health watch

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

November 2011 No. 81

Cesarean Section Deliveries and Inductions of Labor in Colorado: An Analysis of Current Trends and Demographics

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Introduction

Two relatively common medical procedures related to the delivery of a newborn are induction of labor and cesarean section. Cesarean section deliveries are typically performed in the presence of medical indicators which render vaginal delivery potentially harmful to the mother or baby. These indicators include, but are not limited to, a previous cesarean section or other uterine surgery, an infant too large to pass safely through the vagina, an infant presenting in the breech or transverse position, placental problems, umbilical cord prolapse, maternal infections such as HIV or genital herpes, multiple births, fetal distress during labor and certain types of birth defects. Meanwhile inductions of labor are performed in the presence of indicators such as a pregnancy lasting more than 42 weeks, maternal high blood pressure, a uterine infection, maternal diabetes, and an infant growth problem resulting in an infant that is too small.[1] Both procedures are appropriate when medically indicated, particularly when the mother's or baby's life or health are at risk.

Delivery by cesarean section at maternal request and induction of labor without medical indication are controversial and relevant topics of discussion in the United States today. Although there is a vast discrepancy across the field of modern obstetrics on the appropriateness of these procedures,[2] Healthy People 2020 retains its 2010 initiative to reduce cesarean sections among low-risk women to promote the well being of mothers and infants.[3] National evidence suggests that the proportion of elective cesarean sections and inductions are significantly increasing, contributing to the overall increase of cesarean sections and inductions of labor in recent years.[4] A cesarean section is a major abdominal surgery carrying risks to both the mother (including thrombosis, excess bleeding, and bladder damage) and infant (including breathing difficulties), and may also lead to increased cost due to extended hospital stays.[5] Labor induction at any gestational age has also been associated with a two-fold increase in the rate of cesarean delivery.[6]

Due to the contentious nature of these elective procedures, it is difficult to ascertain the true reason (i.e. medically indicated or elective) cesarean sections and inductions of labor are being performed; thus, reliable, population-based data for elective procedures are scant. It is

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worthwhile, however, to utilize existing data containing general information about cesarean section and labor induction to facilitate a better understanding of the trends and populations undergoing these procedures. The goal of this report, therefore, is to inform the medical and public health communities about the use of cesarean section and labor induction, and bring them one step closer to identifying and reducing unnecessary elective procedures.

Methods

Statistics regarding cesarean sections and inductions of labor were based on data from Colorado's birth certificate registry, which are maintained by the Health Statistics Section at the Colorado Department of Public Health and Environment. A group of 1,251,817 birth records was utilized from birth years 1990-2010. Inclusion criteria consisted of all singleton births occurring within Colorado to Colorado resident mothers. Smaller subpopulations were extracted from this initial selection for further analysis.

Results

In 2010, 24.4 percent of all live births in Colorado were delivered via cesarean section, while 20.6 percent of Colorado deliveries included induction of labor (Table 1.) It is worth noting that induction of labor and cesarean section are not mutually exclusive, and that a single delivery may have included both procedures. In 2010, there were 2,208 deliveries in which both procedures were performed, that is, 14.2 percent of all cesarean section deliveries were preceded by induction, while 16.8 percent of all inductions were followed by a cesarean section.

Maternal Characteristics

The percentage of births by cesarean section increases along with maternal age (<18 years: 13.6%; 35+ years: 32.5%); maternal education, with the exception of mothers with an 8th grade education or less—a phenomenon possibly due to complications in very young mothers (9th-12th grade, no diploma: 19.6%; doctorate or professional degree: 31.3%); and increasing household income (<$15,000: 20.9%; $75,000+: 29.8%). Asian American/Pacific Islander mothers have the highest cesarean section rate (27.9%), while White-Hispanic mothers have the lowest (22.1%). Married mothers have a higher rate (25.3%) than nonmarried mothers (22.2%). Deliveries for which the principal source of payment of the delivery was private insurance have the highest percentage (27.4%), while those identified as "self-pay" have the lowest (13.6%). As expected, mothers who had a previous birth and a previous cesarean section had a rate much higher (81.1%) than mothers who have had a previous birth and no previous cesarean section (10.9%). However, mothers with no previous birth have a cesarean section rate very similar to the overall percentage (24.8%).

The percentage of labor inductions also increases with household income (<$15,000: 17.7%; $75,000+: 22.5%). The proportion of induction of labor and maternal age increases until 22-24 years of age and then decreases (<18 years: 17.7%; 22-24 years: 21.6%; 35+ years: 19.8%). The same is true for maternal education, increasing through an associate's degree and then decreasing (8th grade or less: 13.4%; associate's degree: 23.7%; doctorate or professional degree: 19.5%). Married mothers have a slightly higher percentage of labor inductions (20.8%) than do nonmarried mothers (20.0%). White, non-Hispanic mothers have the highest labor induction percentage (22.3%), while Asian American/Pacific Islander mothers have the lowest (16.5%). There is a similar percentage of labor inductions among mothers with a previous birth and no previous cesarean section (22.3%) and mothers with no previous birth (23.4%), while mothers who have had a previous birth and a previous cesarean section have a drastically lower rate (3.2%), likely due to the high prevalence of cesarean sections among women with previous cesarean section deliveries.

Table 1: Cesarean section deliveries and inductions of labor among live births by selected maternal characteristics: Colorado residents, 2010.

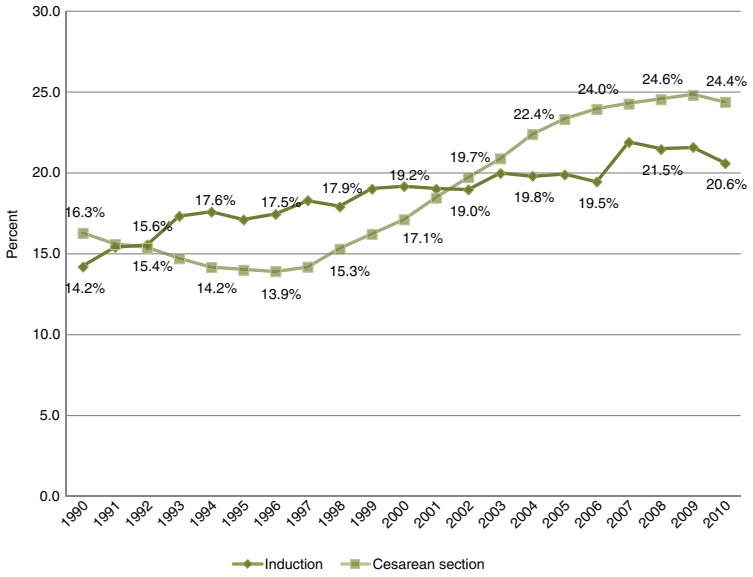
	Total Births (N)	Cesarean Sections (N)	Cesarean Sections (%)	Inductions of Labor (N)	Inductions of Labor (%)
TOTAL BIRTHS	63,852	15,575	24.39%	13,154	20.60%
MATERNAL AGE					
<18 years	1,718	234	13.62%	305	17.75%
18-21 years	8,733	1,496	17.13%	1,801	20.62%
22-24 years	8,835	1,829	20.70%	1,909	21.61%
25-30 years	21,793	5,019	23.03%	4,573	20.98%
31-34 years	12,609	3,423	27.15%	2,545	20.18%
35+ years	2,394	778	32.50%	473	19.76%
MATERNAL RACE					
White non-Hispanic	38,238	9,606	25.12%	8,765	22.92%
White Hispanic	16,113	3,558	22.08%	2,680	16.63%
Black	3,291	857	26.04%	544	16.53%
Asian American/ Pacific Islander	2,403	670	27.88%	396	16.48%
American Indian/ Alaskan Native	635	147	23.15%	118	18.58%
Other/Unknown	3,172	737	23.23%	651	20.52%
MATERNAL EDUCATION					
8th grade or less	2,782	609	21.89%	373	13.41%
9th-12th grade, no diploma	9,060	1,772	19.56%	1,531	16.90%
High school graduate or GED	12,854	2,867	22.30%	2,612	20.32%
Some college credit, no degree	13,385	3,131	23.39%	3,128	23.37%
Associate's degree	4,534	1,252	27.61%	1,075	23.71%
Bachelor's degree	13,620	3,691	27.10%	2,965	21.77%
Master's degree	5,465	1,613	29.52%	1,076	19.69%
Doctorate or professional degree	8,162	468	31.26%	292	19.51%
HOUSEHOLD INCOME					
<$15,000	15,344	3,203	20.87%	2,719	17.71%
$15,000 - $24,999	7,705	1,730	22.45%	1,515	19.66%
$25,000 - $34,000	5,700	1,348	23.65%	1,236	21.68%
$35,000 - $49,999	5,456	1,305	23.92%	1,193	21.87%
$50,000 - $74,999	8,162	2,059	25.23%	1,870	22.91%
$75,000+	14,775	4,409	29.84%	3,320	22.47%
MARITAL STATUS					
Married	47,642	11,984	25.25%	9,921	20.82%
Not married	16,138	3,578	22.17%	3,224	19.98%
ESTIMATED GESTATION					
<32 weeks	702	357	50.85%	68	21.69%
32-36 weeks	3,934	1,295	32.92%	550	9.69%
37 weeks	4,835	1,225	25.34%	831	13.98%
38 weeks	10,434	2,427	23.26%	1,533	17.19%
39 weeks	22,698	6,396	28.18%	4,923	14.69%
40 weeks	15,444	2,595	16.80%	3,325	21.53%
>40 weeks	5,787	1,279	22.10%	1,924	33.25%
PAYMENT TYPE					
Private insurance	32,702	8,970	27.43%	7,247	22.16%
Self-pay	2,684	364	13.56%	286	10.66%
Medicaid	23,754	5,216	21.96%	4,471	18.82%
Other source*	4,515	976	21.62%	1,120	24.81%
PREVIOUS BIRTH					
Previous birth, no previous c-section	30,165	3,296	10.93%	6,722	22.28%
Previous birth, previous c-section	6,979	5,659	81.09%	226	3.24%
No previous birth	26,655	6,607	24.79%	6,201	23.36%

*Includes CHAPMUS, TRICARE, Indian Health Service, other governmental sources, charity, other sources.
Births may be counted in both cesarean section and induction of labor categories when both procedures were performed.
Sums may not add to total due to cases with certain characteristics unknown.
SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

Trends Over Time

There was a marked increase in the percentage of births by cesarean section and induction of labor from 2000 to 2010 (Induction of labor, 2000: 19.0%; 2010: 20.6%; Cesarean section, 2000: 16.2%; 2010: 24.4%).

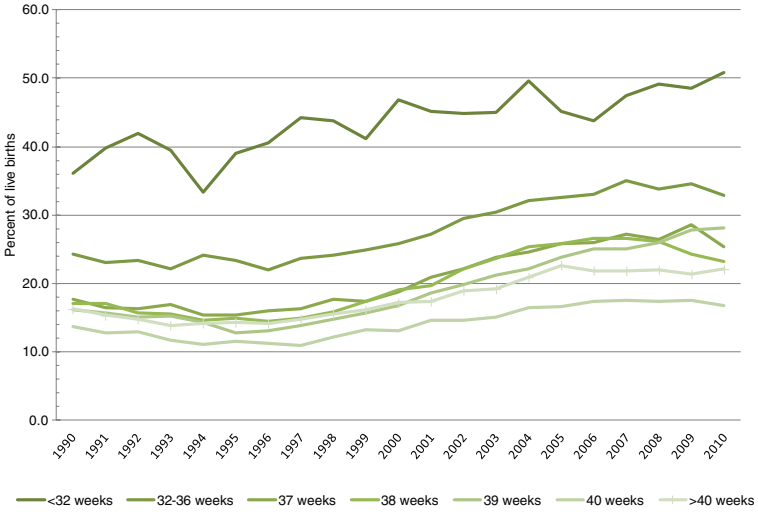
Figure 1: Induction of labor and cesarean section 1990-2010



SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

Trends by Estimated Gestational Age

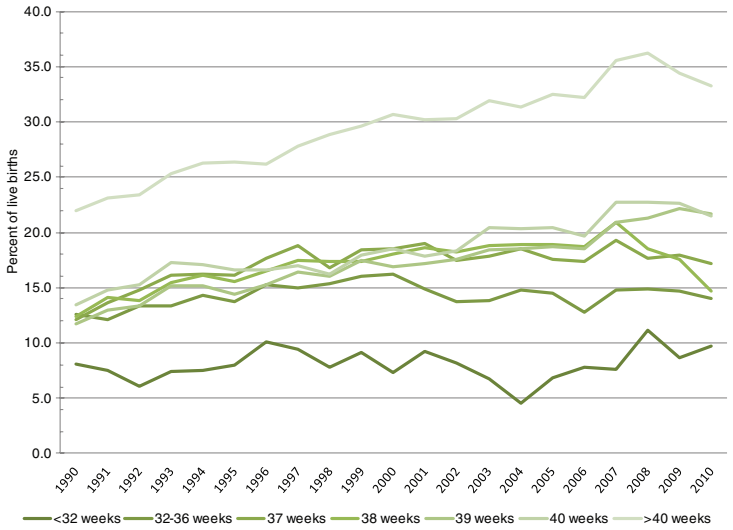
Figure 2: Cesarean section by estimated gestation 1990-2010



SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

While all of the gestation categories follow the generic shape of the overall cesarean section curve (Figure 2), there is a clear distinction between several of the individual gestational periods. Infants born at <32 weeks gestation have consistently held a rate of at least 8 percent higher than the next highest gestation category of 32-36 weeks, with a difference of 17.9 percent in 2010. Births at 40 weeks gestation consistently held the lowest percentage of cesarean sections, falling a few percentage points below a gestation of >40 weeks.

Figure 3: Induction of labor by estimated gestation 1990-2010



SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

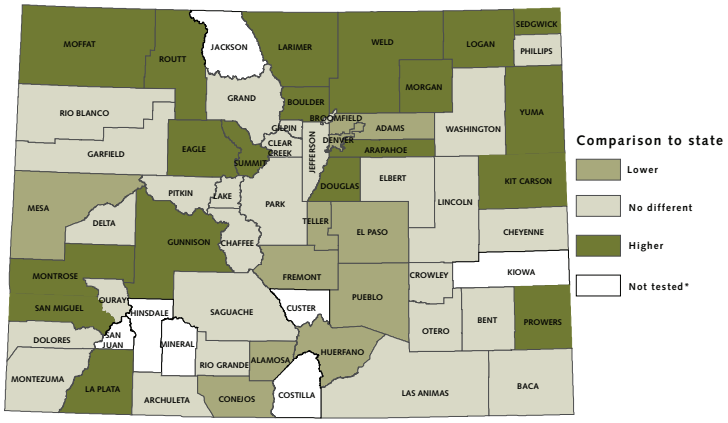
Again, all of the gestation categories follow the generic shape of the overall induction curve, but there is a clear distinction between several of the individual gestation periods. As expected, infants born with >40 weeks gestation have consistently held the highest percentage, while infants born with <32 weeks gestation have consistently held the lowest percentage. Each category's percentage showed a decrease from 2009 to 2010, with the exception of infants with <32 weeks gestation (increasing from 8.6% in 2009 to 9.7% in 2010).

Procedures by County of Residence

The proportion of live births delivered via cesarean section varied by maternal county of residence, ranging from 15.1 percent to 42.4 percent in the time period 2008-2010. Similarly,

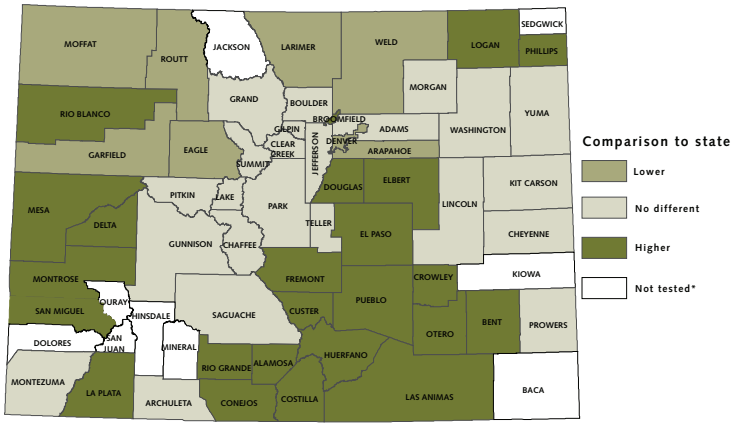
the proportion of induced live births also varied by maternal county of residence, ranging from 8.7 percent to 41.2 percent in the same period.

Figure 4: Cesarean Section Deliveries by Maternal County of Residence: Colorado Residents, 2008-2010.



*Counties with fewer than 20 cesarean section deliveries not tested for statistical difference from state proportion due to concerns with statistical reliability
SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

Figure 5: Inductions of Labor by Maternal County of Residence: Colorado Residents, 2008-2010.



*Counties with fewer than 20 inductions of labor not tested for statistical difference from state proportion due to concerns with statistical reliability
SOURCE: Health Statistics Section, Colorado Department of Public Health and Environment

Figures 4 and 5 present which counties' proportions of cesarean sections and inductions differ statistically from the statewide proportion. Geographic differences may reflect a variety of phenomena, including the distribution of higher risk pregnancies; differences in cultural or societal views of these procedures, and willingness to undergo them; regional differences in practice of hospitals specializing in complex or high risk deliveries that may utilize these procedures; and the availability of and access to elective procedures.

Interestingly, while deliveries via cesarean section are less common among younger and White women, Hispanic mothers, as well as mothers with lower educational attainment and household income, many counties that had statistically higher percentages of cesarean sections also have larger proportions of these socio-demographic characteristics. The same is true for inductions of labor, demonstrating that while deliveries utilizing these procedures vary by maternal demographics at the statewide level, it does not vary the same way across all of Colorado's counties. This suggests that there are additional factors not described here that influence both mothers' and physicians' decisions to utilize these procedures, and that additional county, community, and even hospital-specific analyses are warranted to describe and address these procedures

Discussion

Several increasing trends in the rates of both cesarean sections and inductions of labor are described in this report. The increase in cesarean section rates with increasing maternal age found here is supported by work done by Romero, et al. in North Carolina. In a survey conducted on opinions of cesarean delivery upon maternal request (CDMR), mothers who preferred CDMR tended to be significantly older than mothers who preferred vaginal birth.[2] The same was also found by Fairley et al. in a study conducted in Scotland.[5] Fairley et. al also found an increase in elective cesarean section rate with an increase in the level of maternal education in England, supported by our findings. They also reported, however, a decrease in overall cesarean section rate with an increase in maternal education level in both Norway and Scotland.[5] This is possibly due to an increased need for emergency cesarean section deliveries in younger mothers.

In Colorado, White Hispanic mothers had the lowest rate of cesarean delivery. This is supported by the survey conducted by Romero et al., who found that White Hispanic mothers were among those who supported cesarean section by maternal request the least.[2] Fairley et al. determined that single mothers were less likely than married mothers to have an elective cesarean delivery.[5] This is supported by the findings in this report. A study conducted in Austria, however, concluded there is no difference in cesarean rates among mothers with or without a supportive companion.[7] In agreement with our findings, it has been shown across the board that mothers with a previous cesarean section were far more likely to have a repeat cesarean section.[2,5]

Also in accordance with our findings, Revicky et al. found an increase in inductions of labor in older mothers and primiparous (first-time) mothers.[8] White non-Hispanic mothers were found to have the highest percentage of labor inductions, coinciding with the findings in a study conducted in Chicago, Illinois.[9]

The rate of cesarean sections and inductions of labor has been consistently increasing around the globe. One major reason for this increase is the increased perception of these procedures as "safe," despite the associated risks and increased costs.[10] Other considerations taken into account are women's rights and wishes (including a lack of confidence, fear of pain, and the experience of previous negative birth outcomes)[2] and maternal and professional satisfaction.[10]

The proportions of live birth deliveries utilizing these procedures are increasing among those of both early and greater gestational age. Of particular concern are the increases observed among those births of early gestation, that is, premature births.[8] Several studies have been conducted worldwide to confirm and promote the benefits of delaying these procedures to at least 39 weeks gestation, and to find methods to accomplish this.

Elective cesarean sections performed at 39 weeks gestation were found to be associated with an increased likelihood of respiratory morbidity and admissions to the neonatal intensive care unit.[11] A recent study conducted by the March of Dimes found that postponing any type of elective delivery to at least 39-weeks gestation was estimated to prevent 48 percent of cases of complications among deliveries at 37 weeks, and 28 percent of cases of complications among deliveries at 38 weeks.[4]

It is argued that the rate of elective deliveries (both cesarean sections and inductions of labor) should be decreased, especially those conducted before 39 weeks gestation. Information gathered from this report can be used in the development of interventions to identify those demographic groups with the highest rates. In Ohio, the rate of elective induction of labor before 39 weeks was reduced from 25 percent to 5 percent in just one year by changing hospital policies and processes and giving feedback to healthcare providers.[6] The rate of early term elective induction in Salt Lake City, Utah, fell from 28 percent to less than 3 percent after implementing strict guidelines that discouraged the use of elective induction.[6]

While the trends of the percentages of both cesarean sections and inductions of labor have shown a slight decrease from 2009 to 2010, possibly indicating a positive response to the knowledge of the negative outcomes of these elective procedures, the findings of this report suggest further research beyond demographic analysis to determine the underlying causes for these differences in cesarean section and induction of labor rates.

To aid these future analyses, the Colorado Pregnancy Risk Assessment Monitoring System (PRAMS) has added to its 2012 survey several questions related to elective cesarean section and induction of labor, including:

- "Did your doctor, nurse, or other health care worker try to induce your labor (start your contractions using medicine)?" and if so, "Why did your doctor, nurse, or other health care worker try to induce your labor (start your contractions using medicine)?"

- "How was your new baby delivered, vaginally or cesarean delivery (c-section)?" and if by cesarean section, "What was the reason that your new baby was born by cesarean delivery (c-section)?"

The follow-up questions for both labor induction and cesarean delivery allow for a variety of possible responses, including those that distinguish between a medically indicated or elective procedure. The combination of the trends and demographic analysis presented in this report with future analyses of these survey questions may inform changes in practice and policy, which, if implemented, may help minimize unnecessary procedures, and thus mitigate the associated medical and surgical risks to both mother and infant.

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