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Oregon's Hard-Stop Policy Limiting Elective Early-Term Deliveries: Association With Obstetric Procedure Use and Health Outcomes

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Abstract

Objectives—To evaluate the association of Oregon's hard-stop policy limiting early elective deliveries (before 39 weeks of gestation) and the rate of elective early-term inductions and cesarean deliveries and associated maternal–neonatal outcomes.

Methods—This was a population-based retrospective cohort study of Oregon births between 2008 and 2013, using vital statistics data and multivariable logistic regression models. Our exposure was the Oregon hard-stop policy, defined as the time periods pre-policy (2008 – 2010) and post-policy (2012 – 2013). We included all term or postterm, cephalic, nonanomalous, singleton deliveries (N= 181,034 births). Our primary outcomes were induction of labor and cesarean delivery at 37 or 38 weeks of gestation without a documented indication on the birth certificate (i.e., elective early term delivery). Secondary outcomes included neonatal intensive care unit admission, stillbirth, macrosomia, chorioamnionitis, and neonatal death.

Results—The rate of elective inductions before 39 weeks declined from 4.0% in the prepolicy period to 2.5% during the postpolicy period ($P<0.001$); a similar decline was observed for elective early term cesareans (from 3.4% to 2.1%; $P<0.001$). There was no change in neonatal intensive

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care unit admission, stillbirth, or assisted ventilation pre-policy and post-policy, but chorioamnionitis did increase (from 1.2% to 2.2%, $P<0.001$; adjusted odds ratio, 1.94, 95% confidence interval, 1.80 – 2.09).

Conclusions—Oregon’s statewide policy to limit elective early-term delivery was associated with a reduction in elective early-term deliveries, but no improvement in maternal or neonatal outcomes.

Precis

Although Oregon’s hard-stop policy was associated with a reduction in elective early-term deliveries, several perinatal outcomes do not differ between the pre-policy and post-policy periods.

INTRODUCTION

Rates of obstetric interventions have increased dramatically in the United States in recent decades. The exact proportion of deliveries that are elective (i.e., performed without medical or obstetric indication) remains unclear, but a recent study estimated that between 2005 and 2008, 26% of US nulliparous women delivered by elective induction or elective cesarean.(1) The risk of adverse neonatal outcomes varies across the term period, with infants born early-term (i.e., 37 or 38 weeks of gestation) at increased risk of mortality, respiratory distress syndrome, admission to the neonatal intensive care unit (NICU), and long-term neurological morbidity.(2–5) These trends, as well as increases in maternal death and severe morbidity(6), have led to increased clinical and policy focus on limiting elective early-term inductions and cesareans as one potential way to improve maternal and neonatal health outcomes.

Elective delivery before 39 weeks of gestation has been broadly identified as a core quality metric to be decreased(7, 8), and campaigns to limit elective early-term deliveries have been implemented at the institutional level,(9) within health systems,(10) and across many hospitals within a state.(11) In 2011, Oregon became the first state to implement a “hard-stop” policy at the state level when the Oregon Perinatal Collaborative introduced a policy limiting elective inductions and cesarean deliveries before 39 weeks of gestation. The hard-stop policy limited early-term deliveries by requiring review and approval for any delivery without documented indication before 39 weeks of gestation (in contrast with other approaches, e.g., “soft-stop” policies, which give providers more discretion(12)).

In this population-based retrospective cohort study, we leverage this natural experiment to evaluate the effect of Oregon’s hard-stop policy on the rate of elective early-term inductions and cesareans, as well as associated maternal and neonatal outcomes. Our primary hypothesis was that the rate of early-term induction and cesarean without a medical–obstetric indication documented on the birth certificate would decline after implementation of the policy in 2011. We also hypothesized that adverse neonatal outcomes related to early-term birth would decrease (e.g., admission to the NICU, assisted ventilation), and that fetal and maternal outcomes related to prolonged gestation or labor at term would increase (e.g., stillbirth, macrosomia, chorioamnionitis).

MATERIALS AND METHODS

We analyzed Oregon vital statistics data provided by the Oregon Center for Health Statistics. The Center for Health Statistics provided vital records files on birth, infant death, and fetal death for the years 2008 through 2013. We matched birth records to death records using a unique identifier (95% linkage rate for infant deaths), and appended fetal death records to the matched birth–death data.

Our primary exposure of interest was the hard-stop policy, which had been adopted by 49 out of 52 of Oregon hospitals providing maternity care by early 2012 (representing 98% of Oregon births). We defined exposure to the hard-stop policy as the time periods pre-policy (2008 – 2010) and post-policy (2012 – 2013). We excluded 2011 because it contained time periods that were both unexposed (i.e., pre-policy) and exposed (post-policy). We restricted analyses to women with singleton, non-anomalous, cephalic-presenting fetuses, who delivered in hospitals. We excluded women with the following preexisting and pregnancy-related conditions as documented on the birth certificate: chronic hypertension, pre-pregnancy diabetes, and gestational diabetes.

The primary outcomes of interest were elective early-term induction of labor (all methods of induction) and cesarean delivery, i.e., procedures occurring at 37 or 38 completed weeks of gestation (i.e., the early-term period(13)), without a documented medical or obstetric indication on the birth certificate. The definition of indications for delivery was based on the birth certificate-based algorithms defined by Ananth et al. and MacDorman et al.,(1, 14) and included the following conditions: gestational hypertension, preeclampsia, eclampsia, and fetal growth restriction (birthweight <10th percentile for that week of gestation). In contrast to exclusion criteria such as chronic hypertension, these conditions may develop during the term period, and are therefore a possible outcome of policies that prolong gestation (e.g., the hard-stop policy).

The definition of elective early-term cesarean delivery was based on the definition of “elective delivery” in the Specifications Manual for the Joint Commission National Quality Measures for Perinatal Care Measure PC-01, where indications included contra-indications for vaginal birth as well as the indications for early-term birth listed above(15). The exception is that we did not consider prior cesarean delivery as an indication, because we were interested in the effects of the policy in the broader obstetric population, including women with a prior cesarean. The definition of elective early-term cesarean delivery also excluded cesareans where labor was documented on the birth certificate (e.g., when the trial of labor check-box was marked, or in the case of prolonged labor or fetal intolerance of labor). Because the Joint Commission definitions rely on diagnostic and procedure codes, we adapted these definitions using all conditions that are recorded on the birth certificate.

In addition to elective early-term delivery, we also analyzed various secondary outcomes: outcomes other than elective early term delivery which might be affected by the policy. Among these secondary outcomes were elective full-term inductions–cesareans and indicated full-term induction of labor. This group contained women reaching full-term gestation (i.e., 39 completed weeks of gestation (13)) and beyond. It is possible that changes

in obstetric practice in the early-term period may affect obstetric practice and outcomes at full- and late-term gestations (e.g., delaying elective induction from 37 to 39 weeks of gestation, or expectantly managing pregnancy at 37 weeks with subsequent development of an indication for delivery, such as preeclampsia). We did not expect that early-term indicated induction of labor should be affected by the hard-stop policy; therefore we analyzed this outcome as a sensitivity analysis.

For these analyses where labor induction or cesarean delivery were the outcomes, rates were calculated using the denominator of all ongoing pregnancies at the index gestation (i.e., all women reaching 37 weeks of gestation for early-term induction or cesarean, and pregnancies that reached 39 weeks for full-term induction or cesarean). Because obstetric practice relating to labor induction and potential outcomes of procedures may differ by parity,(16) we conducted analyses of induction and cesarean overall and stratified by parity (i.e., separate for nulliparous women and multiparous women).

We were interested not only in whether the policy was implemented successfully (i.e. reduction in early elective deliveries) but also in its association with another set of secondary outcomes: maternal and fetal/neonatal complications. We analyzed the association of the policy with several outcomes available on the birth certificate that could be affected by changes in obstetric practice and gestational age at delivery. Maternal outcomes were severe (3rd or 4th degree) perineal lacerations among vaginal deliveries, maternal intensive care unit (ICU) admission, maternal blood transfusion, chorioamnionitis, and operative vaginal delivery (i.e., either vacuum, forceps, or both). The fetal/neonatal outcomes considered were the following: stillbirth, neonatal death, perinatal death (i.e., a composite of stillbirth and neonatal death), infant death, neonatal seizures, neonatal intensive care unit (NICU) admission, depressed 5-minute Apgar scores (Apgar score of <7 and separately, Apgar score of <4), assisted neonatal ventilation (of any duration), meconium staining of the amniotic fluid, and macrosomia (birthweight ≥ 4,000g). We compared rates of outcomes between pre- and post-hard stop periods using the chi-square test and the Fisher exact test where necessary.

To control for factors that may have changed between the pre-policy and post-policy periods, we employed multivariable logistic regression. These models controlled for: maternal race/ethnicity (non-Hispanic white versus other), parity (nulliparous versus multiparous), insurance status (public/none versus other), prenatal care utilization (≥ 5 visits versus fewer), advanced maternal age (≥ 35 years versus fewer), maternal education (>12 years versus 12 or fewer), and certified nurse-midwife (CNM) birth attendant. This was a complete case analysis (i.e., analysis of records with non-missing values for covariates and outcomes; missingness data presented in Appendixes 1–4, available online at <http://links.lww.com/xxx>). All data management and analysis was performed in Stata (version 12, StataCorp, College Station, TX). This research was approved by the Institutional Review Board of Oregon Health & Science University.

RESULTS

Our study population included a total of 181,034 women who delivered in Oregon hospitals between 2008 and 2013, excluding 2011. 111,292 women delivered in the period before the hard-stop policy (2008 – 2010), and 69,742 women delivered after the rollout of the policy (2012 – 2013). The demographic makeup of the population was largely similar in the periods before and after the policy (Table 1). A majority of women were non-Hispanic white (67.5% pre-policy and 68.6% post-policy), with approximately 13% of women age 35 or greater (12.7% pre-policy, 14.1% post-policy).

The proportion of elective inductions before 39 weeks declined from 4.0% in the pre-policy period to 2.5% during the post-policy period ($P<0.001$), for elective early-term cesareans, the decrease was from 3.4% to 2.1% ($P<0.001$; Table 2). For elective early-term induction, the magnitude of the decrease was more pronounced in multiparous women (i.e., from 4.4% to 2.5%; a decrease of 43%, $P<0.001$) as compared to nulliparous women (from 3.4% to 2.5%; a decrease of 27%, $P<0.001$; $P<0.001$ test for homogeneity). However, the overall rate of term induction of labor remained approximately the same (29.9% pre-policy versus 29.4% post-policy, $P=0.024$). This lack of overall change in induction of labor was due to increases in the rate of indicated induction at and beyond 39 weeks of gestation (4.9% pre-policy, 5.3% postpolicy; $P=0.003$).

These findings persisted after confounder adjustment in multivariable models (Table 3). The odds of elective early-term induction decreased by almost 40% during the post-policy period as compared to the pre-policy period (aOR, 95% CI: 0.61, 0.58 – 0.65); elective early-term cesarean delivery decreased by a similar magnitude (aOR, 95% CI: 0.60, 0.57 – 0.64). Again, for elective early term induction this association was more pronounced in multiparous women (aOR, 95% CI: 0.55, 0.51 – 0.59) than nulliparous women (0.74, 0.67 – 0.81; $P<0.001$ for interaction). In contrast, the adjusted odds of indicated induction increased during the post-policy period overall (aOR, 95% CI: 1.11, 1.07 – 1.16). This increase was driven by a rise in indicated full-term induction of labor (aOR, 95% CI: 1.10, 1.05 – 1.16). Our sensitivity analysis demonstrated that there was no significant change in indicated early-term inductions (1.04, 0.96 – 1.12).

A number of perinatal outcomes differed between the study periods but the odds of stillbirth, neonatal death, neonatal seizures, NICU admissions, and assisted ventilation remained the same (Table 4). In multivariable logistic regression models, the odds of maternal blood transfusion were elevated in the post-policy period compared with the pre-policy period (aOR, 95% CI: 1.42, 1.20 – 1.67), as were the odds of chorioamnionitis (aOR, 95% CI: 1.94, 1.80 – 2.09) and 5-minute Apgar score <4 (aOR, 95% CI: 1.36, 1.16 – 1.61; Table 4). There were significantly increased odds of chorioamnionitis and depressed Apgar score in both the early-term and full-term subgroups, while the increased odds of maternal blood transfusion were statistically significant only in the 39-week group (results not shown).

DISCUSSION

Our results show that Oregon's hard-stop policy aimed at limiting elective early-term delivery were associated with decreased rates of elective induction of labor and cesarean delivery before 39 completed weeks of gestation.. The fact that Oregon's hard stop policy decreased elective early term delivery is especially notable given the fact that the baseline rate of elective early-term delivery in Oregon was well below the national average.(1, 17) Notably, the overall rate of labor induction remained essentially unchanged. This was driven by an increase in indicated full-term inductions at and after 39 weeks of gestation. One possible consequence of prolonging gestation by limiting elective early term deliveries would be an increase in the time at risk for pregnancy-related morbidities (e.g., preeclampsia). This could in turn increase the rate of indicated induction, although such potential risks must also be weighed against the documented neonatal benefits of full-term delivery.

The picture was less clear regarding the effect of the hard-stop policy on adverse maternal and neonatal outcomes. In particular, the hypothesized decrease in NICU admissions that motivates the adoption of policies limiting elective early delivery,(10, 18) and which was observed in other studies,(9) was not observed in our study. Recent evidence suggests that thresholds for NICU admission may have decreased within the past decade,(19) and this could mask a potential association between reduced early-term deliveries and lower NICU admissions. We observed increases in maternal blood transfusion and chorioamnionitis, which may result from prolonged gestation and increased duration of labor (although detailed clinical detail to explain this finding are lacking in our data). These could also result from delivery of larger babies, however we found no change in the rates of macrosomia. Reassuringly, we observed no change in the rate of term stillbirth, in contrast with previous studies.(9, 20)

Our study is not without limitations. First, we used vital statistics data, which have well-known limitations and are not collected for research purposes.(21–24) In particular, reporting of procedures is more accurate than reporting of diagnoses in birth certificate data, (25) and the incidence of elective induction, one of our key outcome variables, is over-reported in birth certificate data.(23) Also, our definition of “elective” and “indications” was based on information collected in the birth certificate, and therefore do not take into account some indications for obstetric procedures (e.g., decreased fetal movement for induction of labor)In light of this, our observed rates of elective early-term induction and cesarean (in the 1 – 5% range) should be regarded as upper bounds of the true rates. Finally, the baseline low rate of elective early-term delivery in Oregon before the policy means that the decrease we observed (and associated perinatal outcomes) might be different in other settings where elective early-term delivery is more common.

Furthermore, it is possible that the recording of variables on the birth certificate changed between the study periods (before and after the hard-stop policy). The hard-stop policy called state-wide attention to the issue of elective early term delivery, so obstetric providers may have been motivated to more thoroughly document indications for induction of labor, or to up-code the presence of indications, to avoid the appearance of elective early term

delivery. Such changes in data recording would exaggerate the true effect of the policy and also could drive the increased in indicated induction that we observed. It is also possible that we were underpowered to capture modest differences in some of our outcomes due to the rarity of these outcomes (e.g. stillbirth, for which our study had 82% power to detect an increase of 50%, but only 43% power for a 30% increase post-policy). Also, in addition to secular trends that may have been occurring in Oregon between 2008 and 2013, there are known changes in healthcare systems and organization in the state during this time period. In 2012, Oregon transformed its Medicaid program, launching the Coordinated Care Organizations.(26–28) This change affected the organization of healthcare delivery for publicly insured pregnant women, nearly half of our study population, in the post-policy period. These temporal changes or others may have affected ability to validly estimate the effects of the hard-stop policy.

The lack of the hypothesized decrease in the rate of NICU admission, and the increase in some maternal morbidities linked to longer gestations, as hypothesized, are also noteworthy. This lack of association between rates of elective early-term delivery and perinatal morbidity corroborates a recent study which found no association between these outcomes.(29) Collectively, these findings raise the question of whether elective early-term delivery is a meaningful marker for quality of obstetric care, i.e., one which predicts maternal and neonatal morbidity

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Source(s) of the work or study.

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REFERENCES

1. Ananth CV, Wilcox AJ, Gyamfi-Bannerman C. Obstetrical interventions for term first deliveries in the US. *Paediatric and perinatal epidemiology*. 2013 Sep; 27(5):442–451. [PubMed: 23930780]
2. Sengupta S, Carrion V, Shelton J, Wynn RJ, Ryan RM, Singhal K, et al. Adverse neonatal outcomes associated with early-term birth. *JAMA pediatrics*. 2013 Nov; 167(11):1053–1059. [PubMed: 24080985]
3. Zhang X, Kramer MS. Variations in mortality and morbidity by gestational age among infants born at term. *The Journal of pediatrics*. 2009 Mar; 154(3):358–362. 62 e1. [PubMed: 18950794]
4. Reddy UM, Bettegowda VR, Dias T, Yamada-Kushnir T, Ko CW, Willinger M. Term pregnancy: a period of heterogeneous risk for infant mortality. *Obstetrics and gynecology*. 2011 Jun; 117(6): 1279–1287. [PubMed: 21606738]

5. Seikku L, Gissler M, Andersson S, Rahkonen P, Stefanovic V, Tikkanen M, et al. Asphyxia, Neurologic Morbidity, and Perinatal Mortality in Early-Term and Postterm Birth. *Pediatrics*. 2016 Jun;137(6)
6. Berg CJ, Callaghan WM, Syverson C, Henderson Z. Pregnancy-related mortality in the United States, 1998 to 2005. *Obstetrics and gynecology*. 2010 Dec; 116(6):1302–1309. [PubMed: 21099595]
7. The Joint Commission. Questions and Answers: The Perinatal Care Core Measure Set. Joint Commission Perspectives. 2013; 33(11):12–14.
8. Centers for Medicare and Medicaid Services (CMS). Reducing early elective deliveries in Medicaid and CHIP. 2012
9. Ehrenthal DB, Hoffman MK, Jiang X, Ostrum G. Neonatal outcomes after implementation of guidelines limiting elective delivery before 39 weeks of gestation. *Obstetrics and gynecology*. 2011 Nov; 118(5):1047–1055. [PubMed: 22015872]
10. Oshiro BT, Henry E, Wilson J, Branch DW, Varner MW. Decreasing elective deliveries before 39 weeks of gestation in an integrated health care system. *Obstetrics and gynecology*. 2009 Apr; 113(4):804–811. [PubMed: 19305323]
11. Donovan EF, Lannon C, Bailit J, Rose B, Iams JD, Byczkowski T. A statewide initiative to reduce inappropriate scheduled births at 36(0/7)–38(6/7) weeks' gestation. *American journal of obstetrics and gynecology*. 2010 Mar; 202(3):243, e1–e8. [PubMed: 20207241]
12. Clark SL, Frye DR, Meyers JA, Belfort MA, Dildy GA, Kofford S, et al. Reduction in elective delivery at <39 weeks of gestation: comparative effectiveness of 3 approaches to change and the impact on neonatal intensive care admission and stillbirth. *American journal of obstetrics and gynecology*. 2010 Nov; 203(5):449, e1–e6. [PubMed: 20619388]
13. Spong CY. Defining "term" pregnancy: recommendations from the Defining "Term" Pregnancy Workgroup. *Jama*. 2013 Jun 19; 309(23):2445–2446. [PubMed: 23645117]
14. MacDorman MF, Declercq E, Zhang J. Obstetrical intervention and the singleton preterm birth rate in the United States from 1991–2006. *Am J Public Health*. 2010 Nov; 100(11):2241–2247. [PubMed: 20864720]
15. Kozhimannil KB, Macheras M, Lorch SA. Trends in childbirth before 39 weeks' gestation without medical indication. *Medical care*. 2014 Jul; 52(7):649–657. [PubMed: 24926713]
16. Miller NR, Cypher RL, Foglia LM, Pates JA, Nielsen PE. Elective Induction of Labor Compared With Expectant Management of Nulliparous Women at 39 Weeks of Gestation: A Randomized Controlled Trial. *Obstetrics and gynecology*. 2015 Dec; 126(6):1258–1264. [PubMed: 26551184]
17. Laughon SK, Zhang J, Grewal J, Sundaram R, Beaver J, Reddy UM. Induction of labor in a contemporary obstetric cohort. *American journal of obstetrics and gynecology*. 2012 Jun; 206(6):486, e1–e9. [PubMed: 22520652]
18. Oshiro BT, Kowalewski L, Sappenfield W, Alter CC, Bettgowda VR, Russell R, et al. A Multistate Quality Improvement Program to Decrease Elective Deliveries Before 39 Weeks of Gestation. *Obstetrics and gynecology*. 2013; 121(5):1025–1031. [PubMed: 23635739]
19. Harrison W, Goodman D. Epidemiologic Trends in Neonatal Intensive Care, 2007–2012. *JAMA pediatrics*. 2015 Sep; 169(9):855–862. [PubMed: 26214387]
20. Nicholson JM, Kellar LC, Ahmad S, Abid A, Woloski J, Hewamudalige N, et al. US term stillbirth rates and the 39-week rule: a cause for concern? *American journal of obstetrics and gynecology*. 2016 May; 214(5):621, e1–e9. [PubMed: 26880736]
21. Roberts CL, Bell JC, Ford JB, Morris JM. Monitoring the quality of maternity care: how well are labour and delivery events reported in population health data? *Paediatric and perinatal epidemiology*. 2009 Mar; 23(2):144–152. [PubMed: 19159400]
22. Lydon-Rochelle MT, Cardenas V, Nelson JL, Tomashek KM, Mueller BA, Easterling TR. Validity of maternal and perinatal risk factors reported on fetal death certificates. *Am J Public Health*. 2005 Nov; 95(11):1948–1951. [PubMed: 16195532]
23. Bailit JL. Rates of labor induction without medical indication are overestimated when derived from birth certificate data. *American journal of obstetrics and gynecology*. 2010 Sep; 203(3):269, e1–e3. [PubMed: 20816150]

24. Roberts CL, Bell JC, Ford JB, Hadfield RM, Algert CS, Morris JM. The accuracy of reporting of the hypertensive disorders of pregnancy in population health data. *Hypertens Pregnancy*. 2008; 27(3):285–297. [PubMed: 18696357]
25. Lain SJ, Hadfield RM, Raynes-Greenow CH, Ford JB, Mealing NM, Algert CS, et al. Quality of data in perinatal population health databases: a systematic review. *Medical care*. 2012 Apr; 50(4):e7–e20. [PubMed: 21617569]
26. McConnell KJ, Chang AM, Cohen DJ, Wallace N, Chernew ME, Kautz G, et al. Oregon's Medicaid Transformation: An Innovative Approach To Holding A Health System Accountable For Spending Growth. *Healthc (Amst)*. 2014 Sep; 2(3):163–167. [PubMed: 25540719]
27. Howard SW, Bernell SL, Yoon J, Luck J, Ranit CM. Oregon's Experiment in Health Care Delivery and Payment Reform: Coordinated Care Organizations Replacing Managed Care. *J Health Polit Policy Law*. 2014 Dec 5.
28. Muoto I, Luck J, Yoon J, Bernell S, Snowden JM. Oregon's Coordinated Care Organizations Increased Timely Prenatal Care Initiation And Decreased Disparities. *Health Affairs*. 2016 In press.
29. Howell EA, Zeitlin J, Hebert PL, Balbierz A, Egorova N. Association between hospital-level obstetric quality indicators and maternal and neonatal morbidity. *Jama*. 2014 Oct 15; 312(15): 1531–1541. [PubMed: 25321908]

Table 1

Demographic and health-related characteristics of Oregon births (N = 181,034) before and after implementation of the hard-stop policy, total & percent

	Before (2008 – 2010) N=111,292	After (2012 – 2013) N= 69,742	P-value
Maternal race/ethnicity	-	-	<0.001
White	75,085 (67.5)	47,876 (68.6)	
African-American	2,709 (2.4)	1,749 (2.5)	
Hispanic	23,123 (20.8)	13,166 (18.9)	
Asian-American	6,303 (5.7)	4,209 (6.0)	
American Indian/ Alaska Native	2,696 (2.4)	1,796 (2.6)	
Other	1,376 (1.2)	946(1.4)	
Nulliparous	46,704 (42.0)	28,892 (41.4)	0.024
Public insurance	47,232 (42.4)	31,085 (44.6)	<0.001
Prenatal visits 5	106,766 (95.9)	65,814 (94.4)	<0.001
Maternal age 35 years	14,154 (12.7)	9,855 (14.1)	<0.001
Education > 12 years	61,077(54.9)	42,546 (61.0)	<0.001
CNM care	20,782 (18.7)	13,647 (19.6)	<0.001
<i>Population trends of indications for induction of labor</i>			
Gestational hypertension/preeclampsia	4,680 (4.2)	3,642 (5.2)	<0.001
Eclampsia	519(0.47)	291 (0.42)	0.128
FGR	9,903 (8.9)	6,343 (9.1)	0.154

Abbreviations: CNM, certified nurse-midwife; FGR, fetal growth restriction (<10th percentile for that week of gestation)

Table 2

Count and rates* of early-term and full-term elective induction and cesarean before and after implementation of the hard-stop policy

	Overall			Nulliparous			Multiparous		
	Before (2008–10)	After (2012–13)	P-val	Before (2008–10)	After (2012–13)	P-val	Before (2008–10)	After (2012–13)	P-val
Elective inductions	26,406 (23.7)	15,859 (22.7)	<0.001	11,338 (24.3)	6,719 (23.3)	0.001	15,068 (23.4)	9,140 (22.4)	<0.001
<39 weeks	4,422 (4.0)	1,743 (2.5)	<0.001	1,604 (3.4)	733 (2.5)	<0.001	2,818 (4.4)	1,010 (2.5)	<0.001
39 weeks	21,984 (25.9)	14,116 (25.44)	0.030	9,734 (26.1)	5,986 (25.4)	0.048	12,250 (25.7)	8,130 (25.4)	0.262
Indicated inductions	6,093 (5.5)	4,116 (5.9)	<0.001	3,777 (8.1)	2,543 (8.8)	0.001	2,316 (3.6)	1,623 (4.0)	0.001
<39 weeks	1,921 (1.7)	1, 234 (1.8)	0.490	1,147 (2.5)	727 (2.5)	0.605	774 (1.2)	507 (1.2)	0.532
39 weeks	4,172 (4.9)	2,932 (5.3)	0.003	2,630 (7.1)	1,816 (7.7)	0.003	1,542 (3.2)	1,116 (3.5)	0.060
Elective cesareans	12,204 (11.0)	7,697 (11.1)	0.630	1,279 (2.7)	722 (2.5)	0.046	10,925 (16.9)	6,975 (17.1)	0.485
<39 weeks	3,742 (3.4)	1,457 (2.1)	<0.001	336 (0.7)	138 (0.5)	<0.001	3,406 (5.3)	1,319 (3.2)	<0.001
39 weeks	8,462 (10.0)	6,240 (11.2)	<0.001	943 (2.5)	584 (2.5)	0.687	7,519 (15.8)	5,656 (17.6)	<0.001

* Denominators are presented in Appendix 1 (<http://links.lww.com/xxx>).

Bold indicates statistical significance of $P < 0.05$

Table 3

Multivariable logistic regression ^{*} results of the effect of the hard-stop policy on elective induction and cesarean (adjusted odds ratio, 95% confidence interval)

	Overall		Nulliparous		Multiparous	
	Before (2008–10)	After (2012–13)	Before (2008–10)	After (2012–13)	Before (2008–10)	After (2012–13)
Elective inductions	Ref.	0.94 (0.92 – 0.96)	Ref.	0.95 (0.92 – 0.99)	Ref.	0.94 (0.91 – 0.97)
<39 weeks [†]	Ref.	0.61 (0.58 – 0.65)	Ref.	0.74 (0.67 – 0.81)	Ref.	0.55 (0.51 – 0.59)
39 weeks [‡]	Ref.	0.97 (0.95 – 0.99)	Ref.	0.97 (0.94 – 1.01)	Ref.	0.97 (0.94 – 1.00)
Indicated inductions	Ref.	1.11 (1.07 – 1.16)	Ref.	1.12 (1.06 – 1.18)	Ref.	1.10 (1.03 – 1.18)
<39 weeks [†]	Ref.	1.04 (0.96 – 1.12)	Ref.	1.05 (0.95 – 1.15)	Ref.	1.02 (0.91 – 1.15)
39 weeks [‡]	Ref.	1.10 (1.05 – 1.16)	Ref.	1.12 (1.05 – 1.20)	Ref.	1.07 (0.99 – 1.16)
Elective cesareans	Ref.	1.00 (0.97 – 1.03)	Ref.	0.88 (0.80 – 0.97)	Ref.	1.01 (0.98 – 1.05)
<39 weeks [†]	Ref.	0.60 (0.57 – 0.64)	Ref.	0.63 (0.51 – 0.77)	Ref.	0.60 (0.56 – 0.64)
39 weeks [‡]	Ref.	1.11 (1.07, 1.16)	Ref.	0.95 (0.85, 1.06)	Ref.	1.14 (1.09, 1.18)

^{*} Models controlled for maternal race/ethnicity, parity (in the overall model; nulliparous versus multiparous), public insurance status, prenatal care utilization (5 versus <5), advanced maternal age, education (12 years versus <12), and CNM care.

[†] Denominator for early-term induction (“at-risk” group): deliveries at and beyond term (37 weeks). See Table, Supplemental Digital Content 2, for description of analytic sample sizes.

[‡] Denominator for full-term induction (“at-risk” group): deliveries at and beyond full term (39 weeks). See Appendix 2 (<http://links.lww.com/xxx>), for description of analytic sample sizes.

Bold indicates statistical significance of $P < 0.05$

Table 4
Maternal and neonatal outcomes, comparing time periods before and after the hard-stop policy

	Unadjusted, n (%) [*]		P-value	Adjusted, [†] Odds ratio (95% CI)	
	Before (2008 – 10)	After (2012 – 13)		Before (2008 – 10)	After (2012 – 13)
Maternal					
Perineal lacerations (vaginal)	1,409 (1.7)	877 (1.7)	0.628	Ref.	0.95 (0.87 – 1.04)
Maternal ICU admission	102 (0.09)	64 (0.09)	0.993	Ref.	1.02 (0.74 – 1.41)
Maternal blood transfusion	310 (0.28)	273 (0.39)	<0.001	Ref.	1.42 (1.20 – 1.67)
Chorioamnionitis	1,313 (1.2)	1,559 (2.2)	<0.001	Ref.	1.94 (1.80 – 2.09)
Operative vaginal delivery (vacuum or forceps)	4,388 (4.0)	2,457 (3.5)	<0.001	Ref.	0.90 (0.85 – 0.95)
Neonatal					
Stillbirth [‡]	110 (0.10)	83 (0.12)	0.201	Ref.	1.20 (0.88 – 1.63)
Perinatal death [‡]	157 (0.14)	125 (0.18)	0.045	Ref.	1.25 (0.97 – 1.60)
Neonatal death	47 (0.04)	42 (0.06)	0.093	Ref.	1.34 (0.87, 2.07)
Infant death	175 (0.16)	107 (0.15)	0.842	Ref.	0.94 (0.73 – 1.22)
Neonatal seizures	44 (0.04)	28 (0.04)	0.949	Ref.	1.12 (0.68 – 1.82)
NICU admission	2,881 (2.6)	1,887 (2.7)	0.129	Ref.	1.03 (0.97 – 1.10)
5-minute Apgar score <7	1,963 (1.8)	1,267 (1.8)	0.402	Ref.	1.04 (0.97 – 1.12)
5-minute Apgar score <4	327 (0.29)	272 (0.39)	0.001	Ref.	1.36 (1.16 – 1.61)
Assisted ventilation	3,691 (3.3)	2,219 (3.2)	0.118	Ref.	0.95 (0.90 – 1.01)

	Unadjusted, n (%) [*]		Adjusted, [†] Odds ratio (95% CI)	
	Before (2008 – 10)	After (2012 – 13)	Before (2008 – 10)	After (2012 – 13)
Meconium	5,775 (5.2)	3,734 (5.4)	0.123 Ref.	1.02 (0.98 – 1.07)
Macrosomia	12,069 (10.9)	7,572 (10.9)	0.920 Ref.	0.99 (0.96 – 1.02)

^{*} See Table, Appendix 3 (<http://links.lww.com/xxx>), for description of denominators and analytic sample sizes for regressions.

[†] Models controlled for maternal race/ethnicity, parity (nulliparous versus multiparous), public insurance status, prenatal care utilization (5 versus <5), advanced maternal age, education (12 years versus <12), and CNM care.

[‡] Denominator for stillbirth and perinatal death analyses is all term, singleton, vertex, non-anomalous births (IUFDs + livebirths); denominator for all other outcomes is term, singleton, vertex, non-anomalous livebirths.

Bold indicates statistical significance of $P<0.05$