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## SURVEILLANCE OF CESAREAN SECTION DELIVERIES, NEW JERSEY 1999-2004

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### Abstract

Objective: Describe recent trends in cesarean section delivery in New Jersey. Study design: Data on delivery method, medical indications and patient characteristics were extracted from electronic birth certificate files. Results: Cesarean section deliveries increased as a proportion of live births by 6% annually. Growth was roughly uniform across an 8-part clinical typology. Repeat C-sections contributed only proportionately to the overall trend. The greatest acceleration was observed for procedures without trial of labor, and in medical situations where cesarean delivery had been relatively rare. Conclusion: Medical indications recorded on the birth certificate explained only a small portion of the rapid growth in utilization of cesarean delivery. A sustained autonomous shift in patient preferences and/or practice patterns seems the most likely driver of the overall trend.

### Introduction

Nationally and in New Jersey, the cesarean delivery rate has been increasing steadily for nearly a decade, and especially since 1999 (1-3). The decision to deliver by cesarean section depends on a variety of clinical indications, including previous cesarean delivery (4), multiple gestation (5,6,7), length of gestation (8), malpresentations (9), fetal distress, lack of progress, and maternal medical conditions such as infertility, advanced maternal age, obesity, diabetes and hypertensive disorders (10-17). Population surveillance methodologies based on such indications are, however, underutilized.



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One reason for this underdevelopment in surveillance is that cesarean delivery also depends on how medical factors interact with provider and patient preferences and judgments. Whether the procedure is planned or emergent, the decision often rests on balancing health risks of the mother and child (18-22), as well as on external factors such as schedules, practice setting (23-25) and financial risk management (26). The birth record contains a great deal of information on medical indications, but the status of a cesarean as “elective” is not recorded. Alternative concepts such as “medically unnecessary” or “potentially preventable” cesareans are difficult to operationalize.

New Jersey is in many respects a microcosm of national health issues and trends, including reproductive health (unless noted, the following data are from birth certificate files and references 1-3). New Jersey had 576,586 live births 1999 to 2003, with 20 percent to Hispanic mothers, 16 percent to black and 8 percent to Asian non-Hispanic mothers. Foreign-born mothers accounted for 34 percent of all live births. The distribution of maternal age at childbirth tracks the national trend: 6.8 percent of live births in NJ are to teens, and 52 percent are to mothers thirty and over. New Jersey’s rates of low birthweight (7.8%), preterm delivery (9.6%), infant mortality (0.6%) and fetal mortality (0.7%) are comparable to national averages, as are racial disparities in those outcomes.

New Jersey also experiences the same challenges of health insurance and service delivery as the nation as a whole. Roughly 32 percent of all deliveries are covered by Medicaid, S-CHIP or are uninsured (according to 2002-03 data from the Pregnancy Risk Assessment Monitoring System). In 2004, 35 percent of births were to women who lived in municipalities that were designated “medically underserved” for primary care by the U.S. Department of Health and Human Services, Health Resources and Services Administration. Almost 15 percent of live births were to mothers who reside in ten counties without any hospital designated for intensive perinatal care. New Jersey’s cesarean section rate is typically among the top five states; in 2003 the total cesarean rate was 33.1 percent, 20 percent above the national average (26.5%).

In this report we present a detailed population surveillance framework for cesarean delivery of live births. We attempt to address the underlying nature of recent trends by disaggregating different contexts of the procedure as much as the available birth certificate data will allow. First, we identify the largest contributions to the overall trend. We then examine rates within selected medical indications. Our goal is to isolate, in some relatively common cases, trends in practice patterns—inextricably confounding provider and patient preference—that are distinct from the documented clinical context.

## **Methods**

New Jersey Electronic Birth Certificate files record cesareans performed, trial of labor, induction of labor, prior cesarean, reproductive history, maternal risk factors of pregnancy, labor and delivery complications, and other variables. Records for all deliveries in New Jersey hospitals from 1999 to 2004 were included. Outcomes in 1996-98 were also available, but the 1999-2004 trend is more consistent and probably less heavily influenced by cost containment initiatives within managed care earlier in the 1990s (3,27,28). Since the birth certificate files capture all births for the analysis period, we forego statistical inferences predicated on sampling variability. The public health significance of trend magnitudes and subgroup differences are and should be judged on clinical and public policy criteria.

*Robson classification:* We adapt a clinically oriented typology developed by the British obstetric researcher Michael Robson (29,30). Three categories represent primary cesareans for full term

singleton deliveries with cephalic presentation (referred to as “standard” deliveries), distinguished by parity (nullipara, i.e., women with no previous live births, versus all others) and previous cesarean. Another four categories reflect the major indications preterm delivery, multiple gestation and malpresentation by parity. (Due to data limitations we could not distinguish among breech, oblique and transverse presentations, as Robson suggests.) A residual category captures repeat sections in these latter nonstandard cases. Table 1 describes the categories exactly.

*Crude rates:* We start by disaggregating the overall cesarean delivery rate according to our adapted Robson classification. These rates use all live births as the single denominator for every class, and sum to the overall rate. The distribution of cesarean deliveries across classes is proportional to these components. These rates are, however, confounded with the number of births within each specific class.

*Specific rates* use denominators representing only births within the specified class, and are further disaggregated by spontaneous labor, induction and no trial of labor.

To smooth variation in annual cesarean rates, we fit an exponential curve to each trend and report the *annual growth rate* derived from that curve. As a result, growth trends use all six yearly data points from 1999 to 2004 rather than just the end-points.

*Full-term* is defined as 37 or more weeks of gestation according to the clinical estimate. Presentation, trial of labor, multiple gestation and parity are taken from the birth record.

## Results

The total number of cesarean deliveries in New Jersey increased from 23,617 in 1996 to 29,122 in 1999 to 39,578 in 2004. The overall rate increased from 0.242 to 0.265 to 0.353 per live birth, an average annual rate of increase of 4.9 percent. From 1999 onward, the increase was 6.0 percent annually. Crude rates stratified by the Robson classification are presented in Table 1, and their growth trajectories are surprisingly uniform by category. We consider these components in order of their relative contribution to all cesareans in 1999.

The primary cesarean rate for standard deliveries (term, singleton, cephalic presentation) to nulliparas (class 1) was 0.082 per live birth in 1999, and the rate increased to 0.111 per live birth by 2004, a 6.2 percent *annual* increase. Rates for repeat cesareans (standard deliveries, class 7) were virtually identical, increasing at 6.3% annually. Since they increased at a rate close to the average, these important classes maintained their share of all cesareans at just over 30 percent each.

Standard deliveries to multiparas without a prior cesarean (class 2) is the largest share of all live births, but their lower risk of primary cesarean delivery gives them a much smaller share of all procedures conducted. This category, however, experienced the greatest proportional increase—8.6 percent annually. Primary cesareans for multiple gestations and singleton preterm deliveries (class 5, 6) both increased at slightly above average rates, 6.2 and 6.8 percent, respectively. Repeat cesareans for multiple gestations, preterm birth and malpresentations (class 8) increased at 5.0 percent annually. By contrast, primary cesareans for malpresentations (class 3 and 4) increased hardly at all.

**Table 1. Trends in Crude Cesarean Rates**

Class	#	Cesareans per live birth *					Share of all Cesareans	
		1999		2004		annual growth rate**	1999	2004
		cesareans	rate	cesareans	rate		%	%
All Live Births		29,122	0.265	39,578	0.353	6.0	--	--
<i>Primary Cesarean:</i>								
Standard nullipara***	1	8,960	0.082	12,460	0.111	6.2	30.8	31.5
Standard multipara	2	2,630	0.024	4,076	0.036	8.6	9.0	10.3
Malpresent nullipara	3	1,774	0.016	1,842	0.016	0.9	6.1	4.7
Malpresent multipara	4	1,070	0.010	1,107	0.010	1.1	3.7	2.8
All multiple gestation	5	2,465	0.022	3,252	0.029	6.2	8.5	8.2
Singleton preterm	6	1,417	0.013	2,047	0.018	6.8	4.9	5.2
<i>Repeat Cesarean:</i>								
Standard with prior cesarean	7	9,007	0.082	12,447	0.111	6.3	31.0	31.5
All other with prior cesarean	8	1,799	0.016	2,347	0.021	5.0	6.2	5.9

\* Denominator for all rows is ALL live births that year.  
\*\* Estimated growth parameter from exponential curve fitted to annual percentages from 1999 to 2004.  
\*\*\* "Standard" delivery is singleton, term 37+ weeks, cephalic presentation.

Because rates of increase within classes were so comparable, the relative share of cesareans for each class changed very little. By 2004, primary cesareans for malpresentations (class 3 and 4) decreased in their share of all sections from 9.8 to 7.5 percent. Primary cesareans to multiparas without prior cesarean (standard delivery, class 2) accounted for 10.3 percent of all cesareans.

Table 2 presents specific cesarean rates by the Robson classification and labor status. The most striking finding here is that no-trial cesareans outgrew all others by a wide margin within every Robson category except malpresentations. For example, primary cesarean deliveries among standard nulliparas (class 1) without trial of labor increased by 16.6 percent per year, while cesareans after spontaneous labor rose by 2.4 percent annually in that class.

Aside from malpresentations, two basic patterns regarding circumstances of labor emerge in Table 2. For standard and singleton preterm deliveries (class 1, 2, 6), cesarean rates increased significantly for *all* labor situations. Induction played an important role in increasing cesarean risk; standard deliveries with induced labor grew from 15.4 to 17.7 percent of all deliveries during the period (data not shown).

For multiple gestations and all repeat cesareans, increasing rates of no-labor cesarean was coupled with *declining* rates of cesarean after spontaneous or induced labor. As expected from current practice guidelines, cesarean after induction became extremely rare. Among attempted VBACs for standard deliveries with spontaneous labor, the rate of subsequent cesarean declined by 40 percent, from 0.133 to 0.080 per live birth in the category.

We did several further analyses to address the hypothesis that cesarean rates are being driven up by increasing incidence of complications. Table 3 addresses the question of how many additional cesarean deliveries might be attributable to the "usual suspects": frequency of childbirth beyond age 35; maternal obesity, reflected in preexisting and gestational diabetes;

**Table 2. Trends in Specific Cesarean Rates**

Class	#	Cesareans per live birth in category *				annual growth rate**
		1999		2004		
		cesareans	rate	cesareans	rate	%
<i>Primary Cesarean:</i>						
Standard nullipara***	1					
no trial of labor		1,092	0.029	2,510	0.065	16.6
induced labor		2,886	0.076	4,234	0.110	7.6
spontaneous labor		4,982	0.131	5,716	0.148	2.4
Standard multipara	2					
no trial of labor		830	0.019	1,747	0.041	15.3
induced labor		545	0.013	859	0.020	9.8
spontaneous labor		1,255	0.029	1,470	0.035	3.1
Malpresent nullipara	3					
no trial of labor		1,173	0.594	1,308	0.650	1.5
induced labor		73	0.037	102	0.051	6.4
spontaneous labor		528	0.267	432	0.215	-4.5
Malpresent multipara	4					
no trial of labor		686	0.511	772	0.599	2.7
induced labor		72	0.054	84	0.065	3.5
spontaneous labor		312	0.232	251	0.195	-4.1
All multiple gestation	5					
no trial of labor		1,615	0.408	2,568	0.595	7.9
induced labor		169	0.043	112	0.026	-10.8
spontaneous labor		681	0.172	572	0.132	-4.7
Singleton preterm	6					
no trial of labor		733	0.111	1,191	0.173	9.6
induced labor		265	0.040	342	0.050	4.3
spontaneous labor		419	0.064	514	0.075	2.8
<i>Repeat Cesarean:</i>						
Standard with prior cesarean	7					
no trial of labor		6,702	0.510	11,214	0.798	9.4
induced labor		564	0.043	108	0.008	-36.3
spontaneous labor		1,741	0.133	1,125	0.080	-11.3
All other with prior cesarean	8					
no trial of labor		1,396	0.612	2,086	0.799	5.7
induced labor		58	0.025	21	0.008	-25.9
spontaneous labor		345	0.151	240	0.092	-9.9

\* Denominator for each row is category-specific live births that year.

\*\* Estimated growth parameter from exponential curve fitted to annual percentages from 1999 to 2004.

\*\*\* "Standard" delivery is singleton, term 37+ weeks, cephalic presentation.

**Table 3. Specific Cesarean Rates for High-Risk Subgroups**

<b>Subgroup:</b>	<b>Live births</b>		<b>Cesarean delivery rate</b>		<b>Increase in cesarean sections</b>		<b>Relative risk**</b>	
	<b>1999</b>	<b>2004</b>	<b>1999</b>	<b>2004</b>	<b>Observed</b>	<b>1999 rates***</b>	<b>1999</b>	<b>2004</b>
<i>Standard deliveries:*</i>								
Nullipara, age 35+	3,861	4,419	0.394	0.481	603	218	1.8	1.6
Nullipara, prior or gestational diabetes	771	1,077	0.392	0.398	127	120	1.7	1.2
Multipara, no prior cesarean, age 35+	9,897	10,594	0.082	0.130	570	59	1.5	1.5
Previous cesarean	13,136	14,052	0.686	0.886	3,440	633	11.1	9.1
All multiple gestations ****	3,956	4,317	0.623	0.753	787	224	2.4	2.1
All deliveries	109,930	111,959	0.265	0.353	10,456	--	--	--

\* Singleton, Term 37+weeks, cephalic presentation  
\*\* Reference groups: Nullipara, age 35+ vs. younger; Nullipara, diabetes yes vs. no; Multipara age 35+ vs. younger; Previous cesarean vs. multipara no prior cesarean; All multiple gestations vs. rate for all live births.  
\*\*\* Number of births in risk group in 2004 multiplied by the rate in 1999, minus the number of cesareans in 1999.  
\*\*\*\* Multiple gestations subgroup is not restricted by term or presentation.

decline in VBACs; and multiple gestations. Table 3 gives total births and cesarean deliveries in each high-risk subgroup for 1999 and 2004. The overall observed increase in number of cesarean sections is given, as well as the predicted increase if 1999 cesarean rates are applied to all 2004 deliveries. For example, births in the standard nulliparas class (1) who were age 35 or older increased from 3,861 to 4,419, and the cesarean rate increased such that 603 more cesareans were performed in 2004 than in 1999. If the 1999 cesarean rate of 0.394 were applied to the 4,419 women in this high-risk group, however, only 218 additional cesareans would have been performed. Aside from women with previous cesareans, no subgroup accounts for a very large observed increase; in that subgroup as well as most others, the older rates would predict a much smaller increase than is observed. In other words, the increasing use of cesarean delivery within specific medical contexts, i.e., the higher specific rates, is the larger share of the story. To reinforce this point, the last two columns of Table 3 track changes in the relative risk of each category versus its natural reference group. With one exception the relative risks *narrowed* between 1999 and 2004, indicating that cesarean rates for low-risk groups have increased faster than for high-risk groups.

Figures 1 and 2 show trends for the subset of deliveries with no complications or medical risk factors coded at all. In this group, no-trial cesareans increased by 22.6 percent per year among nulliparas, from 0.018 per live birth in 1999 to 0.060 in 2004. No-trial cesareans likewise increased by 19.6 percent per year among multiparas. Cesarean after induced labor increased by 10.9 and 19.8 percent per year for nulliparas and multiparas, respectively; cesareans after spontaneous labor increased by 6.9 and 3.5 percent. No-indication, no-trial cesareans may be the best proxy measure for “elective” procedures, but they account for only a fraction of the overall increase: 610 cesareans to nulliparas and 392 to multiparas in 2004, up 398 and 326 from 1999. On the other hand, the trend reinforces the conclusion that the dominant causes are largely independent of medical indications.

Figure 1. Primary Cesareans, No Recorded Indications, Nullipara, by Circumstances of Labor

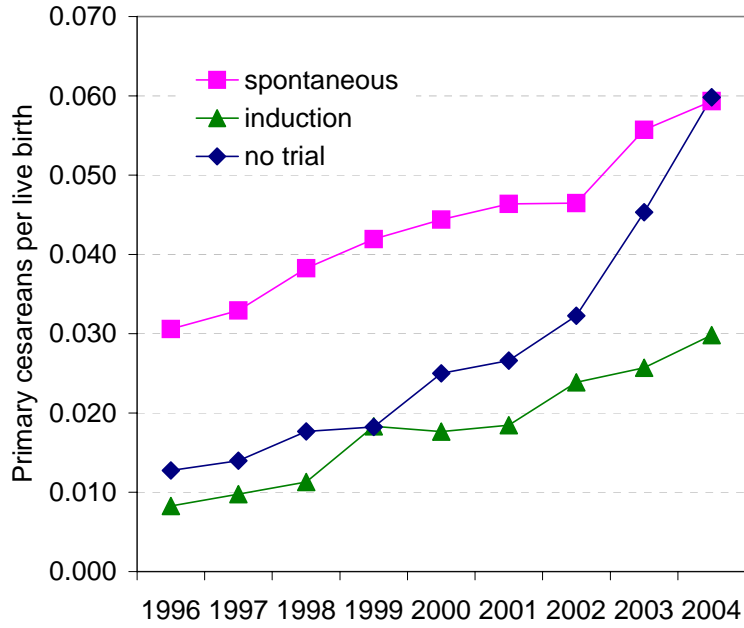
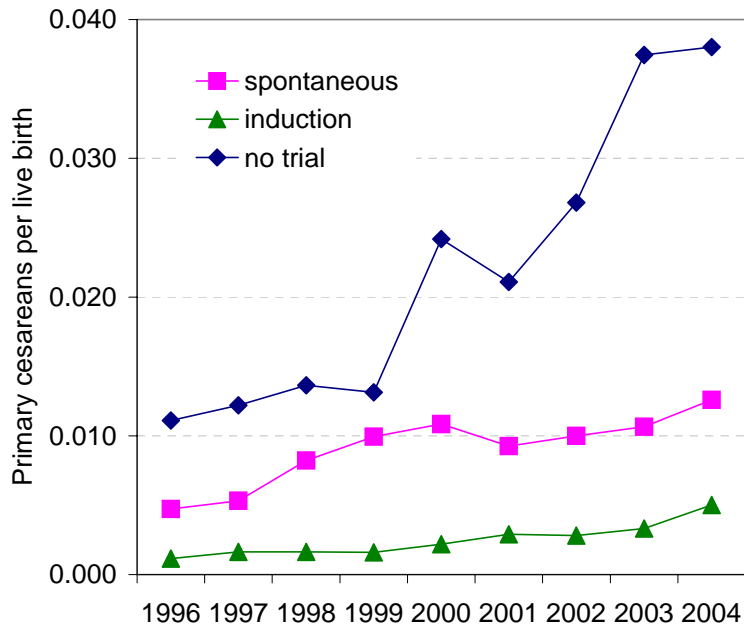


Figure 2. Primary Cesareans, No Recorded Indications, Multipara, by Circumstances of Labor



## Discussion

Substantial increase in the use of cesarean sections was observed across nearly every obstetrical context, as captured by Robson's classification. The most dramatic growth was in use of the procedure without a trial of labor, especially in categories in which cesareans had formerly been least frequent, e.g., full-term singletons with cephalic presentation. This pattern was evident when examining (crude) rates per live birth (Table 1), which include the effects of shifts in underlying risk factors, and specific rates (Table 2), which describe behavior in defined medical contexts more precisely.

We think the findings regarding cesareans with no medical indication are especially indicative within the larger context. Analysis of what Robson refers to as "standard primiparous women" (29:p.28) comes closest to isolating a baseline trend for purely "elective" procedures. Our other analyses augment this supposition by replicating the trend across the Robson typology, and by considering—and rejecting—the leading plausible explanations for the trend based on population composition.

Repeat cesareans have been the subject of much investigation and debate, and are often cited as a major driver of the overall trend. In our analysis the trend for repeat sections is not remarkable, only proportional. Repeat procedures grew at the roughly same rate as the total, with no increase in the share of total cesareans. Other indications, some part of the Robson classification and others not, also fail to account for more than a proportional share of overall growth. Having eliminated all the major hypotheses dealing with shifting risk factors, we can conclude that changing conditional rates are the dominant factor in explaining New Jersey's overall trend.

It is possible that changing specific rates reflect shifts in medical risks that we have not accounted for. It seems unlikely that any set of such factors would affect all categories as nearly equally as we observe. Our analysis in Table 3 is illustrative, both as to approach and conclusion. We also think it is significant that procedures with and without trial of labor increased in tandem in several categories. We might have expected that discriminating selection of cases for no-trial sections would decrease the rate "downstream," i.e., once a trial of labor was initiated. For example, it might be expected that no-labor sections would be chosen for more severe hypertensive conditions, and the remainder would be more likely to achieve vaginal births. At best, such a selection effect only seems to slow the acceleration in procedures after trial of labor that must be due to other causes.

Parallel to findings in other studies (11,12,31-33), we surmise that the across-the-board nature of the trend seems to signal an autonomous shift in practice and/or preferences during the period. Patients and providers may feel more comfortable with, or more compelled toward, a more interventionist approach to the timing of delivery and the management of medical risks compared even to the late 1990s (34,35). Given the complexity of the decision making process and the penetration of the concept of patient-centered care into this arena, the concept of "elective procedure" and/or binary judgments about medical necessity may not be meaningful (36). Adding a field to the birth certificate that indicates whether the cesarean was planned in advance would be helpful, but by no means definitive.

At various times different stakeholders—patient advocacy groups, providers, regulators—have raised the question of whether some cesareans are unnecessary and therefore preventable, or alternatively whether cesarean section should be more aggressively used to manage certain medical situations. Insurance companies, hospitals and individual practitioners have overlapping



and sometimes contradictory motivations (27,37-39). Because each decision is complex and documentation on the birth certificate is limited, assessing conformance with any definition of best medical practice will remain beyond the scope of routine surveillance. Such surveillance as we have performed here is nevertheless important for tracking the aggregate tendency of those individual decisions.

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