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Full length article

# Respiratory distress after planned births compared to expectant management – Target trial emulation

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ABSTRACT

*Objective:* The primary aim of this study was to determine the appropriate gestational age for planned births by elective cesarean section (ECS) or induction of labor (IOL) in relation to no excess risk of neonatal respiratory distress.

*Study design:* Register-based Swedish cohort study including 575,817 singleton live births at 36 weeks or later. Births not eligible for vaginal delivery, preterm premature rupture of membranes and infants with congenital anomalies were excluded. The primary outcome was respiratory distress, and a secondary outcome was Apgar score <7 at five minutes. The risk of outcomes according to onset of birth was calculated for each day from gestational week 36 to 41 and compared with expectant management (EM), defined as births at least one day later.

*Results:* No excess risk of respiratory distress was found for ECS from 40 weeks and for IOL from 38 weeks compared with EM. At 37 weeks, the absolute risk of respiratory distress was 12.4 % for ECS (aRR:5.7; 95 % CI:4.8; 6.5) and 4.0 % for IOL (aRR:1.7; 95 %CI:1.5; 2.0). At 39 weeks, the absolute risk of respiratory distress for ECS was 3.2 % (aRR:1.6; 95 %CI:1.3; 1.8) whereas the risk was reduced for IOL. ECS <38 weeks increased the risk of Apgar <7 compared with EM.

*Conclusion:* Regarding neonatal respiratory distress, IOL was safe from 38 weeks and ECS from 40 weeks. At earlier gestational ages, the risk of respiratory distress was significantly higher, which highlights the importance of clear health policies regarding appropriate timing and indications for planned births by ECS and IOL.

## Introduction

Births are increasingly planned at term by either elective cesarean section (ECS) or induction of labor (IOL). Different rates of planned births are seen between populations, ranging from 18 % to 49 % in Europe in 2013 [1]. This likely reflects a lack of international consensus regarding acceptable indications for planned births. Further, the prevalence of early-term births (37 + 0 to 38 + 6) varies greatly between countries from 15 % to 30 % [2]. From 2008, a rising trend of early-term IOL has been seen in some Nordic countries [3,4]. The evidence supporting improved maternal outcome of early-term IOL in pregnancies complicated by hypertensive disorders in pregnancy (HDP) is relatively strong [5–7], whereas the evidence is weaker for other conditions as gestational diabetes mellitus (GDM) [8,9] Importantly, this evidence is often based on small, randomized trials that were not designed to detect differences in adverse neonatal outcomes between IOL and expectant management (EM) [8,9].

Respiratory distress affects up to 7 % of term newborns [10] which may indicate transient respiratory support and admission to neonatal care [11]. The risk of neonatal respiratory distress following ECS before 39 weeks compared with 39 weeks or later (full-term) is known to be increased [12]. According to the ARRIVE trial, full-term IOL is safe and

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could potentially be beneficial regarding neonatal respiratory distress [13]. However, less is known about the effect of early-term IOL on respiratory distress [5,7,14]. Apgar score <7 at 5 min is associated with moderate to severe asphyxia and is a common reason for admission to neonatal care [15,16]. The aim of this study was to estimate the risk of respiratory distress following planned births (ECS and IOL), compared with expectant management (EM) from gestational week 36 and onward, simulating a randomized controlled trial. Secondarily, we investigated the risk of Apgar <7 at five minutes, according to onset of birth. The primary aim was to find the time-point at term when ECS and IOL can be performed without an excess risk of respiratory distress and explore if that timing differs in pregnancies complicated by hypertension and diabetes.

## Methods

This Swedish cohort study included singleton live-births at 36 weeks or later (Fig. 1). One randomly selected birth per woman from 2010 to 2019 was identified in the Medical Birth Register (MBR). Births with placenta previa or placenta accreta spectrum or two or more previous cesarean sections were excluded as vaginal delivery was contraindicated. Infants with congenital anomalies were excluded as these conditions may strongly affect neonatal outcomes. Also, because of a distinct risk profile, births of infants exposed to preterm premature rupture of membranes were excluded by the diagnostic code O42 in the Swedish version of the 10th revision of the International Classification of Diseases (ICD-10). The final study population included 575,817 births.

### *Exposure and outcome*

The studied interventions were planned births: ECS or IOL. Intervention at each day from 36 weeks and onwards was compared with EM, consisting of pregnancies that continued throughout each of those days. After adjustment for confounders, the groups of ECS, IOL and EM were considered comparable regarding the risk of respiratory distress. The study may be seen as a sequence of mini trials with individuals who had not given birth the day before being eligible for a trial on a given day. Onset of labor was defined as spontaneous, pre-labor emergency cesarean, ECS or IOL based on midwife-reported checkboxes in electronic birth records. Further, information about IOL was retrieved from the ICD-10 diagnostic code O61. In 93.5 % of pregnancies, the expected date of delivery was based on ultrasound before 20 weeks, in 3.5 % on date of last menstrual period and in 3.0 % according to a postnatal assessment. The primary outcome studied was neonatal respiratory distress, based on the ICD-10 diagnostic codes P22 (respiratory distress syndrome, transient tachypnea of the newborn, other or unspecified respiratory distress) or P24 (neonatal aspiration syndromes). The diagnosis excluded pneumonia, pulmonary hemorrhage or chronic pulmonary disorders of the neonate. A secondary outcome was Apgar score <7 at five minutes as a marker for moderate to severe asphyxia.

### *Covariates*

Information on maternal characteristics was recorded at the first antenatal visit. It included height, weight, smoking and pre-gestational diseases that were registered in checkboxes (chronic hypertension, diabetes mellitus, kidney disease, systemic lupus erythematosus, inflammatory bowel disease, epilepsy and asthma). Information about gestational disorders was retrieved from ICD-10 codes that were recorded at birth; hypertensive disorders in pregnancy (HDP: O11, O13-O16) and gestational diabetes mellitus (GDM: O244, O249) [17,18]. Information about antidepressive medication during pregnancy was retrieved from the Prescribed drug register (ATC code: N06A). Information about educational attainment (≤12 and >12 years) was retrieved from the Education register. Information on ultrasound estimation of fetal weight was unavailable, but birthweight should reflect the fetal weight near the time of delivery when most IOL were planned. Therefore, small for gestational age (SGA) was used as a proxy for fetal growth restriction and large for gestational age (LGA) as a proxy for suspected macrosomia, defined by birthweight >2SD below or above mean for gestational age respectively [19].

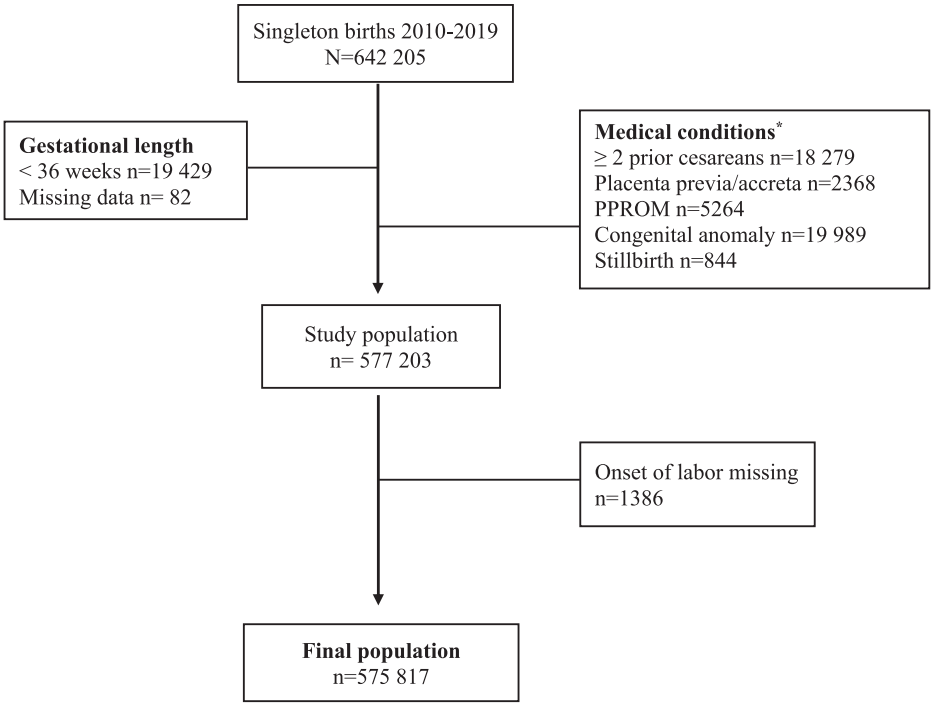


**Fig. 1.** Flowchart describing the study population. * More than one condition may apply to the same birth. PPROM: Preterm premature rupture of membranes.

**Table 1**
Characteristics of planned births before 40 weeks compared with expectant management (n = 575 817[*†]).

| | Gestational week 36–37* | | | Gestational week 38-39† | | |
|---|---|---|---|---|---|---|
| | ECS n = 1781 | IOL n = 7955 | EM n = 542 742 | ECS n = 30 472 | IOL n = 27 565 | EM n = 327 037 |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| Age ≥ 35 (years) | 722 | 2095 | 124 297 | 11 725 | 7460 | 73 018 |
| *missing n = 2* | (40.6) | (26.3) | (22.9) | (38.5) | (27.1) | (22.3) |
| BMI ≥ 30 (kg/m$^{2)}$ | 376 | 1774 | 676 93 | 4164 | 5792 | 41 486 |
| *missing n = 32 152* | (23.1) | (23.7) | (13.2) | (14.4) | (22.2) | (13.4) |
| Nulliparous | 734 | 3979 | 278 393 | 12 662 | 13 724 | 176 149 |
| *missing n = 0* | (41.2) | (50.0) | (51.3) | (41.6) | (49.8) | (53.9) |
| Smoking | 111 | 616 | 26 749 | 1383 | 1833 | 14 948 |
| *missing n = 28 044* | (6.7) | (8.2) | (5.2) | (4.7) | (7.0) | (4.8) |
| Education >12 years | 930 | 3916 | 302 033 | 18 102 | 14 041 | 184 349 |
| *missing n = 17 011* | (54.1) | (50.5) | (57.3) | (60.8) | (52.4) | (58.1) |
| Chronic hypertension | 36 | 151 | 2297 | 215 | 379 | 1167 |
| *missing n = 0* | (2.0) | (1.9) | (0.4) | (0.7) | (1.4) | (0.4) |
| Pre-gestational diabetes | 151 | 456 | 2879 | 306 | 860 | 934 |
| *missing n = 0* | (8.5) | (5.7) | (0.5) | (1.0) | (3.1) | (0.3) |
| Kidney disease | 21 | 112 | 2227 | 187 | 211 | 1244 |
| *missing n = 0* | (0.3) | (1.4) | (0.4) | (0.6) | (0.8) | (0.4) |
| IBD | 50 | 114 | 4266 | 507 | 307 | 2310 |
| *missing n = 0* | (2.8) | (1.4) | (0.8) | (1.7) | (1.1) | (0.7) |
| Epilepsy | 21 | 72 | 2709 | 222 | 217 | 1538 |
| *missing n = 0* | (1.2) | (0.9) | (0.5) | (0.7) | (0.8) | (0.5) |
| Asthma | 193 | 785 | 39 191 | 2704 | 2573 | 23 179 |
| *missing n = 0* | (10.8) | (9.9) | (7.2) | (8.9) | (9.3) | (7.1) |
| Antidepressants | 242 | 1196 | 39 070 | 3178 | 3255 | 20 035 |
| *missing n = 0* | (13.6) | (15.0) | (7.2) | (10.4) | (11.8) | (6.1) |
| HDP | 231 | 2666 | 21 837 | 657 | 5999 | 11 532 |
| *missing n = 0* | (13.0) | (33.5) | (4.0) | (2.2) | (21.8) | (3.5) |
| Gestational diabetes | 103 | 431 | 8460 | 624 | 1409 | 3854 |
| *missing n = 0* | (5.8) | (5.4) | (1.6) | (2.0) | (5.1) | (1.2) |
| SGA | 124 | 865 | 10 609 | 302 | 1235 | 6377 |
| *missing n = 424* | (7.0) | (8.6) | (2.0) | (1.0) | (4.5) | (2.0) |
| LGA | 265 | 773 | 16 185 | 2170 | 2063 | 7318 |
| *missing n = 424* | (14.9) | (9.7) | (3.0) | (7.1) | (7.5) | (2.2) |

* Women with spontaneous onset 36 + 0 to 37 + 6 excluded, n = 23 339, † Women with labor onset 36 + 0 to 37 + 6 or spontaneous onset 38 + 0 to 39 + 6 excluded, n = 157 668, ECS: elective caesarean section, IOL: induction of labor, EM: expectant management, BMI: body mass index, IBD: Inflammatory bowel disease, HDP: hypertensive disorder in pregnancy, SGA: infant small for gestational age defined as birth weight for gestational age less than 2SD, LGA: infant large for gestational age defined as birth weight for gestational age more than 2SD.

*Statistical analysis*

Characteristics of the study population were described with absolute and relative frequencies according to planned birth (ECS, IOL) at 36–37 weeks and 38–39 weeks versus EM.

The risk of 1) respiratory distress and 2) Apgar <7 according to onset of birth was analyzed with a logistic regression model using penalized splines to model continuous variables. Multiplicative interaction between intervention and gestational age was included to allow for time-varying risks of neonatal respiratory distress for the different interventions. Risk differences (RD) and risk ratios (RR) were derived from the model-predicted risks and 95 % confidence intervals (CI) were generated using the non-parametric bootstrap with 200 replicates. RD and RR were presented continuously from 36 to 41 weeks compared with EM in the figures and for the first day each week in the tables. Confounders were identified through a directed acyclic graph (DAG) based on a theoretical framework of the authors (Appendix Fig. A1). Both potential sets of minimal sufficient adjustment for the total effect of respiratory distress included maternal body mass index (BMI), pre-gestational diseases, antidepressants, gestational disorders, SGA and LGA with the addition of smoking or maternal age and parity. As age and parity are generally highly correlated with pregnancy and delivery complications, these were included in models together with smoking to reduce potential residual confounding. Birth unit was included as a random factor to account for clustering and different management of labor between units.

In a second step, analysis was restricted to: a) women with hypertension (chronic hypertension or HDP) and b) women with diabetes mellitus (pre-gestational or gestational), as these conditions are major medical indications for a planned early-term births. Estimates were compared with unadjusted results from the non-restricted cohort, as a backward check of confounding by indication or effect modification.

Statistical analyses were performed using SPSS software for Mac, version 28 (IBM Corp., Armonk, NY, USA) and R version 3.6.3.

*Ethical approval*

The study was approved by the Swedish Ethical Review Authority, nr 2019–04925 with amendment nr 2022-00922-02.

## Results

Women with planned births (ECS or IOL) were more likely to be older than 35 years and have pre-gestational diseases (Table 1), compared with those delivering later (EM). Also, planned births were more often complicated by HDP or GDM and infants were more likely to be LGA or SGA compared with EM (Table 1).

The overall risk of respiratory distress in infants born from 36 weeks was 2.4 % (12,924 with respiratory distress or transient tachypnea of the newborn, and 838 with meconium aspiration). The observed absolute risk of respiratory distress following births at 36 weeks by ECS was 26.2 % (95 % CI:21.3 %; 31.1 %). The risk decreased steeply to 3.2 % (95 % CI:3.0 %; 3.5 %) at 39 weeks of gestation, and no excess risk compared with EM was observed from 40 weeks (Fig. 2 and Table 2). After IOL, the

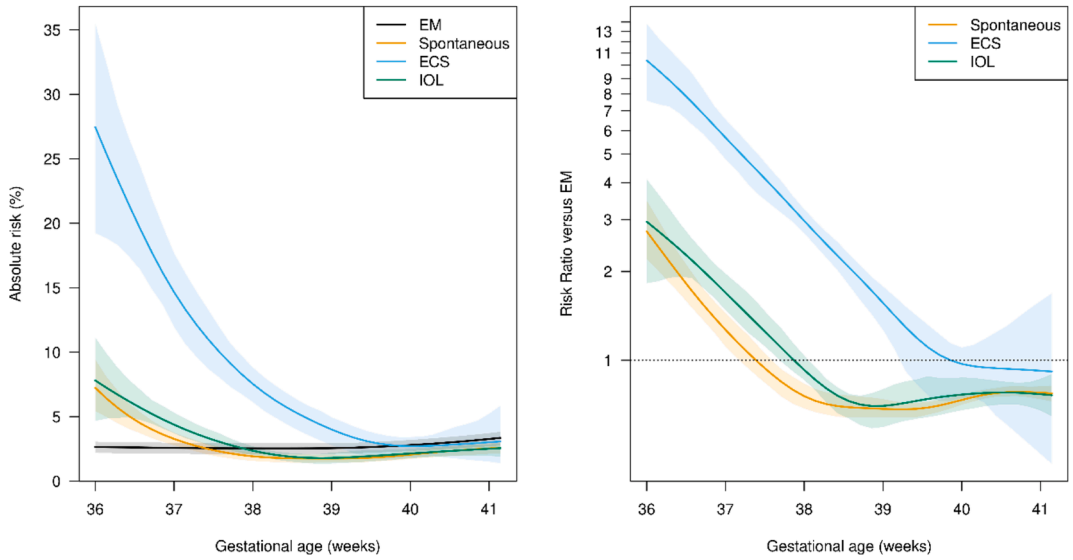


**Fig. 2.** Neonatal respiratory distress according to gestational age at birth after induction of labor (IOL), elective cesarean section (ECS) and spontaneous onset of delivery compared with expectant management (EM), presented as absolute risk *on the left figure* and risk ratio *on the right figure*, adjusted maternal age, parity, body mass index, smoking, pre-gestational diseases (chronic hypertension, diabetes mellitus, kidney disease, systemic lupus erythematosus, inflammatory bowel disease, epilepsy, asthma), antidepressive medication, hypertensive disorder in pregnancy, gestational diabetes mellitus, small- or large for gestational age.

absolute risk was 8.9 % (95 % CI:7.4 %; 10.3 %) at 36 weeks and 4.0 % (95 % CI:3.5 %; 4.5 %) at 37 weeks, but no excess risk compared with EM from 38 weeks. Compared with EM, the risk of respiratory distress was tripled with IOL at 36 weeks and with ECS at 38 weeks, with RD of 5.2 % (95 % CI:2.1 %; 8.4 %) and 5.0 % (95 % CI:3.9 %; 6.0 %), respectively (Table 2). Compared with EM, the RD of respiratory distress for ECS at 39 + 0 was 1.4 % (95 % CI:0.6 %; 2.1 %) whereas IOL at 39 weeks or later compared with EM was associated with reduced risk of respiratory distress (Table 2). The results for IOL in pregnancies complicated by hypertension were similar as in the non-restricted group (Table 3). However, in pregnancies complicated with diabetes mellitus, there was an increased risk of respiratory distress with IOL compared with EM until 39 weeks of gestation (Table 3). The highest absolute risk for Apgar <7 at 5 min was observed for ESC < 38 weeks. There was a slightly increased risk of Apgar <7 at 5 min with IOL at 38 weeks (RR 1.1 (95 % CI 1.0–1.4) compared with EM, but not at later gestations (Fig. 3).

## Discussion

Our results support that IOL can be performed from 38 completed weeks of gestation without increased risk of respiratory distress. Further, the results confirm the importance of scheduling ECS after the minimum of 39 completed weeks to avoid an increased risk of respiratory distress. The three-fold risk of respiratory distress with ESC at 38 and IOL at 36 weeks compared with EM should be balanced against the possible complications that could result from delaying the birth.

In this study, we investigated two neonatal conditions that may be considered non-harmful for most infants in the long term but are common and resource demanding at birth. It was previously established that respiratory morbidity is more common after ECS before 39 weeks compared with ECS that are scheduled later, [12] and guidelines advocate ECS at maternal request after 39 weeks [20] Our results support that ECS should not be planned <39 weeks, and that the preferable timing is near the estimated date of delivery. Moreover, ECS before 38 weeks was associated with increased risk of Apgar <7 at 5 min, a condition previously associated with neurological morbidity, especially at early term [15,16].

In accordance with our results, full-term IOL in a low-risk population reduced the need for neonatal respiratory support in the ARRIVE trial [13]. In HYPITAT-II [6] and PHOENIX [7] trials, late-preterm IOL (34–37 weeks) in women with HDP were associated with more neonatal respiratory complications compared with EM. We found a three-fold increased risk of respiratory distress of IOL at 36 weeks compared with EM. The absolute risk of respiratory distress after IOL at 36 weeks was 8.9 %, but dropped to 2.2 % at 38 weeks, indicating a non-neglectable aspect to weight against maternal benefits of late preterm/early-term IOL specific to each indication. No increased risk of respiratory distress was reported for term IOL compared with EM in women with HDP (HYPITAT-I) [5] or suspected LGA infants [9]. However, a high proportion of infants in these two trials were born at 38 weeks of gestation or later and may thereby be consistent with our results. The only randomized trial on induction in GDM was very small (n = 425), reporting only three cases of respiratory distress in the induction group and two in the EM group [8].

Early-term birth rate increased in the United States because of planned births, from 19 % in 1992 and peaking in 2006 at 31 % [3,21]. In the Nordic countries, the early-term birth rate has remained low (18 % or less in 2010) [2] but a trend for increased early-term IOL has been seen recently in some Nordic countries [3,4] Importantly, a clear medical indication is not always recorded for early-term births [4,22]. The results of this study should encourage continuous audit of planned early-term births both by ECS and IOL. Further, we report considerably higher absolute risk of respiratory distress for ECS at 37 weeks (12.4 %) than IOL at 37 weeks (4.0 %). Therefore, the optimal timing of planned birth that balances potential benefit and harm for the mother and neonate also depends on the planned intervention [5–7].

We found an increased risk of respiratory distress with IOL at 38 weeks compared with EM among pregnancies complicated by diabetes, a condition consistently associated with respiratory distress, [17,23] possibly due to delayed production of surfactant [24] Lung function maturity tests that detect surfactant production cannot eliminate risk of respiratory morbidity following early-term ECS, [25] perhaps because it is often caused by transient tachypnea of the newborn [10,26]. Although the mechanism is not fully explained, labor contractions are associated with more rapid lung fluid clearance, reducing the risk of transient tachypnea [27]. There is limited evidence of the effectiveness of postnatal interventions, such as diuretics and fluid restriction to treat transient tachypnea of the newborn [11].

This study included half a million births in Sweden, a country with free antenatal and delivery care and thereby unlikely to be affected by

**Table 2**
The risk of neonatal respiratory distress associated with different timing of planned births; induction of labor (IOL) or elective cesarean section (ECS), compared with expectant management (EM).

| Gestational age* | | n | % (95 % CI) | Crude RR (95 % CI) | Adjusted† RR (95 % CI) | Adjusted† RD Planned – EM% |
|---|---|---|---|---|---|---|
| 36 weeks | ECS | 83 | 26.2 (21.3; 31.1) | 13.8 (11.0; 18.3) | 10.4 (7.6; 13.8) | 24.8 (16.7; 33.1) |
| | IOL | 132 | 8.9 (7.4; 10.3) | 4.7 (3.3; 6.4) | 3.0 (1.8; 4.1) | 5.2 (2.1; 8.4) |
| | EM | 13 064 | 2.3 (2.3; 2,3) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |
| 37 weeks | ECS | 181 | 12.4 (10.7; 14.1) | 8.0 (6.6; 9.8) | 5.7 (4.8; 6.5) | 12.1 (9.6; 14.8) |
| | IOL | 258 | 4.0 (3.5; 4.5) | 2.5 (2.2; 2.9) | 1.7 (1.5; 2.0) | 1.8 (1.3; 2.5) |
| | EM | 12 151 | 2.2 (2.2; 2.3) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |
| 38 weeks | ECS | 667 | 4.9 (4.6; 5.3) | 3.6 (3.2; 3.9) | 3.0 (2.7; 3.2) | 5.0 (3.9; 6.0) |
| | IOL | 268 | 2.2 (1.9; 2.4) | 1.2 (1.1; 1.4) | 0.9 (0.9; 1.0) | −0.2 (−0.4; 0.1) |
| | EM | 10 432 | 2.2 (2.2; 2.3) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |
| 39 weeks | ECS | 550 | 3.2 (3.0; 3.5) | 1.6 (1.3; 1.8) | 1.6 (1.3; 1.8) | 1.4 (0.6; 2.1) |
| | IOL | 325 | 2.1 (1.9; 2.4) | 0.9 (0.7; 1.0) | 0.7 (0.6; 0.8) | −0.8 (−1.0; −0.5) |
| | EM | 7 913 | 2.4 (2.4; 2.5) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |
| 40 weeks | ECS | 52 | 3.7 (2.7; 4.7) | 1.1 (0.9; 1.3) | 1.0 (0.7; 1.1) | −0.1 (−0.6; 0.3) |
| | IOL | 482 | 2.6 (2.3; 2.8) | 1.0 (0.8; 1.1) | 0.8 (0.7; 0.9) | −0.7 (−1.0; −0.3) |
| | EM | 4501 | 2.9 (2.8; 2.9) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |
| 41 weeks | ECS | 18 | 2.8 (1.5; 4.0) | 1.1 (0.7; 1.7) | 0.9 (0.5; 1.6) | −0.3 (−1.7; 2.0) |
| | IOL | 578 | 3.3 (3.0; 3.5) | 0.9 (0.8; 1.0) | 0.8 (0.7; 0.9) | −0.8 (−1.1; −0.4) |
| | EM | 1487 | 3.4 (3.3; 3.6) | 1.0 *(ref)* | 1.0 *(ref)* | 1.0 *(ref)* |

* Estimates for RR: risk ratio and RD: risk difference presented above apply to deliveries on the first day of each completed weeks (e.g. 37 + 0), whereas the number of events and proportion (%) applies to deliveries during each week (e.g. 37 + 0 to 37 + 6). †Adjustments were made for the following confounders: Maternal age, parity, body mass index, smoking, pre-gestational diseases (chronic hypertension, diabetes mellitus, kidney disease, systemic lupus erythematosus, inflammatory bowel disease, epilepsy, asthma), antidepressive medication, hypertensive disorder in pregnancy, gestational diabetes mellitus, small- or large for gestational age (as proxy for fetal growth restriction and macrosomia).

selection bias. The Swedish MBR is regularly validated, with excellent coverage, and validity of gestational length, pre-gestational and gestational disorders are considered high [28]. This study aimed to simulate a clinical trial comparing planned births with EM. The large size of the data enabled us to produce results that present the absolute and relative risk of respiratory distress associated with each day of gestation and further stratify by diabetes and hypertension which are common medical conditions indicating planned births. The data did not include information about birth plans for individuals that had a spontaneous onset of labor before IOL or ECS, consistent with a per-protocol analysis in a randomized controlled trial. However, the planned mode of birth was probably unchanged in most cases. Further, HDP diagnosis was first recorded at birth and adjusting for this could bias the results by creating a "healthier" population of EM, especially as the severity of HDP influences the decision of planned birth. The lack of data on prenatal suspicion of fetal growth restriction or macrosomia was a limitation, but we adjusted for standardized birthweight instead. However, bias from residual confounding by indication cannot be excluded. We did not have information about previous use of corticosteroids, which are used in Sweden when there is an imminent threat of birth before 34 weeks. If the corticosteroid effect last >14 days, the lack of adjustment for corticosteroid use would be expected to attenuate the estimates of risk increase rather than overestimating the risk [29]. Further, we did not have information about admissions to neonatal intensive care or postnatal ventilation. Although, the setting of the study was a high-resource country, we believe that our findings could be consistent in other settings.

**Table 3**
The risk of neonatal respiratory distress associated with different timing of labor induction (IOL) compared with expectant management (EM), restricted to pregnancies complicated by diabetes and hypertension, before or during pregnancy.

| Gestational age | Diabetes* n = 13066 | | Hypertension† n = 28259 | |
|---|---|---|---|---|
| | Crude RR (95 % CI) | Crude RD Planned – EM% | Crude RR (95 % CI) | Crude RD Planned – EM% |
| 36 + 0 | 2.7 (1.4; 4.2) | 7.5 (1.8; 14.3) | 2.6 (1.6; 3.5) | 6.5 (2.5; 10.2) |
| 37 + 0 | 2.0 (1.5; 2.8) | 3.9 (2.3; 7.3) | 1.6 (1.4; 2.0) | 2.4 (1.4; 3.8) |
| 38 + 0 | 1.4 (1.1; 1.7) | 1.4 (0.4; 2.5) | 1.0 (0.9; 1.2) | 0.1 (−0.5; 0.7) |
| 39 + 0 | 1.0 (0.8; 1.3) | 0.1 (−0.7; 1.0) | 0.8 (0.6; 0.9) | −0.8 (−1.4; −0.3) |
| 40 + 0 | 0.9 (0.7; 1.1) | −0.3 (−0.9; 0.3) | 0.8 (0.7; 1.0) | −0.6 (−1.0; 0.2) |
| 41 + 0 | 0.8 (0.5; 1.2) | −0.6 (−1.7; 0.8) | 0.8 (0.6; 1.0) | −0.8 (−1.8; −0.1) |

RR: risk ratio and RD: risk difference *Diabetes defined by pre-gestational diabetes mellitus recorded in check box at first antenatal visit or the diagnosis of gestational diabetes mellitus (ICD: O244, O249).
†Hypertension defined by pre-gestational hypertension recorded in check box at first antenatal visit or diagnosis of hypertensive disorder in pregnancy (ICD: O11, O13-O16).

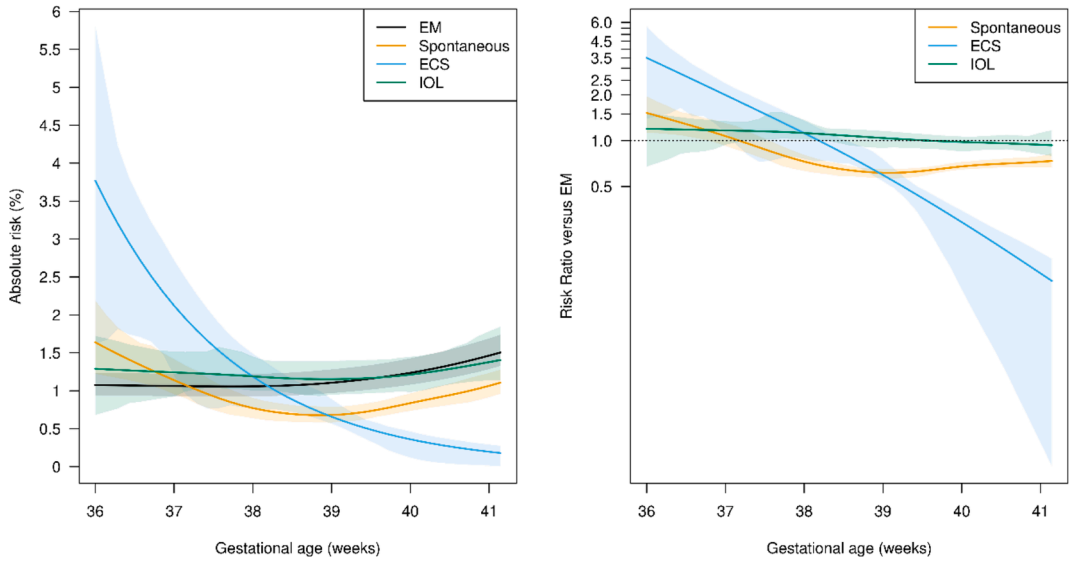


**Fig. 3.** Apgar score under 7 at 5 min according to gestational age at birth after induction of labor (IOL), elective cesarean section (ECS) and spontaneous onset of delivery compared with expectant management (EM), presented as absolute risk *on the left figure* and risk ratio *on the right figure*, adjusted maternal age, parity, body mass index, smoking, pre-gestational diseases (hypertension, diabetes mellitus, kidney disease, systemic lupus erythematosus, inflammatory bowel disease, epilepsy, asthma), antidepressive medication, hypertensive disorder in pregnancy, gestational diabetes mellitus, small- or large for gestational age.

## Conclusion

When a shared decision for planned births is made, the parents should be informed about the excess risk of respiratory distress associated with IOL before 38 weeks and ECS before 40 weeks. The results indicate that apart from the mode of birth, the gestational age is the main contributor to the need for postnatal respiratory support. The results support the need for a clear health policy about the timing of planned births, particularly ECS [30]. The definition of term gestation at ≥37 weeks may affect the perception of risks [31] and therefore this definition should be discussed further in relation to the increased population awareness about autonomy in birth planning.

## CRediT authorship contribution statement

**Johanna Gunnarsdottir:** Writing – original draft, Methodology, Conceptualization. **Erik Lampa:** Writing – review & editing, Visualization, Software, Methodology, Formal analysis. **Maria Jonsson:** Writing – review & editing, Methodology, Conceptualization. **Linda Lindström:** Writing – review & editing, Methodology. **Kristjana Einarsdottir:** Writing – review & editing, Methodology, Conceptualization. **Anna-Karin Wikström:** Writing – review & editing, Resources, Conceptualization. **Susanne Hesselman:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Susanne Hasselman reports financial support was provided by Center for Clinical Research, Falun, Sweden (grant CKFUU-982156). If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

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