.13
D.O.	13	131	0.52	0.29	0.92	0.02
Number of prenatal visits						
None	12	113	0.60	0.33	1.10	0.98
1 to 5	62	434	0.85	0.64	1.11	0.23
6 to 10	784	4979	0.95	0.87	1.04	0.95
11 to 15	1987	12056	referent			
16 to 20	200	911	1.43	1.21	1.68	<0.01
21 to 25	27	87	2.28	1.44	3.60	<0.01
26 or more	8	30	1.84	0.82	4.15	0.14

Table 4 - Crude and Adjusted Odds Ratio of Primary Cesarean Section Among Women in Virginia with Singleton Births of at Least 38 Weeks Gestation, 2004

			Crude		Adjusted	
Variable	**Total (N)**	**Prim C-Section (N)**	**OR**	**95% CI**	**OR**	**95% CI**
Maternal race						
White	13738	2142	referent		referent	
Black	3489	705	1.37	1.25, 1.51**	1.58	1.42, 1.76**
Asian	1070	173	1.04	0.88, 1.24	0.96	0.80, 1.15
Other	555	81	0.93	0.73, 1.18	1.07	0.82, 1.40
Maternal age						
19 and younger	3438	405	0.87	0.77, 0.99*	0.87	0.76, 1.00
20-24	5690	755	referent		referent	
25-29	4933	853	1.37	1.23, 1.52**	1.50	1.33, 1.69**
30-34	3409	698	1.68	1.50, 1.88**	1.84	1.61, 2.11**
35-39	1177	314	2.38	2.05, 2.76**	2.57	2.16, 3.05**
40 and older	225	78	3.47	2.61, 4.61**	3.81	2.76, 5.26**
Maternal residence						
Central Virginia Region	2969	668	1.59	1.42, 1.77**	1.80	1.58, 2.04**
Eastern Virginia Region	4839	758	1.01	0.91, 1.13	1.27	1.12, 1.44**
Northern Virginia Region	5653	875	referent		referent	
Northwest Virginia Region	2558	421	1.08	0.95, 1.22	1.40	1.22, 1.61**
Southwest Virginia Region	2854	381	0.84	0.74, 0.96*	0.98	0.84, 1.13
Maternal Education Level						
Elem and Middle School	742	83	0.74	0.59, 0.94*	0.91	0.71, 1.18
High School	7864	1140	referent		referent	
College	9893	1808	1.32	1.22, 1.43**	0.92	0.83, 1.02
Method of payment						
Medicaid	4731	629	referent		referent	
Private insurance	12531	2229	1.41	1.28, 1.55**	1.22	1.09, 1.37**
Self pay	832	82	0.71	0.56, 0.91**	0.75	0.58, 0.98*
Birth Attendant						
Physician	17313	3050	referent		referent	
Nurse Midwife	1306	17	0.06	0.04, 0.10**	0.06	0.04, 0.10**
Other attendant	67	7	0.55	0.25, 1.20	0.74	0.33, 1.66
D.O.	131	13	0.52	0.29, 0.92*	0.52	0.28, 0.97*
Number of prenatal visits						
None	113	12	0.60	0.33, 1.10	0.61	0.27, 1.34
1 to 5	434	62	0.85	0.64, 1.11	0.92	0.67, 1.26
6 to 10	4979	784	0.95	0.87, 1.04	0.99	0.89, 1.09
11 to 15	12056	1987	referent		referent	
16 to 20	911	200	1.43	1.21, 1.68**	1.33	1.11, 1.58**
21 to 25	87	27	2.28	1.44, 3.60**	2.43	1.47, 4.02**
26 or more	30	8	1.84	0.82, 4.15	1.73	0.69, 4.34

* p-value <0.05
** p-value <0.01

Table 5 - Virginia household income data, 1999

Maternal residence	Mean of the median household income, 1999
Central Virginia Region	$ 38,736
Eastern Virginia Region	$ 40,384
Northern Virginia Region	$ 71,102
Northwest Virginia Region	$ 41,413
Southwest Virginia Region	$ 31,752

Figures

Figure 1—Cesarean delivery subheadings and terminology

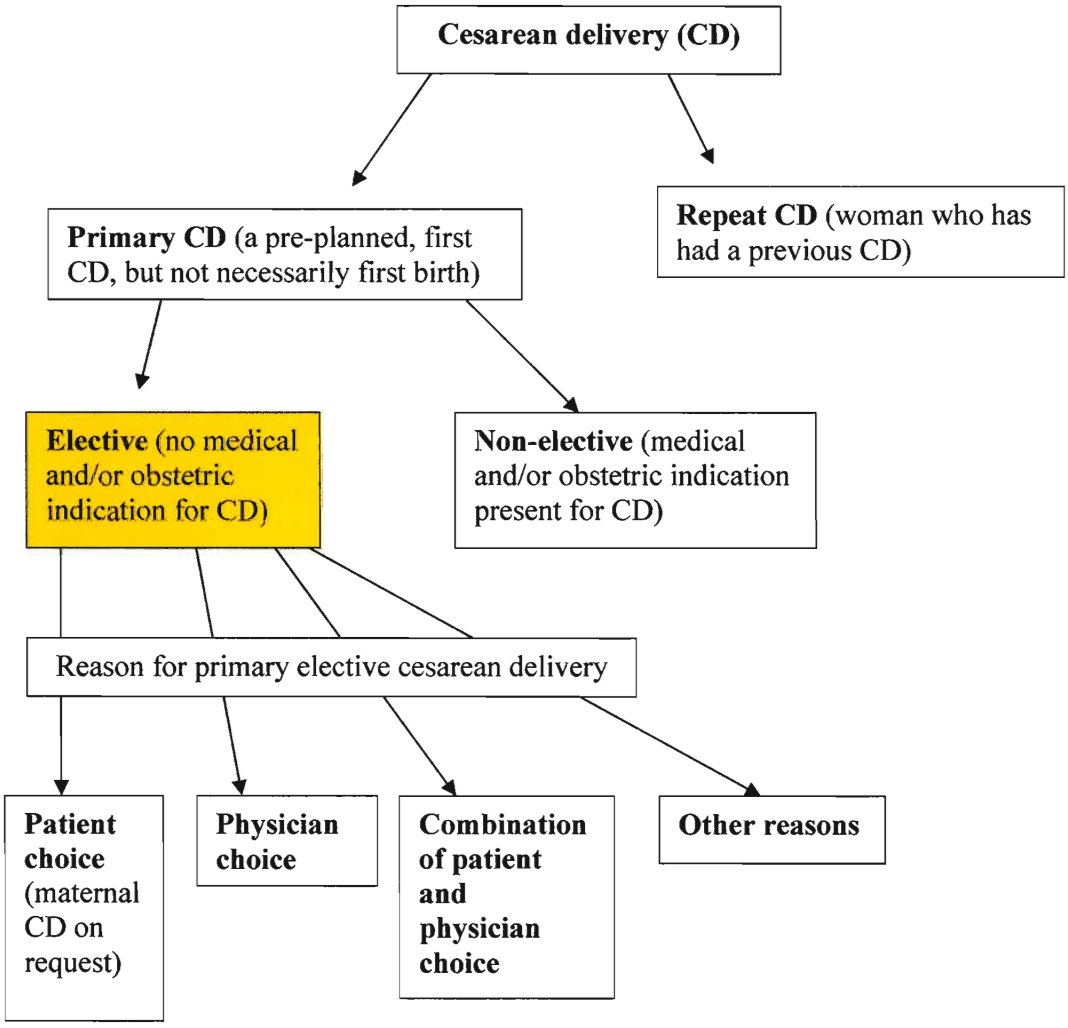
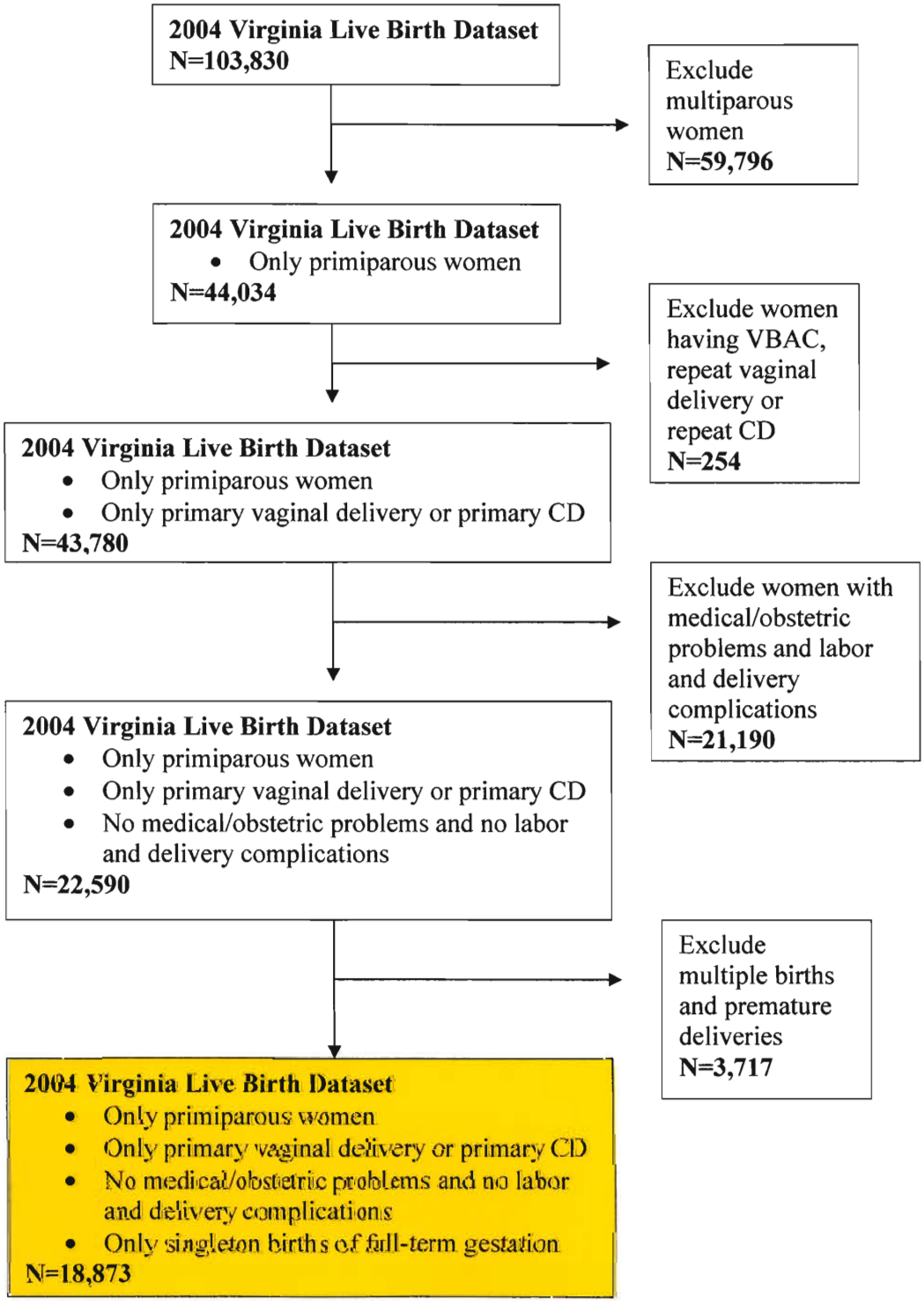


Figure 2—Flowchart of participant selection for the study



Appendices

Appendix 1: Geographic regions of Virginia by county and city

Central Virginia Region includes:
Amelia County
Brunswick County
Buckingham County
Charles City County
Charlotte County
Chesterfield County
Colonial Heights City
Cumberland County
Dinwiddie County
Emporia City
Goochland County
Greensville County
Halifax County
Hanover County
Henrico County
Hopewell City
Lunenburg County
Mecklenburg County
New Kent County
Nottoway County
Petersburg City
Powhatan County
Prince Edward County
Prince George County
Richmond City
Surry County
Sussex County

Appendix 1 (continued): Geographic regions of Virginia by county and city

Eastern Virginia Region includes:
Accomack County
Chesapeake City
Essex County
Franklin City
Gloucester County
Hampton City
Isle of Wight County
James City County
King and Queen County
King William County
Lancaster County
Mathews County
Middlesex County
Newport News City
Norfolk City
Northampton County
Northumberland County
Poquoson City
Portsmouth City
Richmond County
Southampton County
Suffolk City
Virginia Beach City
Westmoreland County
Williamsburg City
York County

Appendix 1 (continued): Geographic regions of Virginia by county and city

Northern Virginia Region includes:
Alexandria City
Arlington County
Fairfax City
Fairfax County
Falls Church City
Loudoun County
Manassas City
Manassas Park City
Prince William County

Appendix 1 (continued): Geographic regions of Virginia by county and city

Northwest Virginia Region includes:
Albemarle County
Augusta County
Bath County
Buena Vista City
Caroline County
Charlottesville City
Clarke County
Culpeper County
Fauquier County
Fluvanna County
Frederick County
Fredericksburg City
Greene County
Harrisonburg City
Highland County
King George County
Lexington City
Louisa County
Madison County
Nelson County
Orange County
Page County
Rappahannock County
Rockbridge County
Rockingham County
Shenandoah County
Spotsylvania County
Stafford County
Staunton City
Warren County
Waynesboro City
Winchester City

Appendix 1 (continued): Geographic regions of Virginia by county and city

Southwest Virginia Region includes:

Alleghany County
Amherst County
Appomattox County
Bedford City
Bedford County
Bland County
Botetourt County
Bristol City
Buchanan County
Campbell County
Carroll County
Clifton Forge City
Covington City
Craig County
Danville City
Dickenson County
Floyd County
Franklin County
Galax City
Giles County
Grayson County
Henry County
Lee County
Lynchburg City
Martinsville City
Montgomery County
Norton City
Patrick County
Pittsylvania County
Pulaski County
Radford City
Roanoke City
Roanoke County
Russell County
Salem County
Scott County
Smyth County
Tazewell County
Washington County
Wise County
Wythe County

Appendix 2: Commonwealth of Virginia – Certificate of Live Birth

VS 1 1/93

COMMONWEALTH OF VIRGINIA-CERTIFICATE OF LIVE BIRTH
DEPARTMENT OF HEALTH-DIVISION OF VITAL RECORDS
RICHMOND

DATE RECORD FILED | REGISTRATION AREA NUMBER | CERTIFICATE NUMBER | STATE BIRTH NUMBER 145–

IMPORTANT: Use black ribbon in typewriter or print legibly in black unfading ink. This is a permanent record and subject to reproduction by microfilm and other photographic process.

MARGIN RESERVED FOR BINDING

THIS CHILD
1. FULL NAME OF CHILD (first) (middle) (last)
2. SEX OF CHILD ☐ male ☐ female
3. DATE AND TIME OF BIRTH (month) (day) (year) (hour)_____ a.m. _____ p.m.
4. THIS BIRTH ☐ single ☐ twin ☐ triplet
5. IF TWIN OR TRIPLET, BORN ☐ 1ST ☐ 2ND ☐ 3RD

PLACE OF BIRTH
6. NAME OF HOSPITAL OR INSTITUTION OF BIRTH
7. COUNTY OF BIRTH (If independent city, leave blank)
8. CITY OR TOWN OF BIRTH — Inside city limits? ☐ Yes ☐ No
9. STREET ADDRESS OR ROUTE NO. OF PLACE OF BIRTH

USUAL RESIDENCE OF MOTHER
10. STATE (OR FOREIGN COUNTRY) OF MOTHER'S RESIDENCE
11. COUNTY OF RESIDENCE (If independent city, leave blank)
12. CITY OR TOWN OF RESIDENCE — Inside city limits? ☐ Yes ☐ No
13. STREET ADDRESS OR ROUTE NO. OF RESIDENCE — ZIP CODE

MOTHER
14. FULL MAIDEN NAME OF MOTHER
15. AGE OF MOTHER — YEARS
16. MOTHER'S PLACE OF BIRTH (state or foreign country)

FATHER (omit if not married to mother)
17. FULL NAME OF FATHER
18. AGE OF FATHER — YEARS
19. FATHER'S PLACE OF BIRTH (state or foreign country)

INFORMANT
20. I CERTIFY THE ABOVE TO BE CORRECT (signature of mother, father, or other informant) — RELATIONSHIP TO CHILD:

ATTENDANT'S CERTIFICATION
21. I CERTIFY THAT THIS CHILD WAS BORN ALIVE ON THE DATE AND HOUR STATED ABOVE. ☐ MD ☐ DO ☐ CNM ☐ MIDWIFE ☐ OTHER: DATE RECORD SIGNED:
(signature of attendant)
NAME OF ATTENDANT (type or print) — ADDRESS OF ATTENDANT:

REGISTRAR
22. REGISTRAR'S SIGNATURE
RESERVED FOR REGISTRAR'S USE

I request a Social Security card for this child _____ Signature _____ Date

Social Security cards are issued by the Social Security Administration and may take 3 - 4 months for receipt.

CONFIDENTIAL DATA FOR OFFICIAL USE ONLY (this section must be completed) Items 28 and 32 specifically required by Federal Statute

23. CHILD'S MEDICAL RECORD NUMBER
24. MOTHER'S MEDICAL RECORD NUMBER
25. IS MOTHER MARRIED TO FATHER OF CHILD? (OR WAS SHE AT ANY TIME DURING THE 10 MONTHS PRECEDING BIRTH?) ☐ YES ☐ NO
26. RACE OF MOTHER
27. IS MOTHER OF HISPANIC ORIGIN? If Yes, specify Cuban, Mexican, Puerto Rican, etc.: ☐ No ☐ Yes
28. MOTHER'S SOCIAL SECURITY NUMBER
29. EDUCATION OF MOTHER (specify only the highest grade completed) Elementary/Secondary (0-12)_____ College (1-4 or 5 +)_____
30. RACE OF FATHER (omit if not married to mother)
31. IS FATHER OF HISPANIC ORIGIN? If Yes, specify Cuban, Mexican, Puerto Rican, etc.: ☐ No ☐ Yes
32. FATHER'S SOCIAL SECURITY NUMBER
33. EDUCATION OF FATHER (specify only the highest grade completed) Elementary/Secondary (0-12)_____ College (1-4 or 5 +)_____
34. MONTH IN WHICH PRENATAL CARE BEGAN ☐ NONE ☐ 1ST ☐ 2ND ☐ 3RD ☐ 4TH ☐ 5TH ☐ 6TH ☐ 7TH ☐ 8TH ☐ 9TH
35. PRENATAL VISITS Total number (If none, so state)
36. A. SOURCE PRENATAL CARE (check all that apply) ☐ Pvt Phys ☐ Hlth Dept ☐ Other
B. MAIN PAYMENT SOURCE FOR DELIVERY (check only one) ☐ Medicaid ☐ Private Insurance ☐ Self-Pay
37. WEIGHT AT BIRTH (grams)
38. DATE LAST NORMAL MENSES BEGAN (month, day, year)
39. PHYSICIAN'S ESTIMATE OF GESTATION (weeks)

40. PREGNANCY HISTORY (complete each section)
a. LIVE BIRTHS (do not include this child) Now Living, Number_____ ☐ None Now Dead, Number_____ ☐ None — DATE OF LAST LIVE BIRTH (month, year)_____
b. OTHER TERMINATIONS (spontaneous and induced at any time after conception) Number_____ ☐ None — DATE OF LAST OTHER TERMINATION (month, year)_____
41. APGAR SCORE: 1 MIN. | 5 MIN.

42. MOTHER TRANSFERRED PRIOR TO DELIVERY? If Yes, enter name of facility transferred from: ☐ No ☐ Yes
43. INFANT TRANSFERRED? If Yes, enter name of facility transferred to: ☐ No ☐ Yes

44. MEDICAL HISTORY FOR THIS PREGNANCY (check all that apply)
Anemia (Hct. < 30/Hgb. < 10) 01 ☐
Cardiac disease 02 ☐
Acute or chronic lung disease 03 ☐
Diabetes 04 ☐
Genital herpes 05 ☐
Hydramnios/Oligohydramnios 06 ☐
Hemoglobinopathy 07 ☐
Hypertension, chronic 08 ☐
Hypertension, pregnancy-associated 09 ☐
Eclampsia 10 ☐
Incompetent cervix 11 ☐
Previous infant 4000 + grams 12 ☐
Previous preterm or small-for-gestational-age infant 13 ☐
Renal disease 14 ☐
Rh sensitization 15 ☐
Uterine bleeding 16 ☐
Maternal infections (specify)_____ 17 ☐
None 00 ☐
Other (specify)_____ 18 ☐

45. OTHER HISTORY FOR THIS PREGNANCY (complete all items)
Tobacco use during pregnancy ☐ Yes ☐ No
Average number cigarettes per day _____
Alcohol use during pregnancy ☐ Yes ☐ No
Average number drinks per week _____
Drug use during pregnancy:
Heroin ☐ Yes ☐ No
Methadone ☐ Yes ☐ No
Marijuana ☐ Yes ☐ No
Cocaine or Crack ☐ Yes ☐ No
Amphetamines ☐ Yes ☐ No
Other street drugs ☐ Yes ☐ No
(specify)_____
Weight gained during pregnancy_____ lbs.

46. EVENTS OF LABOR AND/OR DELIVERY (check all that apply)
Febrile (> 100° F. or 38° C.) 01 ☐
Meconium, moderate/heavy 02 ☐
Premature rupture of membrane (>12 hrs.) 03 ☐
Abruptio placenta 04 ☐
Placenta previa 05 ☐
Other excessive bleeding 06 ☐
Seizures during labor 07 ☐
Precipitous labor (< 3 hrs.) 08 ☐
Prolonged labor (> 20 hrs.) 09 ☐
Dysfunctional labor 10 ☐
Breech/Malpresentation 11 ☐
Cephalopelvic disproportion 12 ☐
Cord prolapse 13 ☐
Anesthetic complications 14 ☐
Fetal distress 15 ☐
None 00 ☐
Other (specify)_____ 16 ☐

47. OBSTETRIC PROCEDURES (check all that apply)
Amniocentesis 01 ☐
Electronic fetal monitoring 02 ☐
Induction of labor 03 ☐
Stimulation of labor 04 ☐
Tocolysis 05 ☐
Ultrasound 06 ☐
None 00 ☐
Other (specify)_____ 07 ☐

48. CONDITIONS OF THE NEWBORN (check all that apply)
Anemia (Hct. < 39/Hgb. < 13) 01 ☐
Birth injury 02 ☐
Fetal alcohol syndrome 03 ☐
Hyaline membrane disease/RDS 04 ☐
Meconium aspiration syndrome 05 ☐
Assisted ventilation < 30 min. 06 ☐
Assisted ventilation ≥ 30 min. 07 ☐
Seizures 08 ☐
Infectious condition (specify)_____ 09 ☐
Expired 10 ☐
None 00 ☐
Other (specify)_____ 11 ☐

49. METHOD OF DELIVERY (check all that apply)
Vaginal 01 ☐
Vaginal birth after previous C-section 02 ☐
Primary C-section 03 ☐
Repeat C-section 04 ☐
Forceps 05 ☐
Vacuum 06 ☐

50. CONGENITAL ANOMALIES OF CHILD (check all that apply)
Anencephalus 01 ☐
Spina bifida/Meningocele 02 ☐
Hydrocephalus 03 ☐
Microcephalus 04 ☐
Other central nervous system anomalies (specify)_____ 05 ☐
Heart malformations 06 ☐
Other circulatory/respiratory anomalies (specify)_____ 07 ☐
Rectal stenosis/stenosis 08 ☐
Tracheo-esophageal fistula/Esophageal stenosis 09 ☐
Omphalocele/Gastroschisis 10 ☐
Other gastrointestinal anomalies (specify)_____ 11 ☐
Malformed genitalia 12 ☐
Renal agenesis 13 ☐
Other urogenital anomalies (specify)_____ 14 ☐
Cleft lip/palate 15 ☐
Polydactyly/Syndactyly/Adactyly 16 ☐
Club foot 17 ☐
Diaphragmatic hernia 18 ☐
Other musculoskeletal/integumental anomalies (specify)_____ 19 ☐
Down's syndrome 20 ☐
Other Chromosomal anomalies (specify)_____ 21 ☐
None 00 ☐
Other (specify)_____ 22 ☐

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