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Adverse perinatal outcomes in 665,244 term and post-term deliveries—a Norwegian population-based study

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ABSTRACT

Objective: To assess the prevalence and risk of adverse perinatal outcomes in early-term (37^{+0}–38^{+6} weeks), full-term (39^{+0}–40^{+6} weeks), late-term (41^{+0}–41^{+6} weeks), and post-term (>42^{+0} weeks) deliveries with spontaneous labor onset.

Study design: A population-based cohort with data from the Medical Birth Registry Norway (MBRN) and Statistics Norway (SSB) was conducted. The study population consisted of 665,244 women with cephalic singleton live births at term or post-term with spontaneous labor onset during the period of 1999–2014 in Norway. Maternal, obstetric, and fetal characteristics were obtained from the MBRN. Maternal education data were obtained from the SSB. The prevalence rates of adverse perinatal outcomes for each gestational age (GA) group were estimated. Inter-group differences were detected with Chi square tests. Multivariable regression analysis adjusted for maternal age, educational level, smoking, parity, maternal diabetes, and preeclampsia was used to assess adverse outcome prevalence for early- late-, and post-term births compared to full-term births.

Results Deliveries at early-term were associated with an increased prevalence of neonatal jaundice, polyhydramnios, small for gestational age (SGA) status, respiratory support, and neonatal intensive care unit (NICU) admission compared with deliveries at GAs of 39–43 weeks ($p < 0.001$). Low 5-min Apgar scores and newborn antibiotic treatment occurred at an increased prevalence in both early-term and post-term infants, relative to the full-term group ($p < 0.001$). The prevalence of oligohydramnios, meconium-stained amniotic fluid, and newborn birth injuries increased with increasing GA.

Conclusions More perinatal morbidity was observed among early-term infants compared to infants with later term deliveries, underscoring the need for cautious management of low-risk early-term deliveries.

Keywords

Adverse perinatal outcome

Early-term delivery

Population based register data

Perinatal morbidity

Term delivery

INTRODUCTION

Traditionally, term pregnancy has been defined as a pregnancy length between 37^{+0} and 41^{+6} weeks (1). Pregnancies with durations outside of this range are associated with increased perinatal morbidity and mortality (2-7). In recent decades, there has been an increase in non-medically indicated planned deliveries, including labor inductions and caesarean sections, motivated by an intention to avoid post-term complications (8, 9). These increases have been associated with a leftward shift in gestational age (GA) at delivery (10).

Elective labor induction for all pregnant women at 39 weeks gestation has been discussed, though associated benefits for the infant are uncertain (9, 11). Few studies have investigated GA-related perinatal morbidity within the term period (2, 3, 12-15). Relevant published data are challenging to compare due to differing risk profile and GAs across studies (13-15). Neonatal outcomes after term caesarean delivery have been described (16-18), but may not generalize to vaginal delivery cases. The aim of this study was to assess the prevalence and risk of adverse perinatal outcomes in early-term (37^{+0}–38^{+6} weeks), full-term (39^{+0}–40^{+6} weeks), late-term (41^{+0}–41^{+6} weeks), and post-term (>42^{+0} weeks) deliveries with spontaneous labor onset.

MATERIALS AND METHODS

This population-based cohort study is part of The PURPLE Study approved by the Regional Committee for Medical Research Ethics in South-East Norway (2015/681) and the Institutional Personal Data Officer in Oslo University Hospital. All parts of the study followed Norwegian Health Research legislation. Data were obtained from the Medical Birth Registry Norway (MBRN) and Statistics Norway (SSB). The SSB is a central agency that produces official statistics, including of educational level. MBRN and SSB data were merged by applying a similar code scheme that does not reveal personal identification; researchers used anonymized data. The MBRN is a national health registry containing information on all pregnancies and deliveries in Norway since 1967, including homebirths. Information on maternal pre-pregnancy health, pregnancy complications, and obstetric interventions, as well as postnatal fetal/newborn outcomes, is recorded on a standardized form by attending midwives. Information on newborns admitted to a neonatal intensive care unit (NICU) is reported to the MBRN by pediatricians.

A study period of 1999–2014 was chosen because GA in the MBRN has been defined by a 2nd trimester ultrasound, conducted free of charge universally in Norway (>97% use), since 1999. Congenital malformations, multiple pregnancies, preterm deliveries (<37 weeks), breech deliveries, stillbirths, scheduled caesarean sections, and induced labor were excluded. Deliveries registered with a GA of ≥44 weeks were excluded due to likely incorrect GA registration or estimation. The study population was comprised of 665,244 cephalic singleton live births with spontaneous labor onset, with gestational periods of 37^{+0} to 43^{+6} weeks during the years of 1999–2014 in Norway (Fig. 1).

Definition of variables and data collection methods

Respiratory support was defined as newborn treatment with continuous positive airway pressure or use of an endotracheal tube. NICU admissions included transfers to a NICU for observation or treatment for any reason. Antibiotic treatment included treatment with one or more doses of systemic antibiotics. Intracranial hemorrhage was confirmed by ultrasonography. Brachial plexus injures were diagnosed clinically almost exclusively. Clavicle fractures were identified by clinical and radiographic diagnosis. Neonatal jaundice due to hyperbilirubinemia was defined by a need for phototherapy according to Norwegian national guidelines (19). Facial nerve palsy was recognized based on facial asymmetry apparent during clinical examination of the newborn. These conditions were determined and diagnosed by an attending neonatologist and reported to the MBRN.

Small for gestational age (SGA) was defined as a birth weight below the 5th percentile for GA, based on Norwegian fetal growth percentiles (20). A sensitivity analysis showed similarly increased risks of perinatal morbidity among SGA-infants defined by 10th, 5th and 3rd percentile cut-offs. Because the proportion of constitutionally small infants could be overestimated if we adopted the 10th percentile or underestimated with a 3rd percentile cut-off, we chose to use the 5th percentile cut-off.

Low Apgar scores (<7 and <4 at 5 min) were assigned by the attending midwife in normal deliveries and by the neonatologist in complicated deliveries. Meconium-stained amniotic fluid was identified by foul-smelling or discolored amniotic fluid by medical staff after membrane rupture. Oligohydramnios (single deepest pocket of amniotic fluid <2 cm or amniotic fluid index ≤ 5 cm) and polyhydramnios (single deepest pocket of amniotic fluid ≥8 cm or amniotic fluid index ≥ 24 cm) were diagnosed by obstetricians antenatally based on ultrasound criteria.

Spontaneous labor onset was defined as labor starting without intervention. The term-period was divided according to expert recommendations (21): early-term (37^{+0}–38^{+6} weeks), full-term (39^{+0}–40^{+6} weeks), late-term (41^{+0}–41^{+6} weeks), and post-term (>42^{+0} weeks). Preeclampsia was defined as a blood pressure ≥ 140/90 with proteinuria.

Maternal education was used as a substitute measure of socioeconomic status and classified as: none (did not complete compulsory education), compulsory (1–10 years of schooling), secondary (11–13 years of schooling), higher education (Bachelor's degree), or highest education (graduate degree). Maternal smoking during the 1st trimester was categorized as no, sometimes, or daily. Maternal age was categorized into the following groups (in years): <20, 20–24, 25–29, 30–34, 35–39, and ≥40. Maternal diabetes was classified as none, Type 1, Type 2, or gestational.

Patient involvement

Patient subjects were not involved in study planning, design, recruitment, or implementation.

Descriptive analysis

The study population was stratified according to GA. Continuous data were categorized. Adverse perinatal outcome prevalence rates are presented as percentages. Chi square tests (significance level, 1%) were used to detect inter-group differences.

Regression analysis

Regression analysis was performed to determine odds ratios for adverse perinatal outcomes for each term period, with full-term (39^{+0}–40^{+6} weeks) deliveries, defined according to expert recommendations (21), as the reference group. Adjusted odds ratios (aORs) were calculated in multivariable regression with maternal age, education, smoking, parity, maternal diabetes, and preeclampsia as covariates, with the full-term delivery (21) group as the reference group**.** The aORs are reported with 95% confidence intervals (CIs). Variables with an association $p < 0.01$ were included in the multivariate analyses. Data analyses were performed in SPSS version 24 (IBM Corp., Armonk, NY).

Missing values

Maternal educational was not recorded for 4% of the deliveries. A missing information category was managed separately in the regression analysis. Missing smoking status cases (15.5%) were merged with the non-smoking group as in previous studies with MBRN data (22, 23). For all other variables, the missing information rate was <0.05%.

RESULTS

Study population characteristics

Demographic characteristics and obstetric outcomes of the study population are presented in Table 1. Polyhydramnios, neonatal jaundice, SGA, newborn respiratory support, and NICU admission were more prevalent for deliveries at 37 weeks than for deliveries beyond 37 weeks. The prevalence of meconium stained-amniotic fluid, oligohydramnios, and newborn birth injuries increased with GA (Table 2, Fig. 1, and Fig. 2). Low 5-min Apgar scores and newborn antibiotic treatment were most common among early-term and post-term born infants.

Regression analysis

The results of GA-specific regression analyses are reported in Table 3. After adjustment for maternal age, education, smoking, diabetes, preeclampsia, and parity, odds ratios for adverse perinatal outcomes remained similar to those in our crude analysis. Need for respiratory support (aOR 2.20, CI 1.93–2.50) and NICU admission (aOR 2.00, CI 1.90–2.10) were two-fold higher among infants born at 37 weeks than among infants born at 39–40 weeks. The odds ratios of SGA (aOR 1.24, CI 1.17–1.31) and of polyhydramnios (aOR 1.27, CI 1.12–1.45) were higher at week 37 than in weeks 39–40 (Table 3).

The odds ratios of oligohydramnios (aOR 2.9, CI 2.76–3.13) and of newborn birth injury were elevated for post-term infants, including a two- to three-fold higher prevalence of facial nerve palsy (aOR 2.57, CI 1.64–4.04) compared with that in infants born at 39–40 weeks (Table 3). Meconium-stained amniotic fluid was two-fold more common among infants born after 42 weeks (aOR 2.11, CI 2.06–2.17) compared with those born at 39–40 weeks (Table 3).

The odds ratios of low 5-min Apgar scores (<7 points aOR 1.81, CI 1.63–2.02; and <4 points aOR 1.61, CI 1.26–2.06) and of antibiotic treatment were higher for infants born at 42 weeks (aOR 1.59, CI 1.47–1.72) than for infants born at 39–40 weeks. The odds ratios of neonatal jaundice decreased with increasing GA, with a three-fold higher prevalence being observed for infants born at 37 weeks (aOR 3.23, CI 3.10–3.37) compared to those born at 39–40 weeks (Table 3).

COMMENT

Respiratory support and NICU admission were more common among early-term infants than full-term infants, likely due to lung immaturity (2, 4, 13, 14). Errors in GA determination are unlikely in our study owing to ultrasound confirmation (24). NICU admissions of early-term infants could be associated with hypothermia and/or hypoglycemia (25), conditions for which we did not have available data, as well as with a need for antibiotic treatment. Increased prevalence of antibiotic treatment and NICU admission, relative to full-term infants, was also observed among post-term infants, as reported previously (26, 27). Some women giving birth in the early-term period are given antibiotics following prelabor membrane rupture, whereas post-term born infants are more likely to be given antibiotics due to meconium stained amniotic fluid, meconium aspiration, or chorioamnionitis (26). Linder et al. (12) found similar results in a low-risk population, whereas Leal et al. (28) reported increased antibiotic treatment of early-term newborns delivered following medically indicated labor inductions, but not for those born following spontaneous labor onset.

An association of polyhydramnios with preterm birth has been documented (29, 30). It is possible that uterine overdistention is a causative factor of polyhydramnios. Conversely, an unidentified cause of polyhydramnios could affect labor onset timing. High rates of oligohydramnios and meconium-stained amniotic fluid in post-term deliveries could be consequent to gradually increasing placental insufficiency with increasing GA (4, 6, 13).

Although the prevalence of intracranial hemorrhage was highest for the early-term delivery group, it was not significantly higher than that of the full-term reference group in our multivariable regression.

The prevalence of SGA < 5^{th} percentile was also highest among infants in the early term group, suggesting that placental dysfunction could lead to labor onset. Although SGA is an indication for labor induction or planned caesarean, detection of SGA can be missed antenatally. Morken et al. (31), Gouyon et al. (2), and Eskes et al. (32) reported SGA prevalence rates for term and post-term deliveries that were similar to the present findings, whereas Pulver et al. (33) did not find an effect of GA at birth on SGA risk. The study populations in these prior studies, however, varied and the 10^{th} percentile cut-off for SGA was applied in all of them. The reasons for increased prevalence of SGA with spontaneous labor onset at early term remain to be resolved.

Caughey et al. (4) and Cheng et al. (13) reported low Apgar score data similar to our data. Despite enrolling a study population similar to the present one, Linder et al. (12) found no GA-related differences in Apgar scores. Meanwhile, the prevalence of neonatal jaundice decreased with increasing GA in our study, consistent with previous reports (12, 34).

The present finding of birth injury prevalence being highest among post-term infants may be related to their size (4, 13). Comparison with previous studies is challenging, due to varying definitions of birth injuries, diagnosis groupings, and small sample sizes. Notwithstanding, Ojumah et al. (35) found that brachial plexus injuries and clavicle fractures were associated with large fetus size, shoulder dystocia, and vaginal breech deliveries. Meanwhile, newborn facial nerve palsy, a rare complication, has been associated with birth trauma, particularly with forceps delivery and birth weights over 3.5 kg (35, 36). Here, we observed higher forceps delivery rates with increasing GA, consistent with the supposition that later delivery is a major risk factor for this complication.

Early-term delivery can increase long-term health challenges for children, including respiratory complications (37), obstructive sleep apnea (38), and endocrine problems (39). Further research is needed to clarify the pathophysiological mechanisms mediating perinatal morbidity risk among infants with early-term deliveries.

Although labor induction has become common worldwide, there is not yet a consensus regarding the optimal timing (15, 40). It is well recognized that there is a need to balance risks associated with earlier GA delivery versus post-term complication risks, though doing so can be challenging.

This study had three notable strengths. Firstly, we analyzed a large dataset from a population-based registry with robust, reliable data (41), which provides confidence regarding the generalizability of our findings. Secondly, GA was determined by second-trimester ultrasonography, a valid and precise means of determining pregnancy duration (24). Thirdly, because we focused our analysis on a low-risk study population, GA was an appropriate main exposure variable for our analysis of perinatal outcomes.

This study had two notable limitations. Firstly, the MBRN does not collect information on numbers of antenatal visits or antenatal hospital admissions. All pregnant women are offered free antenatal care in Norway, which has resulted in an equalization of antenatal care across socioeconomic backgrounds. In Norway, all high-risk pregnancies, including late- and post-term pregnancies, are referred to obstetricians in maternity units for follow-up. Secondly, health registry information is expected to include some recording errors, missing data, and underreporting for some variables. Underreporting of risk factors can contribute to underestimation and a dilution of potential effect sizes, but does not create false-positive associations. Regarding missing data, only 20% of our study population had a maternal body mass index record. Given that maternal obesity is associated with adverse perinatal outcomes (42), these missing data could be a potential confounder we could not investigate in this study.

Our study sample consisted entirely of births with spontaneous labor onset, which can be considered a low-risk study population because all high-risk pregnancy cases are referred for labor induction or planned caesarean section. Despite the low-risk profile of our subjects, more adverse perinatal outcomes were observed among early-term deliveries than later term deliveries, underscoring the importance of managing even low-risk early-term deliveries with caution. We advocate for vigilant monitoring of early-term labor and attentiveness to potential GA-related complications when undertaking a non-medically indicated delivery.

Contribution to authorship
GM was involved with study design development and planning, data analysis, interpretation of the results, and the writing and revising of the manuscript.
SR was involved with study design development and planning, data-analysis, interpretation of the results, and critical review of the manuscript.
AFJ contributed to the conceptualization and planning of the study, the interpretation of the results, and provided critical review of the manuscript.
KBS conducted data processing, participated in the interpretation of results, and provided critical comments on the manuscript.
LB conducted data processing, participated in the interpretation of results, and provided critical comments on the manuscript.
KL supervised the study and was involved with study design development and planning, as well as with data processing and analyses, interpretation of the results, and revising the manuscript.

All authors read and approved the final version of the manuscript

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Conflict of interest notification
Gulim Murzakanova: none.
Sari Räisänen: none.
Anne Flem Jacobsen: none.
Kristina Baker Sole: none.
Lisa Bjarkø: none.
Katariina Laine: none.

Data sharing statement
No additional data available.
According to Norwegian research legislation and regulations governing the Medical Birth Registry and Statistics Norway, given the sensitive nature of the data, open sharing of data from these institutions is not allowed. Therefore, we are not able to share data outside our research group.

Ethical approval
This study protocol was approved by the Regional Committee for Medical Research Ethics in South East Norway in 2015 (2015/681).

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FIGURE LEGENDS

Figure 1. Flow-chart of study population enrollment and methodology.

Figure 2. Gestational age-specific prevalence (%) of adverse perinatal outcomes. Cephalic singleton live births at term and post-term with spontaneous labor onset were included (N = 665,244); cases involving major anomalies were excluded.

Figure 3. Gestational age-specific prevalence (%) of amniotic fluid abnormalities. Cephalic singleton live births at term and post-term with spontaneous labor onset were included (N = 665,244); cases involving major anomalies were excluded

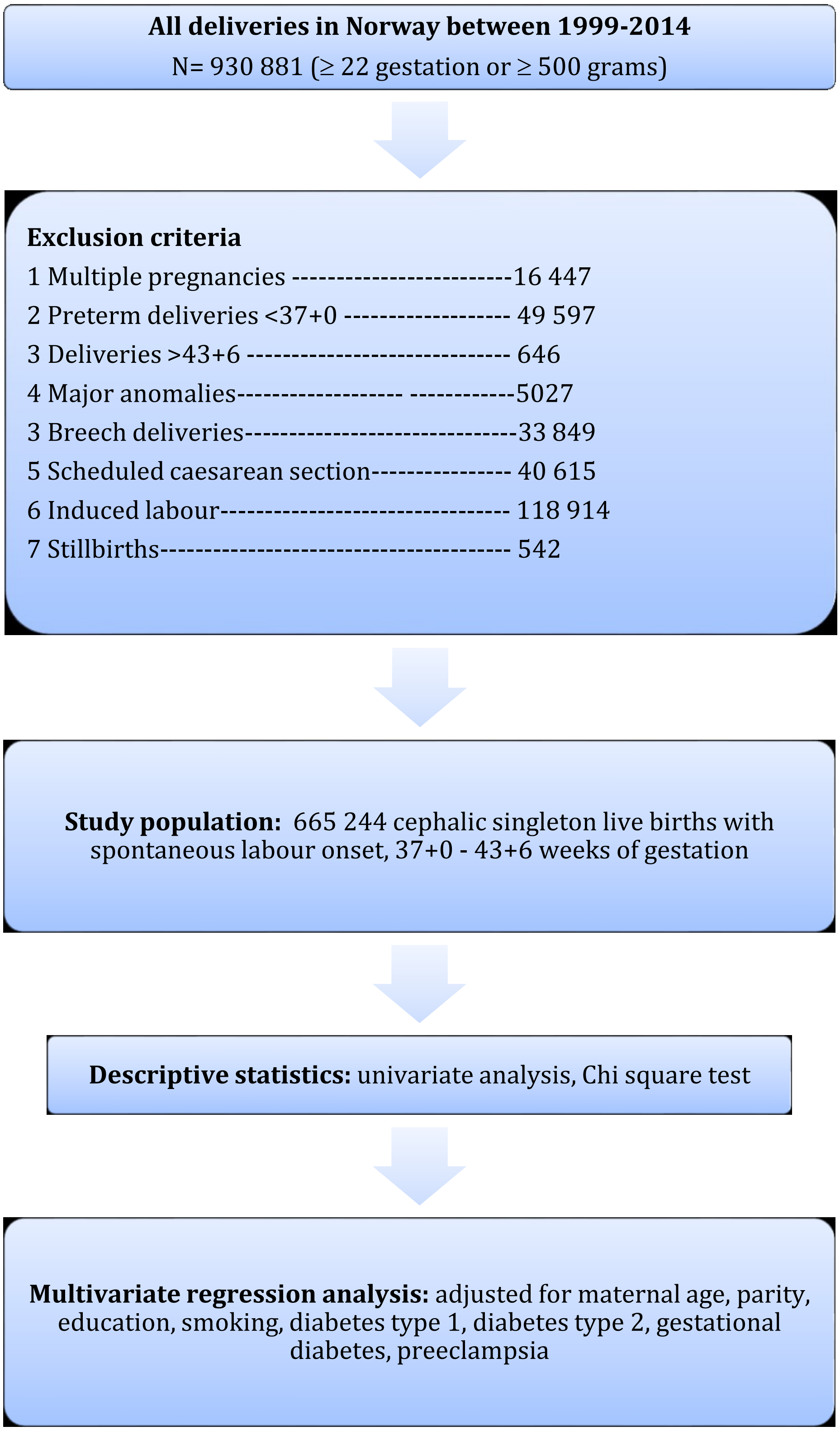
TABLES

Table 1 Summary of patient demographics and obstetric outcomes by GA group, including variables used in the regression analysis, in a study population of term and post-term cephalic singleton live births with spontaneous labor onset (N = 665,244).

Table 2 Adverse perinatal outcomes by GA group in study sample (N = 665,244).

Table 3 Regression analyses of adverse perinatal outcomes in relation to GA grouping (N = 665,244).

Figure 1 Flow-chart of the study population enrollment and methodology



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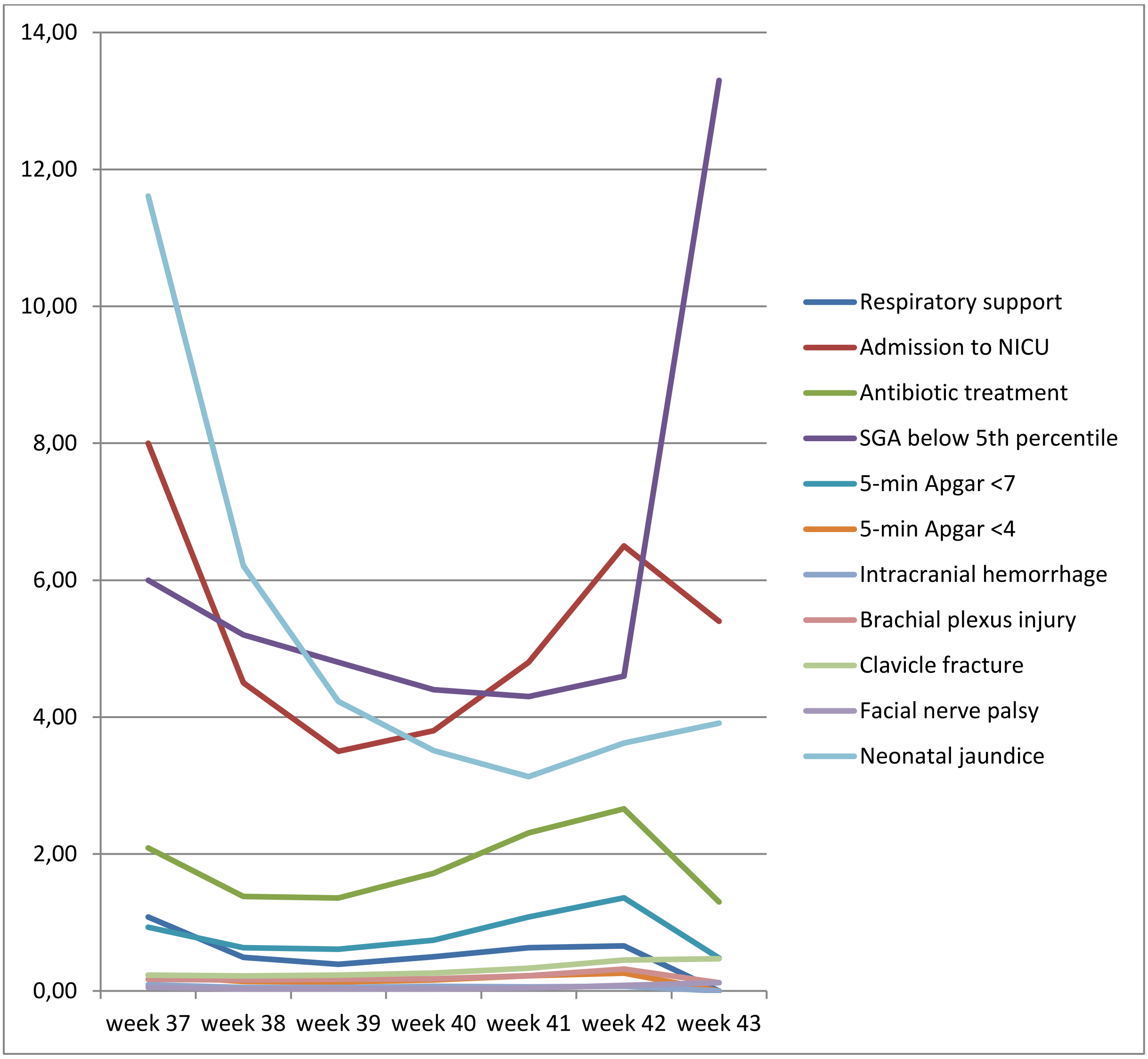

NICU=Neonatal intensive care unit
SGA=Small for gestational age

Figure 3. Gestational age-specific prevalence (%) of amniotic fluid abnormalities. Cephalic singleton live births at term and post-term with spontaneous labor onset were included (N = 665,244); cases involving major anomalies were excluded

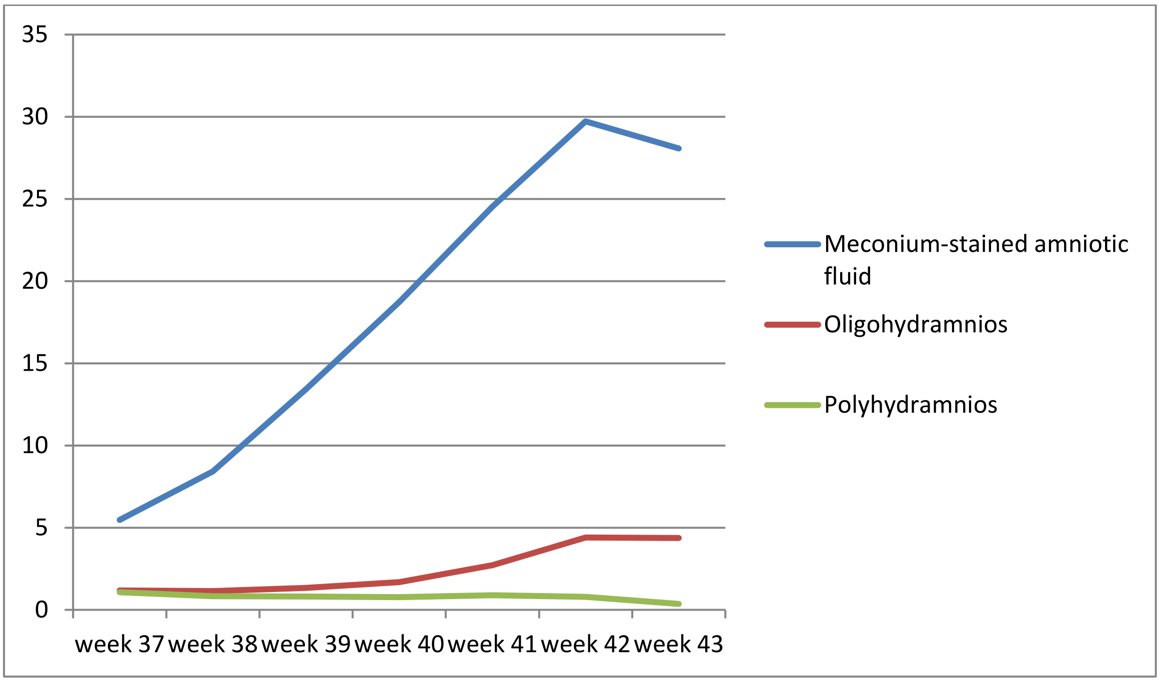

Table 1 Summary of patient demographics and obstetric outcomes by GA group, including variables used in the regression analysis, in a study population of term and post-term cephalic singleton live births with spontaneous labor onset (N = 665,244).

	Week 37 (N=26634)	Week 38 (N=71765)	Week 39 (N=165166)	Week 40 (N=225478)	Week 41 (N=146196)	Week 42 (N=29161)	Week 43 (N=844)
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Maternal age[1]							
- < 20	3.0 (803)	2.7 (1922)	2.4 (3997)	2.2 (4932)	2.0 (2926)	2.1 (620)	4.1 (35)
- 20-24	17.3 (4604)	17.1 (12253)	16.0 (26490)	15.1 (34043)	14.6 (21321)	14.6 (4270)	17.9 (151)
- 25-29	33.2 (8844)	33.6 (24116)	33.9 (56045)	33.8 (76236)	33.3 (48672)	32.8 (9554)	33.3 (281)
- 30-34	30.6 (8163)	31.5 (22575)	32.5 (53688)	33.2 (74924)	33.8 (49432)	34.0 (9918)	30.8 (260)
- 35-39	13.5 (3593)	13.0 (9315)	13.0 (21482)	13.6 (30719)	14.3 (20815)	14.4 (4210)	11.4 (96)
- ≥ 40	2.4 (627)	2.2 (1580)	2.1 (3448)	2.0 (4615)	2.0 (2959)	2.0 (586)	2.5 (21)
Parity							
- Para 0	44.9 (11962)	40.7 (29225)	39.4 (65138)	40.4 (91110)	43.7 (63948)	49.1 (14329)	47.6 (402)
- Para 1	34.5 (9176)	37.5 (26937)	39.0 (64496)	38.5 (86771)	36.1 (52749)	31.9 (9309)	28.7 (242)
- Para ≥ 2	20.6 (5496)	21.7 (15603)	21.5 (35532)	21.1 (47597)	20.2 (29499)	18.9 (5523)	23.7 (200)
Education[2]							
- compulsory (1-10years of schooling)	20.7 (5263)	19.4 (13244)	17.5 (27711)	16.0 (34780)	15.1 (21356)	15.7 (4416)	22.5 (178)
- secondary (11-13 years of schooling)	32.5 (8251)	31.9 (21832)	31.3 (49450)	30.7 (66672)	30.4 (42938)	31.6 (8898)	35.3 (279)
-higher (Bachelor)	36.5 (9254)	37.6 (25709)	39.1 (61755)	40.3 (87441)	41.0 (57866)	40.1 (11285)	32.4 (256)
-highest (Graduate degree)	10.3 (2620)	11.1 (7607)	12.1 (19083)	13.0 (28120)	13.4 (18852)	12.5 (3527)	9.7 (77)
Smoking							
- no	85.1 (22660)	85.9 (61656)	86.9 (143585)	87.4 (197057)	87.5 (127899)	85.5 (24919)	81.4 (687)
- sometimes	1.5 (402)	1.5 (1045)	1.5 (2521)	1.6 (3590)	1.6 (2373)	1.8 (538)	2.5 (21)
- daily	13.4 (3572)	12.6 (9064)	11.5 (19060)	11.0 (24831)	10.9 (15924)	12.7 (3704)	16.1 (136)
Diabetes							
- type 1	0.8 (217)	0.4 (318)	0.2 (342)	0.1 (216)	0.1 (66)	0.1 (14)	0.1 (1)
- type 2	0.4 (105)	0.3 (201)	0.2 (320)	0.1 (337)	0.1 (170)	0.1 (24)	0.2 (2)
- gestational	1.9 (504)	1.6 (1118)	1.2 (1982)	0.9 (1990)	0.5 (768)	0.3 (95)	0.2 (2)
Preeclampsia	3,1 (813)	2,0 (1402)	1,4 (2252)	1,1 (2439)	1,0 (1436)	0,9 (251)	0,9 (8)
Instrumental delivery							
- forceps	1.0 (265)	0.9 (664)	1.0 (1687)	1.2 (2803)	1.7 (2424)	2.2 (655)	2.2 (19)
- vacuum extraction	5.8 (1542)	5.9 (4269)	6.5 (10769)	8.1 (18191)	10.3 (15049)	12.5 (3659)	9.4 (79)
Emergency caesarean section	5.2 (1377)	3.7 (2658)	3.6 (5905)	4.5 (10130)	7.0 (10220)	10.9 (3166)	9.6 (81)

[1]Maternal age -missing values 43/665201
[2]Educational level-missing values 26524/638720
Note: No cases with major anomalies were included in the study sample.

Table 2 Adverse perinatal outcomes by GA group in study sample (N = 665,244).

	Week 37 (N=26634)	Week 38 (N=71765)	Week 39 (N=165166)	Week 40 (N=225478)	Week 41 (N=146196)	Week 42 (N=29161)	Week 43 (N=844)	
Stillbirth/Livebirth	69/26634	93/71765	118/165166	143/225478	83/146196	34/29161	2/844	
Adverse perinatal outcomes	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	P-value
Meconium-stained amniotic fluid	5.47 (1456)	8.41 (6035)	13.41 (22143)	18.73 (42231)	24.52 (35840)	29.72 (8666)	28.08 (237)	0.001
Respiratory support [1]	1.08 (287)	0.49 (350)	0.39 (639)	0.50 (1127)	0.63 (920)	0.66 (193)	0	0.001
5-min Apgar < 7	0.93 (247)	0.63 (449)	0.61 (1012)	0.74 (1667)	1.08 (1572)	1.36 (395)	0.48 (4)	0.001
5-min Apgar < 4	0.23 (61)	0.14 (103)	0.13 (220)	0.16 (358)	0.22 (317)	0.26 (76)	0	0.001
Admission to NICU [2]	8.0 (2006)	4.5 (3043)	3.5 (5541)	3.8 (8140)	4.8 (6604)	6.5 (1753)	5.4 (40)	0.001
Treatment of the newborn with antibiotics, ≥1 dose	2.09 (551)	1.38 (987)	1.36 (2251)	1.72 (3889)	2.31 (3376)	2.66 (777)	1.30 (11)	0.001
SGA[3], below 5th percentile	6.0 (1594)	5.2 (3745)	4.8 (7907)	4.4 (9990)	4.3 (6347)	4.6 (1332)	13.3 (112)	0.001
Intracranial haemorrhage	0.09 (23)	0.05 (33)	0.05 (78)	0.07 (151)	0.06 (93)	0.07 (19)	0	0.0047
Birth injures								
Brachial plexus injury	0.17 (46)	0.16 (115)	0.17 (279)	0.18 (413)	0.22 (328)	0.32 (92)	0.12 (1)	0.001
Clavicle fracture	0.23 (61)	0.22 (160)	0.23 (385)	0.26 (581)	0.33 (482)	0.45 (132)	0.47 (4)	0.001
Facial nerve palsy	0.05 (12)	0.03 (23)	0.03 (44)	0.03 (67)	0.04 (53)	0.08 (22)	0.12 (1)	0.001
Neonatal jaundice	11.61 (3092)	6.21 (4459)	4.23 (6989)	3.51 (7919)	3.13 (4579)	3.62 (1057)	3.91 (33)	0.001
Oligohydramnios	1.18 (314)	1.14 (817)	1.34 (2211)	1.69 (3816)	2.71 (3967)	4.40 (1284)	4.38 (37)	0.001
Polyhydramnios	1.07 (286)	0.83 (597)	0.80 (1329)	0.78 (1766)	0.89 (1307)	0.79 (229)	0.36 (3)	0.001

[1] The need for continuous positive airway pressure or for an endotracheal tube
[2] NICU=Neonatal intensive care unit
[3] SGA=Small for gestational age

Table 3 Regression analyses of adverse perinatal outcomes in relation to GA grouping (N = 665,244).

	Week 37		Week 38		Week 39-40	Week 41		GA ≥ 42	
Adverse perinatal outcomes	Crude OR (95% CI)	aOR (95% CI)	Crude OR (95% CI)	aOR (95% CI)	Ref	Crude OR (95% CI)	aOR (95% CI)	Crude OR (95% CI)	aOR (95% CI)
Meconium-stained amniotic fluid	0.29 (0.28-0.31)	0.28 (0.26-0.29)	0.47 (0.45-0.48)	0.45 (0.44-0.46)	Ref	1.65 (1.62-1.67)	1.65 (1.63-1.67)	2.14 (2.08-2.20)	2.11 (2.06-2.17)
Respiratory support [1]	2.40 (2.12-2.72)	2.20 (1.93-2.50)	1.08 (0.96-1.21)	1.06 (0.95-1.20)	Ref	1.39 (1.29-1.51)	1.39 (1.28-1.51)	1.43 (1.23-1.66)	1.34 (1.15-1.56)
5-min Apgar < 7	1.36 (1.19-1.55)	1.25 (1.09-1.43)	0.91 (0.83-1.01)	0.89 (0.81-0.99)	Ref	1.57 (1.48-1.68)	1.55 (1.46-1.66)	1.95 (1.76-2.17)	1.81 (1.63-2.02)
5-min Apgar < 4	1.55 (1.19-2.02)	1.39 (1.05-1.83)	0.97 (0.79-1.20)	0.95 (0.77-1.18)	Ref	1.47 (1.28-1.68)	1.46 (1.27-1.68)	1.71 (1.35-2.18)	1.61 (1.26-2.06)
Admission to NICU [2]	2.26 (2.15-2.37)	2.00 (1.90-2.10)	1.22 (1.18-1.27)	1.15 (1.11-1.20)	Ref	1.31 (1.27-1.35)	1.31 (1.27-1.35)	1.81 (1.72-1.90)	1.73 (1.64-1.82)
Antibiotic treatment, ≥1 dose	1.32 (1.21-1.45)	1.22 (1.11-1.33)	0.87 (0.82-0.93)	0.86 (0.80-0.92)	Ref	1.48 (1.42-1.54)	1.44 (1.38-1.51)	1.69 (1.57-1.82)	1.59 (1.47-1.72)
SGA[3], below 5th percentile	1.33 (1.26-1.40)	1.24 (1.17-1.31)	1.15 (1.11-1.19)	1.12 (1.08-1.16)	Ref	0.95 (0.92-0.97)	0.91 (0.89-0.94)	1.05 (1.0-1.11)	0.95 (0.90-1.01)
Intracranial haemorrhage	1.47 (0.96-2.26)	1.32 (0.85-2.05)	0.78 (0.54-1.13)	0.77 (0.53-1.12)	Ref	1.09 (0.85-1.38)	1.08 (0.85-1.37)	1.08 (0.68-1.73)	0.85 (0.51-1.41)
Birth injures									
Brachial plexus injury	0.98 (0.72-1.31)	0.88 (0.65-1.21)	0.90 (0.74-1.10)	0.91 (0.74-1.11)	Ref	1.27 (1.11-1.45)	1.28 (1.11-1.46)	1.75 (1.41-2.18)	1.78 (1.42-2.22)
Clavicle fracture	0.93 (0.72-1.20)	0.88 (0.68-1.14)	0.90 (0.76-1.07)	0.87 (0.74-1.04)		1.33 (1.20-1.49)	1.33 (1.19-1.49)	1.84 (1.53-2.20)	1.84 (1.53-2.21)
Facial nerve palsy	1.59 (0.87-2.88)	1.46 (0.80-2.66)	1.13 (0.72-1.77)	1.12 (0.71-1.75)		1.28 (0.92-1.77)	1.270 (0.91-1.76)	2.70 (1.72-4.23)	2.57 (1.64-4.04)
Neonatal jaundice	3.31 (3.18-3.45)	3.23 (3.10-3.37)	1.67 (1.61-1.73)	1.67 (1.61-1.73)	Ref	0.82 (0.79-0.84)	0.79 (0.765-0.82)	0.95 (0.89-1.01)	0.89 (0.83-0.94)
Oligohydramnios	0.76 (0.68-0.85)	0.71 (0.63-0.80)	0.74 (0.68-0.79)	0.72 (0.66-0.77)	Ref	1.78 (1.71-1.85)	1.78 (1.71-1.86)	2.94 (2.77-3.12)	2.9 (2.76-3.13)
Polyhydramnios	1.36 (1.20-1.54)	1.27 (1.12-1.45)	1.05 (0.96-1.15)	1.01 (0.93-1.11)	Ref	1.13 (1.06-1.21)	1.17 (1.10-1.25)	0.98 (0.85-1.12)	1.06 (0.92-1.21)

Adjusted for maternal age, parity, education, smoking, diabetes type 1, diabetes type 2, gestational diabetes, preeclampsia

[1] The need for continuous positive airway pressure or for an endotracheal tube
[2] NICU=neonatal intensive care unit
[3] SGA=Small for gestational age