BMJ Open

Routine induction in late-term pregnancies: follow-up of a Danish induction of labour paradigm

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To cite: Rydahl E, Declercq E, Juhl M, *et al*. Routine induction in late-term pregnancies: follow-up of a Danish induction of labour paradigm. *BMJ Open* 2019;**9**:e032815. doi:10.1136/bmjopen-2019-032815

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2019-032815).

Received 18 July 2019
Revised 17 October 2019
Accepted 14 November 2019

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ABSTRACT

Objectives For many years, routine elective induction of labour at gestational week (GW) 42+0 has been recommended in Denmark. In 2011, a more proactive protocol was introduced aimed at reducing stillbirths, and practice changed into earlier routine induction, i.e. between 41+3 and 41+5 GW. The present study evaluates a national change in induction of labour regime. The trend of maternal and neonatal consequences are monitored in the preintervention period (2000–2010) compared with the postintervention period (2012–2016).

Design A national retrospective register-based cohort study.

Setting Denmark.

Participants All births in Denmark 41+3 to 45+0 GWs between 2000 and 2016 (N = 152 887).

Outcome measures Primary outcomes: stillbirths, perinatal death, and low Apgar scores. Additional outcomes: birth interventions and maternal outcomes.

Results For the primary outcomes, no differences in stillbirths, perinatal death, and low Apgar scores were found comparing the preintervention and postintervention period. Of additional outcomes, the trend changed significantly postintervention concerning use of augmentation of labour, epidural analgesia, induction of labour and uterine rupture (all p<0.05). There was no significant change in the trend for caesarean section and instrumental birth. Most notable for clinical practice was the increase in induction of labour from 41% to 65% (p<0.01) at 41+3 weeks during 2011 as well as the rare occurrence of uterine ruptures (from 2.6 to 4.2 per thousand, p<0.02).

Conclusions Evaluation of a more proactive regimen recommending induction of labour from GW 41+3 compared with 42+0 using national register data found no differences in neonatal outcomes including stillbirth. The number of women with induced labour increased significantly.

Strengths and limitations of this study

- ► Retrospective national registry-based data (2000–2016).
- ► Diagnoses based only on International Classification of Diseases-10.
- ► Includes all births at 41+3 gestational week and beyond in Denmark.
- ► 13 years before and 5 years after a change in clinical practice on induction of labour.
- ► Access to relevant confounders.

INTRODUCTION

In Denmark, a new proactive policy was introduced in 2011 aiming at preventing stillbirth and other foetal and maternal complications in post-term pregnancies. The Danish Society for Obstetrics and Gynaecology introduced the new protocol recommending routine induction of labour in otherwise low-risk pregnant women between gestational week (GW) 41 plus 3 days (41+3 GW) and 41+5 GW to prevent the pregnancy from reaching the post-term period of 42+0 GW. Women at risk (eg, with diabetes or multiple gestations) are according to national guidelines offered induction at earlier gestational ages.[1] The argument for the new policy was a concern for the unborn child, as prolonged pregnancy increases the risk of a malfunctioning placenta, shoulder dystocia, meconium aspiration syndrome, foetal distress and ultimately foetal death.[1] The new protocol was also aimed at reducing post-term maternal complications such as dystocia, birth-related injuries, caesarean section (CS), and postpartum haemorrhage (PPH).[1] This new protocol was a deviation from the former guideline recommending induction at 42+0 GW. Induction of labour may itself impose a risk of adverse consequences such as hyperstimulation, foetal asphyxia, PPH, uterine rupture, and in very rare cases, foetal and maternal death.[2] Induction has been shown to be related to additional interventions such as epidural analgesia, continuous foetal monitoring, confinement to bed, instrumental birth and emergency CS.[3] There is a lack of consensus on how to handle pregnancies beyond term, as both post-term pregnancy and induction of labour may independently be associated with adverse consequences.[4]

Existing studies are limited regarding benefits and harms of routine induction at 41 GW

compared with previous standard of 42 GW. A systematic review by Wennerholm *et al*[5] found a non-significant reduction in stillbirths (RR 0.33, 95% CI 0.10 to 1.09), and a significant reduction in meconium aspiration syndrome (RR 0.43, 95% CI 0.23 to 0.79) using routine induction (41–42 GW) compared with expectant management (42–44 GW). Caughey *et al*[6] arrived at similar conclusions on studies inducing labour (39–41 GW) and found expectant management (41–45 GW) to increase the risk of CS (OR, 1.21 95% CI 1.01 to 1.46). None of these reviews compared induction at 41 GW with the Danish standard at 42 GW, but based conclusions on a wider variation in gestational age. A recently published systematic review narrowed the scope to routine induction at 41+0/6 GW versus 42+0/6 GW.[2] The data lacked statistical power to draw conclusions on perinatal death, but found a significant reduction in oligohydramnios, and meconium-stained amniotic fluid in the induction group (41+0/6). However, the study also found an increased risk of low pH <7.10, CS, chorioamnionitis, labour dystocia, precipitate labour and uterine rupture.[2]

In a normal population, about 25% of the women will still be pregnant at 41+0 GW and about 5% reach 42+0 GW without going into a spontaneous onset of labour.[7 8] Changing the protocol to offer routine induction between 41+3 and 41+5 GW thus changes the number of ongoing pregnancies and could lead to an additional 13%–15% of women being encouraged to have an induction,[4] with possible iatrogenic consequences.[9] One year after the Danish shift in the protocol, the new induction paradigm was almost fully implemented.[10] In the following year, two Danish studies evaluated the consequences and found a considerable reduction in stillbirths.[11 12] Hedegaard *et al* and Zizzo *et al* monitored 1 and 3 years of data, respectively, after implementation of the new protocol, but adjustment for ongoing trends was not performed.[11 12] The aim of this study was to evaluate perinatal outcomes, birth interventions and maternal outcomes after introducing the new 2011 protocol, during a 5-year follow-up period with adjustment for ongoing trends.

MATERIAL AND METHODS

This is a retrospective cohort study using data from the Danish Medical Birth Registry with additional patient level data from other Danish administrative registries. The dataset holds information on all births in Denmark since 1997 in women with either a Danish civil registration number or a temporary registration number. Undocumented migrants are probably also included, as it is legal to give birth anonymously. Data were collected prospectively at all contacts with healthcare providers, for example, midwives and obstetricians.[13] For the purpose of this study, we restricted data to include births in Denmark from 1 January 2000 to 31 December 2016 with a known gestational age. Our analysis is limited to pregnancies that lasted at least 41+3 GW (290 gestational days). Cases were excluded if both birth weight and length deviated substantially from the mean. A cut-off value of three SD was used to avoid including foetuses wrongly coded as late-term or post-term (online supplementary appendix 1).

The population of interest included all ongoing pregnancies from 41+3 GW and onwards. If any important foetal or maternal morbidity was present such as multiparity, body mass index (BMI) >35, maternal age ≥40, hypertension, diabetes mellitus or other medical conditions, the usual clinical practice is to induce labour no later than 41+0 GW. Few women may object to advice of induction of labour and may be included in the present study population.

The exposure of interest was the new protocol from March 2011 and implemented during 2011 at Danish hospitals offering routine induction at 41+3–41+5 GW.[10]

The outcomes of interest were stillbirth, perinatal death (stillborn or dead within the first 7 days), and low Apgar score (<7 after 5 min). We also analysed trends in birth interventions such as induction of labour (medical and/or mechanical), augmentation of labour (synthetic oxytocin), epidural analgesia (pain relief during vaginal birth), and maternal outcomes such as instrumental birth (forceps or vacuum extraction), CS and uterine rupture.

Potential confounding variables of interest included advanced maternal age (≥40 years), nulliparity, previous CS (among multiparous), light/moderate pre-eclampsia (blood pressure ≥140/90 and <160/110 with proteinuria), pre-pregnancy obesity (BMI ≥30); smoking (any smoking after first trimester), and high birth weight (>4000 g).

The variables in the dataset are either based on the International Classification of Diseases (ICD)-10 or use conventionally accepted standards by, for example, WHO.[14] No information on meconium aspiration syndrome, manifest oligohydramnios, pH value, precipitate labour and hyperstimulation was available. Further, the PPH code was changed in 2012 from including only severe bleeding to 'any bleeding' and was thus too imprecise to apply.

When health providers do the documentation, some information must be registered by ticking off a checkbox, if a given event occurs (eg, epidural). In this case, missing values cannot be determined, because the extent to which the provider may have left out a code is unknown (particularly if it does not involve a billing code). Other types of information are mandatory to report (eg, weight of the child). For mandatory variables, the number of observations with missing values was documented. We included a variable if at least 95% of cases were coded. We assumed a random misclassification with equal distribution of missing cases per year. None of the variables exceeded missing observations of more than 5%. The variable with the highest frequency of missing cases was maternal BMI ≥30 with 3.7%. The Strengthening the Reporting of Observational Studies in Epidemiology cohort reporting guidelines were used.[15]

Patient and public involvement

Patients were not directly involved in the study, as it was based on register data. However, in the initial phase of the study, the consumer organisation for Parenthood and Childbirth was contacted to discuss relevance of the aim of this present study. The results from the study will be published in the consumer organisation's journal as well as in other relevant sites of public interest.

Statistical analysis

Analyses were performed as Interrupted Time Series Analysis (ITSA) and, if not suitable, a Poisson regression analysis was conducted (explained below). The independent variable was years separated into quarters (n=68) or, in case of only a few observations, years (n=17). The time-period consisted of a preintervention period of 11 years (2000–2010), 1 year for implementation (2011), and 5 years for the postintervention period (2012–2016). Single-group analysis was used. The model fitted an ordinary least square (OLS) line preintervention and postintervention. If interruptions occurred at other time points during the preintervention period, the period was shortened to fit the best model. We tested robustness by checking if results were sensitive to change of adjoining years. The regression model used Newey-West standard errors and we conducted a Cumby-Huizinga test for autocorrelation.[16] The assumption in ITSA modelling is that any time-varying confounding changes relatively slowly and will not cause concern as long as no other interruption occurs coincidentally with the change in protocol in 2011.[16] Visual inspection is presented in online supplementary appendix 2.

The ITSA model is not optimal for rare outcomes, including less than four observations per time unit[16]; hence, Poisson regression was a more appropriate test for intrauterine and perinatal death with the year of birth as the explanatory variable. To increase precision of the estimates, the time period (year) between 2000 and 2016 was included in the analysis. We used the log (number of births) as an offset in the model to account for the varying number of births. Two models were fitted to the data. The first model included a general time trend only; the second model included a general time trend and an effect of the change in the protocol from 2011. The adequacy of each model was assessed by goodness-of-fit test and the impact of the change in the protocol was evaluated by comparing the slopes of the time trends before and after 2011.

All analyses are presented in graphs or fitted curves depending on the method of analysis. Descriptive statistics on stillbirth and perinatal death are presented as absolute numbers and percentages by year. If the absolute number was less than 5, results are presented as '<5' and rates as '<0.5 per 1000' and absolute numbers are omitted from the Poisson fitted curves to avoid identification.[17] Outcomes are further presented in a table including the interruption jump and slopes of the curves before and after the intervention with 95% CIs. P values present the statistical difference between the preintervention and postintervention slopes. For the Poisson regression, incidence rate ratio (IRR) for both fitted curves, p values and GOF are presented.

Data were analysed in STATA/SE V.15.1 software package (StataCorp. 2017. Stata Statistical Software) adding the STATA ITSA-package 17–4. All reported p values are two-sided, and statistical significance was 5%.

RESULTS

The dataset included 1 057 453 births from 1 January 2000 to 31 December 2016. Of those, we excluded 2712 records with missing information on GW (0.3%). Of the remaining cases, 153 120 pregnancies (14.5%) lasted until 41+3 GW or beyond. We excluded an additional 233 cases (0.15%), all live births, where both the weight and the length were more than three SD from the mean for a final working total of 152 887 pregnancies. In the final population, there were 213 stillbirths (0.14%) and 262 perinatal deaths (0.17%) (online supplementary appendix 1).

Trends in interventions and outcomes before and after the implementation of the new induction of labour protocol are presented in table 1 and further elaborated in figures 1–3. Table 1 presents the results of the interrupted time-series analysis, a preintervention and postintervention slope for each variable, the interruption jump in 2011 and a test for significance between the preintervention and postintervention slopes is presented. For the Poisson regression, a general fit before and after 2011 is shown as an IRR and a significance test for difference in IRR.

Primary outcome: perinatal mortality and morbidity

Table 2 presents stillbirths and perinatal death in absolute numbers per 1000 births. A general decline of intrauterine deaths was observed during the study period, with an initial risk of stillbirth at 2.3 per 1000 births in the year 2000 dropping to a rate of <1 per 1000 from approximately 2009, after which it has generally remained between 1.0 and 0.5 per 1000 births.

Figure 1A,B presents the two fitted curves for stillbirths and perinatal death, respectively. The red curve/diamond shows predicted values for the years 2012–2016 based on the 2000–2010 trend without a change in protocol and the black curve/cross represents a fitted curve after the change in protocol. Figure 1C presents the ITSA model for low Apgar scores with 2011 as an interim year for implementation. The OLS lines preintervention and postintervention are presented.

No difference was observed between the two fitted curves for either stillbirth (p=0.56) or perinatal death (p=1.00). The GOF test was p=0.40 for stillbirth and p=0.24 for perinatal mortality. Figure 1C presents low Apgar score before and after the intervention showing no difference in the slope before and after the new protocol (p=0.11). See table 1 for details.

Table 1 Trend before and after intervention, together with interruption jump (2011)

Outcomes	Interruption jump 2011	Preintervention trend % per year (95% CI)	Postintervention trend % per year (95% CI)	Difference in trends P value
Maternal interventions				
Augmentation of labour (%)	−3.1	−0.87 (−1.14 to 0.61)	0.11 (−0.16 to 0.40)	0.000
Epidural analgesia (%)	4.1	2.80 (2.48 to 3.12)	0.13 (−0.44 to 0.70)	0.000
Induction of labour (%)	22.4	1.70 (1.53 to 1.87)	−2.36 (−3.03 to 1.72)	0.000
Instrumental birth (%)	−0.5	−0.10 (−0.22 to 0.05)	−0.12 (−0.33 to 0.08)	0.881
Maternal outcome				
Caesarean section (%)	0.1	−0.16 (−0.36 to 0.04)	−0.10 (−0.47 to 0.27)	0.757
Uterine rupture (per 1000)	1.6	0.21 (0.12 to 0.30)	−0.24 (−0.60 to 0.13)	0.001
Foetal outcome				
Apgar score <7/5 min (%)	−0.2	0.01 (−0.01 to 0.02)	0.04 (0.01 to 0.07)	0.107
		General fit. IRR all years	General fit. IRR all years	GOF
Stillbirths		0.90 (0.87 to 0.93)	0.91 (0.87 to 0.95)	0.399
Perinatal mortality		0.90 (0.88 to 0.93)	0.90 (0.87 to 0.94)	0.240

GOF, goodness-of-fit test; IRR, incidence rate ratio.

Birth interventions and maternal outcome

Interventions in birth are presented in figure 2A–C, and maternal outcomes are presented in figure 3 A-C (see online supplementary appendix 3 for details).

Induction of labour increased during the preintervention period with an annual average increase of 1.7% and rates rising from 25% to 41%. By 2011, a significant jump from 41% to 65% annual inductions was seen (p<0.00). After the substantial jump in the rate in 2011, the annual decline of 2.4% in induction of labour brought the rate down to 55% (p<0.01). A significant change in trend was observed for augmentation of labour after implementation of the new protocol. As interruption in trend occurred in the preintervention period (2005) the period was shortened to fit the model. From 2005 until 2011 there was a slight annual decrease (−0.9%) in augmentation changing to a marginal annual increase of 0.1% (p<0.01) from 2012 to 2016. Use of epidural analgesia for pain relief during labour increased during the entire preintervention period at approximately 4.1% annually. The observed increase of epidural analgesia flattened in 2011 after the intervention, resulting in a marginal increase of 0.1% (p<0.01).

For CS an interruption in trend occurred in the preintervention period (2005) and the period was shortened to fit the model. No change was found for CSs before and after the change in the protocol (p=0.76) with a non-significant declining trend from 2005 and onwards. The number of instrumental births declined during the entire study period with an annual decrease of 0.1%, and no change was observed after 2011 (p=0.88). Uterine rupture is a rare event and is presented as a rate per 1000 births. During the preintervention period, a steady increase of 0.2 ‰ yearly was observed. In 73% of cases, uterine rupture occurred in women with previous CS. Uterine rupture was followed, similarly to the case of induction, by a substantial increase between 2010 and 2012 from 2.6‰ to 4.2‰ (p<0.02). In the postintervention period, a decline of uterine rupture of 0.3‰ yearly was noted (p<0.01).

Other relevant changes in population

Changes over time for possible confounders and interruptions occurring simultaneously as the intervention of interest (2011) may have biassed the results. We explored the changes in maternal age >40 years, nulliparity, pre-eclampsia, previous CS, BMI ≥30 and smoking status. No changes in trend were noted after 2011. See online supplementary appendix 2.

DISCUSSION

Principal findings

This study included all births in Denmark (n=152 887) from 41+3 GW between 2000 and 2016. We evaluated maternal and neonatal outcomes after a change in the induction of labour protocol in 2011. Once the trend from 2000 to 2010 was taken into account, no differences were found in stillbirth, perinatal death, or low Apgar score. There was, however, a 59% relative increase in the use of labour induction within the first year after the new protocol as well as a significant increase in uterine ruptures. The use of epidural analgesia and augmentation both levelled off after the change in protocol and there was no change in number of CSs in the preintervention and postintervention period.

Strengths and weaknesses of the study

No randomised trials were conducted before or concurrent with the implementation of the new protocol, and

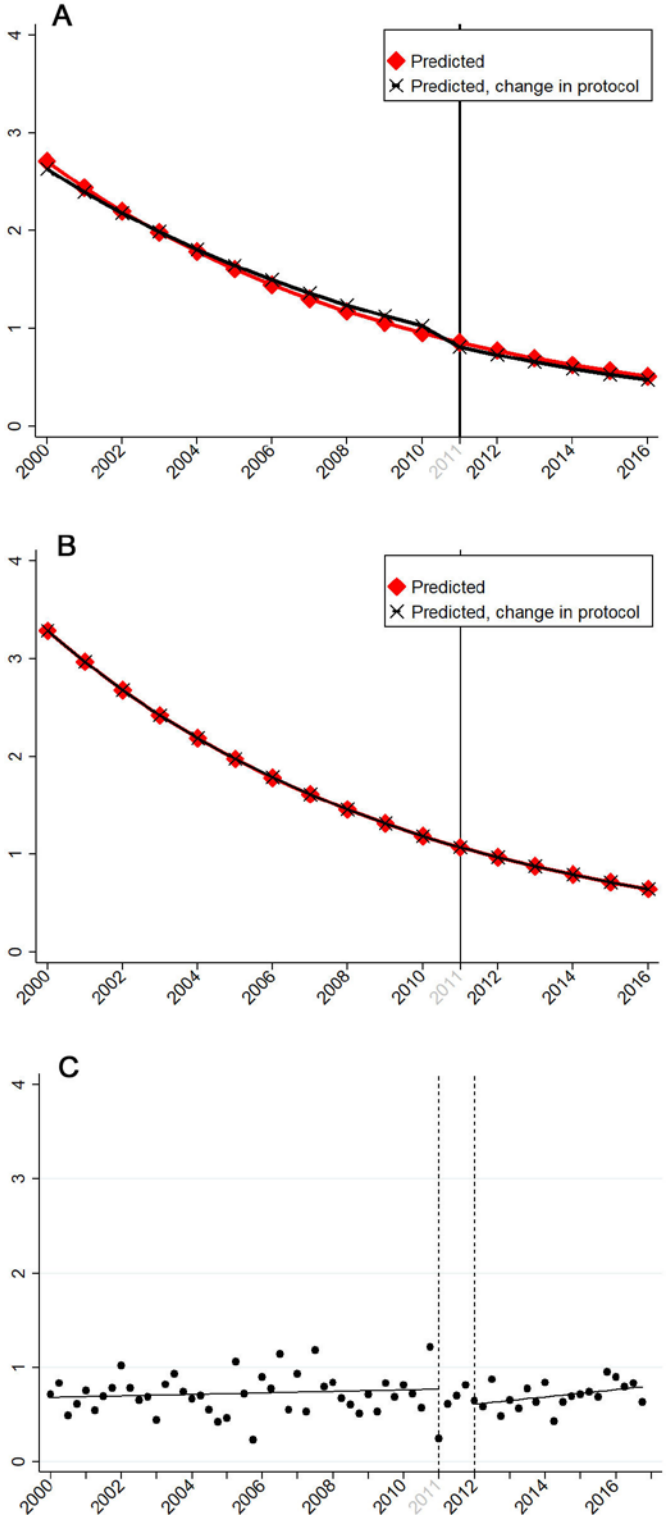

Figure 1 Perinatal outcomes, year 2000–2016 with change in protocol, 2011. (A) Stillbirths per 1000 births (B) Perinatal death per 1000 births. (C) Apgar score <7 after 5 min, per cent (%).

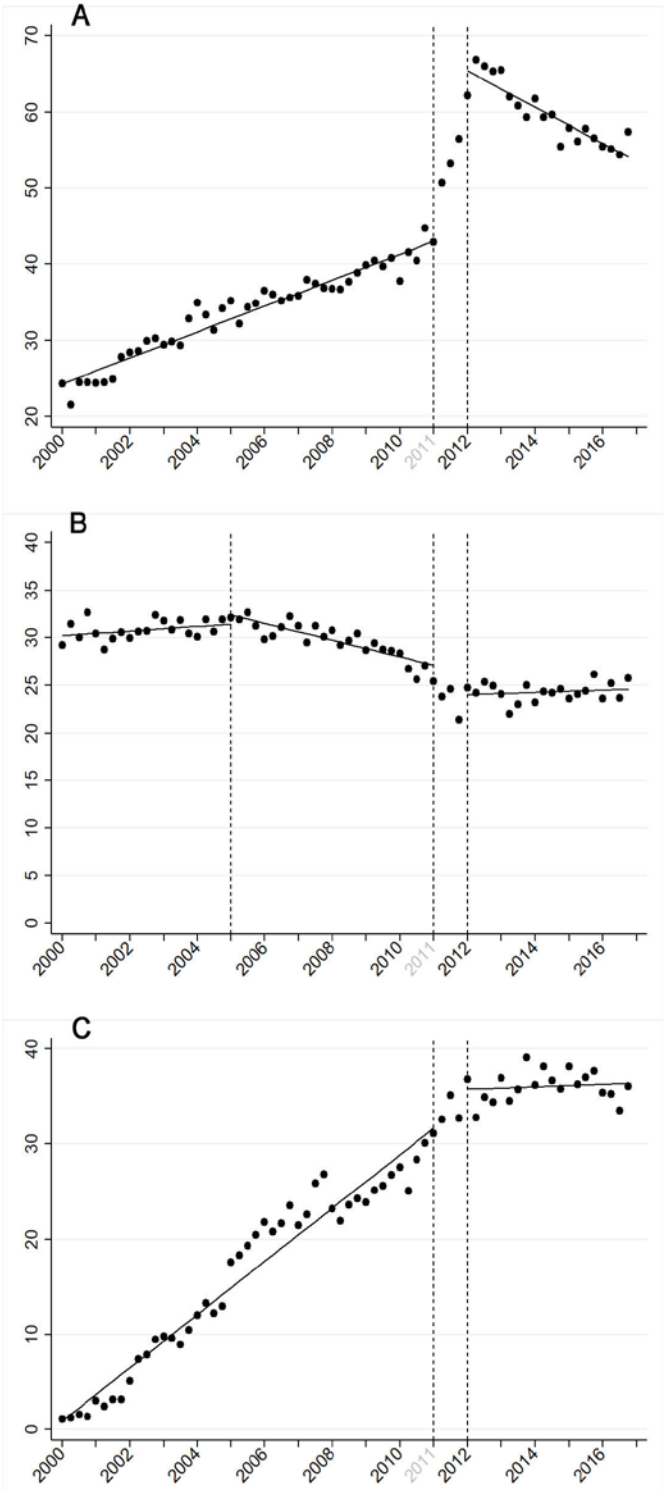

Figure 2 Interventions in childbirth (%), year 2000-2016 with change in protocol, 2011. (A) Labour induction. (B) Augmentation. (C) Epidural analgesia.

the ITSA design provides a robust quasi-experimental alternative.[18] The present design provides a high degree of internal validity[16] as a single-group ITSA offers an advanced approach to evaluation of before and after an intervention including analysis of the ongoing trends.[16]

The data used for this present study were collected prospectively for other purposes. Thus, interpretations of causality is not possible.

In the case of rare outcomes, we used a Poisson regression model. Estimating the trend before 2011 was used to predict the expected outcomes after the implementation. Two Danish retrospective cohort studies monitored the

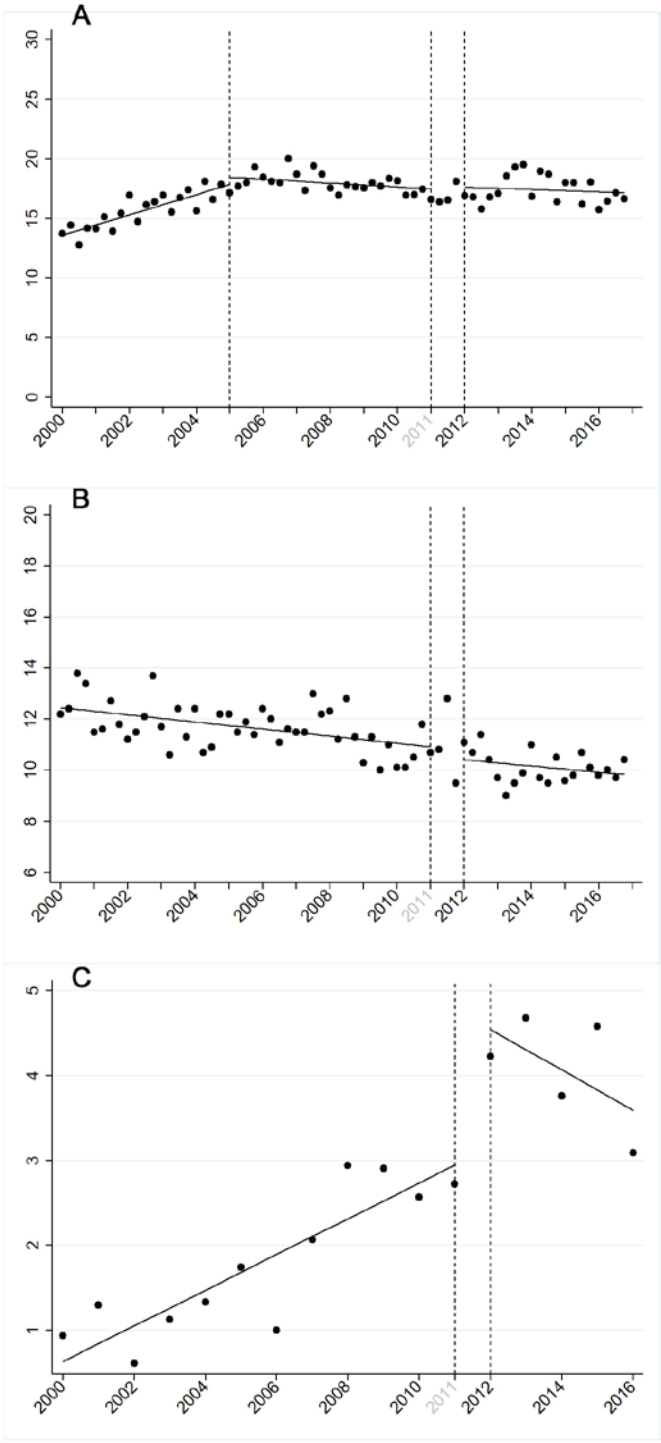

Figure 3 Maternal outcome, year 2000–2016 with change in protocol, 2011. (A) Caesarean section (%). (B) Instrumental birth (%). (C) Uterine ruptures per 1000 births.

impact of the intervention and found about a 50% reduction of stillbirths after 2011.[10 12] One study monitored pregnancies from 41+0 GW and found an adjusted OR of 0.5 (95% CI 0.29 to 0.89),[12] whereas the other study monitored pregnancies from 41+2 and did not arrive at significant results (OR 0.34, 95% CI 0.09 to 1.24).[10] Both studies compared the years before and after but did not consider the ongoing trend which revealed a 62% decrease in the stillbirth rate in the 5 years prior to the intervention and a marginal *increase* in the 5 years after the intervention to the point where the rate was the same in 2016 as it was in 2010 (0.8 per 1000) (table 2). This highlights the importance of including trends and longer time frames in the analysis of trends to ensure the most valid conclusions.

A strength of this register-based study is that it includes all Danish births at or beyond 41+3 GW. Denmark has universal healthcare coverage and selection bias is unlikely, as all women on all income levels and demographic characteristics are covered. The most recent study from 2003 validated the registration data and found that common surgical interventions and procedures matched the medical records.[19] ICD-10 main categories were validated and found acceptable.[19] Interventions are reimbursed if registered, which further increases accuracy.[13]

Not all known adverse effects are available in the register. Oligohydramnios and meconium aspiration syndrome usually increase with gestational age,[2 6] but since these data were not available, low Apgar, stillbirth and perinatal death were used as the best possible proxy outcome for these conditions. PPH is an adverse effect of both ongoing pregnancies in late gestation and induction of labour.[20] Due to a change in the definition of PPH, we considered the PPH data in the study period to be unreliable. Information on labour dystocia is not available in the registry, instead labour augmentation was used as a proxy measure. Information on hyperstimulation of the uterus and precipitate labour was not available, but uterine rupture may be a severe consequence of an overstimulated uterus.

Why the intervention seems to fail its purpose

The main finding of this study is a lack of immediate benefits for the fetus. A possible explanation may be that, in a country like Denmark with a generally high standard in public health and a low mortality rate, there would be fewer opportunities to prevent perinatal deaths.[21] European countries, including Denmark, have experienced a steady decrease in stillbirths and perinatal mortality during this millennium. A cross-European study found this decrease in all gestational ages, which points to multifactorial explanations.[21] Changed screening policies, early termination of pregnancies with lethal abnormalities, better postnatal management, preconception counselling, detection of foetal growth restriction, and a higher quality of prenatal care were mentioned as explanations.[21 22] In addition, a decline in smoking in pregnancy was emphasised as one of the main contributors to the decline in stillbirths.[21] In Denmark the rate of prenatal smoking decreased from 19% in 2000 to 5% in 2016 (online supplementary appendix 2).

It is estimated that suboptimal care accounts for 20%–50% of stillbirths.[21 23] Nonetheless, a number of stillbirths and perinatal deaths are not preventable, especially in case of undetected severe congenital malformations.[24] Several studies have found a marked increase in stillbirths with increasing gestational age,[25–27] which is

Table 2 Stillbirths and perinatal death in years 2000–2016

Year	Births n=152 887	Stillborn n=213	Stillborn per 1000 births	Perinatal death n=262	Perinatal death per 1000 births
2000	10 670	25	2.3	35	3.3
2001	10 765	31	2.9	36	3.3
2002	9887	19	1.9	23	2.3
2003	9702	18	1.9	20	2.1
2004	9025	15	1.7	18	2.0
2005	9181	18	2.0	20	2,2
2006	9041	19	2.1	24	2.7
2007	8681	12	1.4	15	1.7
2008	9173	12	1.3	16	1.7
2009	8943	8	0.9	8	0.9
2010	9326	7	0.8	8	0.9
2011	8462	<5	<0.5	5	0.6
2012	7801	<5	<0.5	<5	<0.5
2013	7700	8	1.0	10	1.3
2014	7716	<5	<0.5	<5	<0.5
2015	8072	6	0.7	9	1.1
2016	8742	7	0.8	8	0.9

According to European Union's General Data Protection Regulation no data <5 observations may be provided. The rate per 1000 births is corrected accordingly.

a relevant argument for routine induction at late term. However, these studies rely on data collected from 1985 to 1996 and may not represent contemporary risks. The same challenges may exist in the evidence base behind the Danish change in guideline,[25 28 29] where data collection draws on stillbirth studies back to the year 1969, long before the general health improvements noted above. This may explain the lack of benefit found in this study associated with offering routine induction of labour a few days earlier than usual practice.

Intervening in the normal processes of childbirth

The few days change in the recommended time for induction of labour caused no improvement in measured perinatal outcomes, but it affected the physiological birth. The rate of labour inductions increased from 41% to 65% in the first year after implementation. Induction of labour interferes with the physiological birth, as it may prolong time in labour and in hospital, confine the woman to the bed attached to monitoring devices and an intravenous drip.[30] This more proactive induction of labour regimens was also implemented in the UK in 2008.[31] Scandinavian countries, in general, are more likely to practice expectant management with regard to induction of labour,[32] weighing the benefits against the potentially harmful consequences of induction of labour.[33]

Since induction of labour has been found to be a risk factor for hyperstimulation and pressure on the uterine cavity, uterine rupture is a well-known adverse effect.[2 7 34] A systematic review comparing inducing labour in women at 41 GW versus 42 GW showed a doubling of the risk of uterine rupture (RR 1.97, 95% CI 1.54 to 2.52).[2] This study found an increase in uterine rupture (p<0,02) with a change from 2.6 to 4.2‰. A long-term trend towards an increased use of epidural analgesia for pain relief levelled out after implementation of the new protocol (figure 2C). In the present study, the use of augmentation of labour increased slightly after a long period of a decreased use (figure 2B). Knowledge of risks associated with augmentation at 41 GW versus 42 GW is limited. One cohort study of 51 473 women found an increase in labour dystocia after induction of labour was performed at 41 GW (RR=1.29, 95% CI 1.22 to 1.37)[35] while a randomised trial of 508 women found no difference (RR 0.55, 95% CI 0.20 to 1.45).[36] Conflicting results have been published regarding induction of labour and risk of CS.[2 37 38] In this study, no change in the CS trend was found, despite the substantial increase in induction of labour. Studies monitoring the normal course of pregnancy between 41 GW and 42 GW have found 70%–75% of the women went into spontaneous labour before 42 GW. The rest were induced due to medical reasons or induced at 42 GW.[36 37 39 40]

Possible implications for clinicians and policymakers

The WHO recommends induction of labour for medical reasons if the expected benefits outweigh the potential harms.[1] The current study highlights the importance of evidence-based practice and careful monitoring of trends after implementation of new interventions in pregnancy and childbirth.

Unanswered questions and future research

The intention behind implementation of a new induction of labour protocol was an expected reduction in stillbirth and perinatal mortality. Based on the results from this present study, the expected reduction in mortality after introducing earlier induction of labour was not achieved. As low stillbirth rates already exist in Scandinavian countries, medicalisation of a large group of low risk women may be ineffective or even provide more harms than benefits. As most register studies only provide the numbers of adverse outcomes, a more detailed study of case fatality is needed not only taking into account congenital abnormalities, but also underlying social mechanisms and suboptimal care, to provide knowledge on how to reduce adverse outcomes in counties with a low stillbirth rate.[41]

Universal and free access to healthcare with focus on health literacy during pregnancy and childbirth and with a continuing and ongoing focus on socioeconomic disadvantages may reduce adverse outcomes for mothers and infants.[42 43]

CONCLUSION

The aim of this study was to evaluate changes in maternal and neonatal outcomes after implementing earlier routine induction of labour after 41+3 GW in the entire Danish population of pregnant women. No change in trend was found in low Apgar scores, stillbirths or perinatal deaths after implementation of earlier routine inductions of labour. The most substantial impact was the number of inductions of labour in women with otherwise low risk pregnancies and an increased number of uterine ruptures. The use of epidural analgesia, augmentation of labour, instrumental births and CSs remained stable. The study highlights a need for a more balanced discussion among health providers on routine induction at late term.

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Acknowledgements We are grateful for Danish midwives' and physician' contribution to collect data from courses of pregnancy and childbirth to be used for research. Further, we acknowledge fruitful discussions with the Parenthood and Childbirth Organisation in the initial planning of the study.

Contributors ER and RDM planned the study. ER and RDM analysed data. ER wrote the manuscript in close correspondence with RDM, MJ, and ED. ER, RDM, MJ and ED revised the manuscript and accepted the final version. ER is the guarantor.

Funding ER received a grant from Danish Association of Midwives and Herlev Hospital supported the scholarship.

Competing interests ER was supported by a shared scholarship from Aarhus University and University College Copenhagen. Further, a grant from the Danish Association of Midwives and Herlev Hospital supported the scholarship.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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