

# BMJ Open Are the Danish stillbirth rates still record low? A nationwide ecological study

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## ABSTRACT

**Objectives** After introduction of a more proactive post-term induction practice, stillbirth rates have decreased substantially throughout the first decade of this century in Denmark. The aim was to follow up on induction and stillbirth rates in Denmark.

**Design** Historical ecological study.

**Participants** We included all delivering women in Denmark during the period 2007–2018.

**Intervention** Induction rates from 41 weeks of gestation.

**Main outcome measure** Stillbirth rates from 41+0 weeks.

**Results** Of 739 570 delivered children, 179 734 (24.3%) were born from 41+0 weeks. The proportion of deliveries after 41 weeks which were induced increased from 25.4% in 2007 to 44.4% in 2012. From 2012 to 2015, the induction rates decreased from 44.4% to 39.4%. After 2015 rates were stable.

During the same period, stillbirth rates decreased from 1.30 in 2007/2008 to 0.38 per 1000 newborn in 2011/12; -54%. From 2012, however, the rates were doubled from 0.38 per 1000 in 2011/2012 to 0.74 per 1000 in 2015/2018; RR 1.97 (95% CI 1.02 to 3.81),  $p=0.033$ . Changes in the included potential confounders cannot explain neither the substantial fall in stillbirth rates from 2007/2008 to 2011/2012, nor the doubling in stillbirth rates after 41 weeks since 2012.

During the whole study period, the cumulated risk of intrauterine foetal death increased from week 41+0 to 41+6 from 0.16 to 1.25 per 1000 ongoing pregnancies or 7.8 folds. Going beyond 42 weeks further increased the risk to 2.46 per 1000 ongoing pregnancies.

**Conclusion** We found a consistent inverse correlation between the proportion of women with induction of labour after 41 weeks of gestation and the stillbirth rates during the same period and same gestational ages. This Danish update on post-term inductions and corresponding stillbirth rates thus confirm previous findings suggesting a causal link between these two parameters.

## INTRODUCTION

We previously reported a close temporal association between post term birth induction regimen and stillbirth rate, that is, with more frequent and earlier induction regime, the stillbirth rate went down.<sup>1</sup> Danish obstetricians decided in 2010 to recommend

## Strengths and limitations of this study

- Nationwide complete data covering the 12-year period 2007–2018.
- Includes 179 734 newborn from 41 weeks of gestation.
- Detailed deaths statistics on each day from 41+0 and cumulated by time.
- Inclusion of other potential confounding factors in analysis.
- Principal limitation: observational non-experimental data.

deliveries to be completed before 42 weeks of gestation, with effective guidelines from 2011. This more proactive induction practice increased the induction rate from 20% to 25%, while the stillbirth rates declined from 1.2 to record low 0.77 per 1000 newborn after 40 weeks of gestation.<sup>1</sup> We also demonstrated improved perinatal outcomes and unchanged caesarean section rates with the more proactive induction practice.<sup>2</sup> Recently, a Swedish randomised study confirmed a higher risk of prenatal foetal death with postponing birth induction until 42 weeks of gestation as compared with induction at 41+0 weeks.<sup>3</sup>

Some have questioned the association between induction scheme and stillbirth rates to be an expression of a causal influence of induction on stillbirth rates and have suggested other changes in obstetrical practice by time to be responsible for the temporal association, for example, better surveillance of post-term pregnant women, better screening for women at risk of obstetrical complications, and declining smoking frequencies in pregnant women by time. Recently, it has been questioned whether an association between induction regime and stillbirth rates exists at all.<sup>4</sup>

One of the challenges with a more frequent and earlier induction regimen, is the demand of an expanded staff to take

care of these inductions, needs which often conflict with attempts to reduce staff as maternity wards are merged and centralised in order to ensure, for example, at site neonatal care facilities.

This study aimed to analyse induction frequencies and national stillbirth rates from 41 completed weeks during the period 2007–2018.

## MATERIAL AND METHODS

### Study design

In a historical ecological design, deliveries from 1 January 2007 to 31 December 2018 were assessed.

### Data sources

Data were retrieved from the Danish Birth Registry, which collects data on all deliveries in Denmark, including home deliveries, deliveries in private clinics and public maternity wards.<sup>5</sup> Time trend figures were based on publicly available data to ensure same data source as a recently published study.<sup>4</sup> The detailed figures according to gestational ages were not publicly available. For these analyses, we had access only to delivering women with a permanent Danish pin code, and this detailed analysis was restricted to singleton deliveries.

Ethnicity was operationalised as country of origin and was achieved from Statistics Denmark.<sup>6</sup>

### Methodological considerations

The new induction regime became national guidelines from 2011. It attempted to ensure delivery before 42 completed gestational weeks. The more proactive induction policy was not, however, implemented over night from January 2011. It implied a more proactive obstetrical practice also earlier after term in case of foetal growth stagnation or maternal complaint, with inductions soon after term. The focus for this analysis is, however, non-complicated pregnancies passing 41 weeks of gestation, which therefore became our cut-off for the present analysis.

Two further attempts influenced our methods. First transparency. While induction figures can easily be calculated annually, the number of stillbirths from 41 weeks became during the study period rather low. As figures below five are not allowed to be reported in scientific papers, all stillbirth figures were calculated for two consecutive years, beginning with 2007–2008, ending with 2017–2018.

The other attempt was to reduce random variation, which makes interpretations more difficult. This goal was also achieved by the 2-year reporting of stillbirths.

Potential confounders considered were age of delivering women, body mass index, smoking in pregnancy, parity and ethnicity. These data were also made up for the same 2-year periods.

Deaths within the first week of life have also been assessed, although we do not expect the same protection with the more proactive induction practice as for

stillbirths. The sum of stillbirths and deaths within first week of life allowed calculation of perinatal deaths and perinatal death rates.

For the whole study period, we calculated cumulated risk of foetal death per 1000 ongoing pregnancies from 41+0 weeks to explore how much the cumulated risk increases for each day a pregnancy is prolonged from 41+0 weeks. These calculations were made on only Danish citizens, that is with a personal identification number (excluding recent immigrants or visitors to Denmark)

Generally, the trends presented are highly significant due to the large number of included deliveries. Differences in death rates were calculated with 95% CIs by  $\chi^2$  test, and level of significance between rates was set at  $p < 0.05$ .

### Patient and public involvement

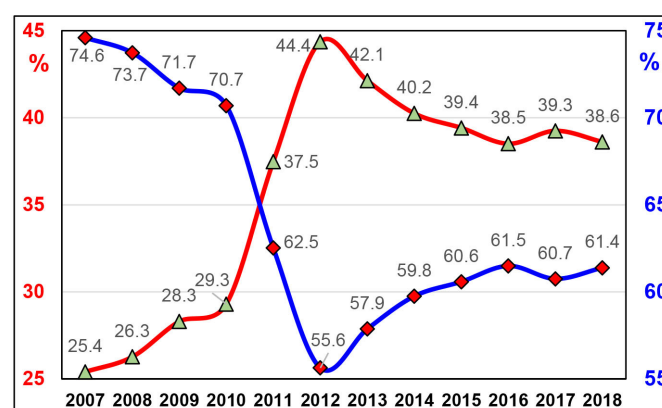
Patient or public were not involved in this register study. The press will be informed about the results when published. Danish legislation prevents data sharing, but annual stillbirth rates are publicly available on [www.esundhed.dk](http://www.esundhed.dk).

## RESULTS

During the study period, 739 570 children were delivered, and of these 731 446 (98.9%) had recorded gestational age. Of those with known gestational age, 179 734 (24.6%) were born from 41+0 gestational weeks.

The proportion of deliveries after 41 completed weeks which were induced increased from 2007 to 2010 from 25.4% to 29.3%, and from 2010 to 2012 further to 44.4% (figure 1). From 2012 to 2018, the induction rates fell from these 44.4% to 38.6% of by 13%. After 2015 induction rates were stable.

During the same period, stillbirth rates decreased from 2007/2008 to 2009/2010 from 1.30 to 0.82 per 1000 newborns, a decrease of 37% (table 1 and figure 2). From 2009/2010 to 2011/2012, the stillbirth rates fell further to 0.38 per 1000 births, a decrease of 54%.



**Figure 1** Induction rates from 41 gestational weeks in Denmark 2007–2018 (red Y1). Proportion of non-induced women also shown (blue Y2).

**Table 1** Characteristics of women delivering from 41+0 gestational weeks in Denmark 2007–2018

		2007–2008	2009–2010	2011–2012	2013–2014	2015–2016	2017–2018
Deliveries	41+	29957	30616	29149	28254	30318	31440
Stillbirths	41+ (n)	39	25	11	18	24	22
	per 1000	1.30	0.82	0.38	0.64	0.79	0.70
Neonatal deaths*		15	5	12	8	5	9
Perinatal deaths†	41+ (n)	54	30	23	26	29	31
	per 1000	1.80	0.98	0.79	0.92	0.96	0.99
Age	% 35+	19.7	20.5	20.5	20.6	20.5	20.1
BMI	% 25+	35.2	35.3	35.4	34.9	34.8	36.6
Smoking	in pregnancy	11.3	9.9	8.7	7.7	6.9	5.9
Parity	% P0	51.4	51.7	50.5	49.5	47.8	47.7
Ethnicity	% AASA	7.1	7.6	8.2	9.3	10.6	11.4

\*Neonatal deaths are deaths within first week of life.

†Perinatal mortality=stillbirths+neonatal deaths.

AASA, African, Asian or South American origin; BMI, body mass index.

From 2012, however, after more than a decade of consistent decrease in stillbirth rates, the rates have increased and were doubled from 2011/2012 to 0.74 per 1000 in 2015/2018; rate ratio 1.97 (95% CI 1.02 to 3.81),  $p=0.033$ . Comparing 2017–2018 with 2011–2012 provided an incidence rate ratio of 1.85 (95% CI 0.90 to 3.82),  $p=0.089$ .

Thus, we observed a close inverse correlation between induction rates from 41 weeks and stillbirth rates during the same years.

The cumulated risk of intrauterine death during the period 2007–2018 according to gestational day from week 41+0 is illustrated in [table 2](#) and [figure 3](#). It appears that risk of intrauterine death increases exponentially with increasing gestational age, from 0.16 per 1000 pregnant women at 41+0 to 1.25 per 1000 pregnant women at 41+6, a 7.8-fold increase. The risk increased further if the pregnancy goes beyond 42 weeks to 2.46 per 1000 pregnancies or by 15-fold when compared with delivering at 41+0 weeks.

For the included potential confounders, the proportion of delivering women with an age of 35 years or older was rather stable around 20% throughout the study

period as was a proportion of around 35% with body mass index above 25 kg/m<sup>2</sup>. The percentage of primiparous women decreased from 51.4% in 2007–2008 to 47.7% in 2017–2018. This decrease should have decreased the stillbirth rates a little through the last part of the study period. The only potential confounder which showed a substantial change was the percentage of smokers in pregnancy declining from 11.3% in 2007–2008 to 5.9% in 2017–2018. This decrease was most prominent from 2012 onwards and should therefore have contributed to a slight decrease in stillbirth rates during the period after 2012. Finally, the proportion of delivering women with origin from Africa, South America or Asia increased during the period 2011–2012 to 2017–2018 from 8.2% to 11.4%.

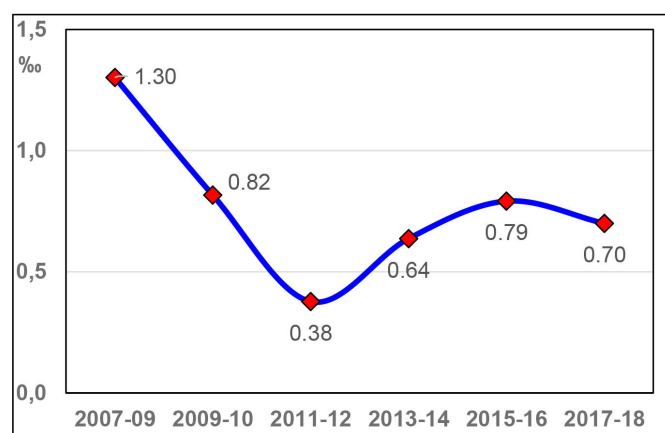
The perinatal mortality figures fell significantly from 2007 to 2008 (1.8 per 1000) to 2011–2012 (0.79 per 1000). After 2012, the perinatal mortality was slightly increasing from 0.92 in 2013–2014 to 0.99 per 1000 in 2017–2018 ((Non-significant (NS)).

## DISCUSSION

In this historical ecological study, we found a strong relationship between induction rates after 41 weeks of gestation and stillbirth rates. During the period of uninterrupted increase in inductions, the stillbirth rates decreased consistently, and most so from 2009–2010 to 2011–2012, coinciding with the new proactive induction practice.

## Evaluation of results

It has been argued that other factors such as better ultrasound equipment or better surveillance of women with post-term pregnancies contributed substantially to the decrease in stillbirths from 2009 to 2012. The significantly increasing trend in stillbirths after 2012, coinciding with a decrease in induction rates after 41 weeks, contradicts such ideas as it is unlikely that the obstetrical surveillance or our technical equipment should have deteriorated



**Figure 2** Stillbirth rates per 1000 born from 41 gestational weeks from 2007 to 2018.

**Table 2** Intrauterine deaths per 1000 pregnant women from 41+0 gestational weeks through the period 2007–2018 in Denmark

2007–2018	41+0	41+1	41+2	41+3	41+4	41+5	41+6	42+
Pregnant	177 334	149 139	123 520	101 677	79 868	60 451	40 896	24 800
Born	28 195	25 619	21 843	21 809	19 417	19 555	16 096	24 800
Risk time (days)*	163 237	136 330	112 599	90 773	70 160	50 674	32 848	12 400
Foetal deaths	26	16	12	14	14	15	7	15
Deaths/1000	0.16	0.12	0.11	0.15	0.20	0.30	0.21	1.21
Cumulated	0.16	0.28	0.38	0.54	0.74	1.03	1.25	2.46
Relative risk†	1	1.7	1.4	1.4	1.4	1.4	1.2	2.0
Relative risk‡	1	1.7	2.4	3.4	4.6	6.5	7.8	15.4

\*Calculated as the number of pregnant women at start of day minus half of deliveries that day.

†As compared with the day before.

‡As compared with rate at 41+0.

over the last 6 years, on the contrary if anything. The declining proportion of smokers and the fewer primiparous women would tend to decrease our stillbirth rates. As all Danish citizens have equal and free access to obstetrical care, prenatal diagnosis and public delivery wards, the modest increase in non-Caucasian delivering women is not expected to have influenced the stillbirth rates more than marginally, partly counter balancing the decreasing influence from fewer smokers and fewer primiparous women. Nevertheless, we saw a significant doubling in these rates. We could not identify any other factor, which could explain the observed increase in stillbirths after 2012.

We do not claim, that the proactive induction paradigm alone was responsible for the fall in stillbirth rates until 2012, and that the reduced induction rates alone are responsible for the increase in stillbirth after 2012, but our data strongly suggest that the induction paradigm has a main responsibility for this development.

### Implication of findings

An increase from 0.38 per 1000 to 0.74 per 1000 born (the average from 2015 to 2018) corresponds to five to six more stillbirths per year among pregnant women after

41 gestational weeks. In other words, the Danish data suggests that five to six more pregnant women experience a stillbirth today than in 2012, due to the 13% decrease in induction rates (=5.8% points decrease).

Thus, the present update to our last publication covering the period 2000–2012<sup>1</sup> supports our earlier interpretation. The background for the decreased induction percentage after 2012 could be lack of resources at the maternity wards due to a general increase in the national birth rate forcing the staff to postpone induction. From year 2000 to 2012, the stillbirth rates among women delivering from 41 weeks fell by 82% or by an annual 30 stillborn per year. With the new increase, we have lost 5 of these 30 prevented deaths and are now back at the level of 2009–2010.

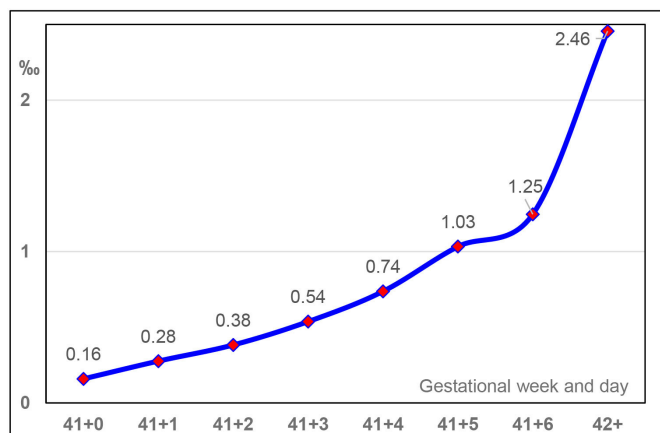
A recent attempt to extrapolate unidirectional trend curves appears to be unsuited to evaluate the influence of induction and implied at total miss of the significant increase in stillbirths over last 6 years.<sup>4</sup> On the other hand, our results are in line with the newly published randomised Swedish study suggesting significantly higher stillbirth rates with postponing induction to 42 weeks instead of at 41 weeks of gestation.<sup>3</sup>

### Strengths and limitations of study

The main limitation of this study is its ecological design implying that even a strong correlation is not an ultimate prove of a causal relationship between induction regimen and stillbirth rates. The few missing deliveries without recorded gestational age (1.1%) are mainly very preterm deliveries, demonstrated by journal check in a sample of deliveries without this information in our previous study.<sup>1</sup> This small lack is thus unlikely to have influenced our main results materially.

Among strengths are the nationwide design including all delivering women over a period of 12 years, ensuring a fair external validity, the generally good data quality in the birth registry, and the high percentage with complete data.

The current Danish recommendation is to initiate induction between 41+3 and 41+5 weeks in order to



**Figure 3** Cumulated risk of intrauterine death from 41+0 gestational weeks per 1000 ongoing pregnancies. Denmark 2007–2018.



accomplish birth no later than 41+6 weeks of gestation. Following to the new Swedish data, it is considered to revise our national guidelines and offer induction to all women at 41+0 weeks. The data in [table 2](#) and [figure 3](#) may be helpful in these considerations.

## CONCLUSION

In conclusion, this follow-up confirms that timely post-term inductions still seem to play a key role for stillbirth rates in women with uncomplicated pregnancies passing 41 gestational weeks. We recommend all obstetrical units to adhere to the national guidelines to ensure record low stillbirth rates as we achieved in 2012.

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**Contributors** ØL, LK and AT conceptualised the study, ØL made the analyses and wrote first draft of paper. All authors, ØL, LK, AT, NPD and OBBP, interpreted the results, revised the manuscript and accepted the final version.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** Most data are publicly available at e-sundhed.dk. Data for the detailed analysis on different gestational days were delivered by permission from the Regional Data Protection Agency: J no P-2020–217.

**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 online supplemental information. All data relevant to the study are included in the article. Only authorised scientists can after relevant permissions from the Danish Data Protection Agency get access to individual medical data in Danish registries.

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