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Breaking the myth: the association between the increasing incidence of labour induction and the rate of caesarean delivery in Finland - a nationwide Medical Birth Register study

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ABSTRACT

Objectives To determine the association between the rate of labour induction and caesarean delivery.

Design Medical Birth Register-based study. We used data from the nationwide Medical Birth Register collecting data on delivery outcomes on all births from 22+0 weeks and/or birth weight of at least 500 g.

Setting Finland.

Participants 663 024 live births in Finland from 2008 to 2019.

Main outcome measures The rates of labour induction and caesarean delivery.

Results The rate of labour induction increased from 17.8% to 30.3%; p<0.001, during the study. The total caesarean delivery rate was 16.5% (n=109 178). An increase of approximately 0.5% in the caesarean delivery rate occurred during the study period. The rate of caesarean delivery following labour induction slightly decreased (15.41% vs 15.35%; p<0.001). In multivariate logistic regression analysis, induction of labour was associated with a reduced risk for caesarean delivery (OR 0.72, 95% CI 0.71 to 0.74). The frequency of advanced maternal age (18.0% vs 23.5%; p<0.001), obesity (11.4% vs 15.1%; p<0.001) and gestational diabetes (9.8% vs 23.3%; p<0.001) increased during the study.

Conclusions The 70% increase in the rate of labour induction in Finland has not led to a significant increase in the rate of caesarean delivery, which has remained one of the lowest in the world. Pregnant women in Finland are more frequently obese, older and diagnosed with gestational diabetes, which may partly explain the increase in the rate of labour induction.

INTRODUCTION

An average of 30% of pregnant women undergo induction of labour (IOL) in developed countries, and the incidence is increasing worldwide.[1–3] In Finland, with approximately 50 000 births annually, the rate of IOL has more than doubled from 13.9% to 31.7% over the last 20 years, while

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Includes extensive registry data covering all deliveries in Finland for over more than a decade.
⇒ We examined the overall rate of caesarean deliveries, and separately the rate of caesarean deliveries in induced labour, and in nulliparous and multiparous women.
⇒ · Data on indications for labour induction is not included since it is not collected in the national Medical Birth Registry data.
⇒ We have no data over metformin treated gestational diabetes.

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the birth rate has decreased.[4] In the USA, the rate of IOL has risen steadily from 9.6% in 1990 to 27.1% of all births and 37.8% of first-time births in 2018.[5] The increase in induction rates may be explained by the advancing maternal age, obesity and pregnancy complications, as well as by advanced diagnostics and pregnancy monitoring practices, growing research data on IOL, development of induction methods, social media and awareness of pregnant women.

An abundance of literature on labour induction shows mixed results for perinatal outcomes and caesarean section (CS) rates following IOL.[6] The studies are of wide heterogeneity and variation in observational or randomised setting, in comparing IOL with spontaneous onset of labour or expectant management, the methods used to induce labour and the outcomes used for comparisons. The recent Cochrane review states that IOL at or beyond term is associated with reduced number of perinatal mortality and a lower risk of CS compared with expectant management.[7]

The rate of CS in Finland has ranged between 15.9% and 18% during the last 10 years, being one of the lowest among all industrialised countries.[8] On average, the rate of emergency CS in Finland is approximately 11%, and the rate of planned CS is approximately 6%.[4] The increasing rate of IOL in the country has raised concerns whether it leads to an increase in the rate of caesarean deliveries. The aim of this study was to investigate the influence of increasing rates of IOL on the rate of caesarean delivery, as well as the changes in the background factors affecting it based on the national Medical Birth Registry data.

METHODS

This register-based and population-based retrospective study included all 663 024 live births in Finland from 2008 to 2019. The data was obtained from The Finnish Medical Birth Register (MBR), maintained by the Finnish National Institute for Health and Welfare, which collects baseline data on pregnancies and delivery outcomes and on all live births and stillbirths from 22+0 gestational weeks and/or birth weight at least 500 g. The MBR data are compiled at the time of birth, using the mother's prenatal charts, the Central Population Register (live births) and the Cause of Death Register (stillbirths and neonatal deaths) as a data source. The 12-year study period was divided into 3-year periods as follows: 2008–2010 (Period 1), 2011–2013 (Period 2), 2014–2016 (Period 3) and 2017–2019 (Period 4). The main outcome included the rates of IOL and caesarean delivery.

Patient and Public Involvement Statement

Patients were not involved in the study. The study design was planned according to public interest and concern in the increasing rate of IOL. The results of this study will be shared to public communities after publication via national media, social media and online research platforms.

As in many Western countries, the birth rate in Finland has decreased over the last decade, currently being approximately 46 000 births annually, with IOL rate of 32% and the caesarean delivery rate of 16%–18%. The perinatal mortality rate is 0.4%. Finland has 5 academic tertiary care university hospitals, and 15 secondary hospitals with childbirth facilities. Helsinki University Hospital constitutes 30% of all deliveries.

The characteristics of the study population included in the MBR data were maternal age, prepregnancy body mass index (BMI), the rates of preterm and post-term pregnancies, incidence of gestational diabetes and the frequency of medicated gestational diabetes. Advanced maternal age was defined as the age of 35 years or more at the time of delivery. Obesity was defined as the prepregnancy BMI of ≥ 30 kg/m^2. Preterm labour was defined as delivery at <37+0 gestational weeks, and post-term pregnancy was defined as gestational age $\geq 42+0$ weeks. In Finland, gestational age was determined by the first-trimester ultrasonography during the study period.

Gestational diabetes was defined as one or more borderline or abnormal values in a 2-hour oral 75 g glucose tolerance test (OGTT) during the first or the second trimester, and 5.3, 10.0 and 8.6 mmol/L are used for 0-hour, 1-hour and 2-hour cut-off values. Most pregnant women in Finland are since 2008 screened for gestational diabetes by OGTT between 24 and 28 gestational weeks. Women with gestational diabetes in the previous pregnancy, family history of diabetes or BMI ≥ 35 undergo the test already at 12–16 gestational weeks and repeat it at 24–28 gestational weeks if normal. Nulliparous women with maternal age <25 years with normal BMI of 18–25 and no family history of diabetes, as well as multiparous women with maternal age <40 years, normal BMI of 18–25, no history of gestational diabetes or macrosomia in the previous pregnancies and no family history of diabetes are not routinely screened. The rate of gestational diabetes was calculated from all pregnant women, not only those who underwent OGTT. Gestational diabetes was treated with diet, metformin tablets, insulin or a combination of these.

The indications and methods for labour induction are not included in the MBR data during the study period. In Finland, IOL is started with cervical ripening by 40–80 mL balloon catheter or misoprostol tablets administered 25 µg orally every 2 hours, 50 µg orally every 3–4 hours or 25 µg vaginally every 4–6 hours if cervix is deemed unripe with Bishop score <6. After reaching Bishop score ≥ 6, membranes are artificially ruptured if not spontaneously ruptured, and oxytocin induction is started in the absence of regular contractions. Continuous cardiotocography is routinely used during labour.

Caesarean delivery was categorised as planned caesarean, emergency caesarean and crash emergency CS. Emergency CS was defined as caesarean delivery within 30 min of a decision to procedure under spinal or epidural anaesthesia, skin preparation and transverse abdominal incision. Crash induction emergency CS was defined as immediate caesarean delivery under general anaesthesia, with no skin preparation, and with a decision to delivery interval of less than 15 min.

Characteristics of the women are given as means with SDs in case of normally distributed continuous variables, by medians with IQR in skewed distributed variables and by number of values as percentages if variables were categorical. Categorical variables were compared by Pearson's χ^2 test. Cochran-Armitage test for trend was used in comparing the variables in different time periods. Univariate and multivariate logistic regression analyses were performed to assess relative risk for emergency CS. The confounding risk factors used in the multivariate analyses were birth year, IOL, parity, preterm delivery, post-term delivery, BMI ≥ 30, maternal age ≥ 35 years and gestational diabetes. A separate model without including IOL as confounding factor was also performed and is presented in supporting material. Results are shown as ORs with 95% CIs in modelling risk factors. Statistical analyses were performed on IBM SPSS Statistics V.27.0 (2021). A p value below 0.05 was considered statistically significant.

Table 1 The rates of labour induction and caesarean delivery during the study periods 1–4 (2008–2019)

	2008–2019		Period 1 (2008–2010)		Period 2 (2011–2013)		Period 3 (2014–2016)		Period 4 (2017–2019)		P value test for trend
	n	%	n	%	n	%	n	%	n	%	
Total	663 024		179 265		176 151		164 896		142 712		
Induction of labour	151 332	22.8	31 898	17.8	35 964	20.4	40 211	24.4	43 259	30.3	<0.001
Caesarean delivery	109 178	16.5	29 285	16.3	28 907	16.4	26 790	16.2	24 196	17.0	<0.001
Planned CS	42 523	6.4	11 432	6.4	11 046	6.3	10 346	6.3	9699	6.8	<0.001
Emergency CS	59 450	9.0	15 667	8.7	15 775	9.0	14 743	8.9	13 265	9.3	<0.001
Crash emergency CS	7205	1.1	2186	1.2	2086	1.2	1701	1.0	1232	0.9	<0.001
Caesarean delivery following IOL	23 283	15.4	4914	15.4	5583	15.5	6145	15.3	6641	15.4	<0.001
Nulliparous	275 303	41.5	75 560	42.1	72 399	41.1	68 272	41.4	59 072	41.4	
Induction of labour	68 090	24.7	14 221	18.8	15 938	22.0	18 623	27.3	19 308	32.7	<0.001
Caesarean delivery	57 603	20.9	15 603	20.6	15 223	21.0	14 116	20.7	12 661	21.4	0.003
Planned CS	15 145	5.5	4101	5.4	3893	5.4	3660	5.4	3491	5.9	<0.001
Emergency CS	38 186	13.9	10 164	13.5	10 067	13.9	9471	13.9	8484	14.4	0.009
Crash emergency CS	4272	1.6	1338	1.8	1263	1.7	985	1.4	686	1.2	<0.001
Caesarean delivery following IOL	16 206	23.8	3435	24.2	3889	24.4	4315	23.2	4567	23.7	<0.001
Multiparous	387 721	58.5	103 705	57.9	103 752	58.9	96 624	58.6	83 640	58.6	
Induction of labour	83 242	21.5	17 677	17.0	20 026	19.3	21 588	22.3	23 951	28.6	<0.001
Caesarean delivery	51 575	13.3	13 682	13.2	13 684	13.2	12 674	13.1	11 535	13.8	<0.001
Planned CS	27 378	7.1	7331	7.1	7153	6.9	6686	6.9	6208	7.4	<0.001
Emergency CS	21 264	5.5	5503	5.3	5708	5.5	5272	5.5	4781	5.7	<0.001
Crash emergency CS	2933	0.8	848	0.8	823	0.8	716	0.7	546	0.7	<0.001
Caesarean delivery following IOL	7077	8.5	1479	8.4	1694	8.5	1830	8.5	2074	8.6	<0.001

CS, caesarean section; IOL, induction of labour.

RESULTS

The study population consisted of 663 024 women delivering during 2008–2019, of which 155 332 (22.8%) were induced. The mean age of the study population was 32.1 (5.2 SD) years, and the median BMI was 23.4, IQR 21.1–26.8 kg/m^2. The proportion of nulliparous women was 41.5% (n=275 303) and the proportion of multiparas was 58.5% (n=387 721). During the study period, the rate of labour induction increased from 17.8% in Period 1 (2008–2010) to 30.3% in Period 4 (2017–2019); p<0.001. The increase is seen in both, nulliparous and multiparous women (table 1, online supplemental figure S1).

The median gestational age at the time of delivery was 41.3 (range 39.6–42.0) weeks with the preterm delivery rate of 5.2% (nulliparas 6. 0% and multiparas 4.5%; p<0.001) and the post-term delivery rate 4.1% (nulliparas 5.9% and multiparas 3.0%; p<0.001). The proportion of post-term deliveries decreased from 6.7% in Period 1 to 4.6% in Period 4 (p<0.001) (nulliparas from 3.8% to 1.9%; p<0.001 and multiparas 5.0% to 3.0%; p<0.001). The proportion of preterm deliveries remained approximately 5% of all deliveries (nulliparas from 6.0% to 6.2%; p=0.24 and multiparas from 4.5% to 4.6%; p=0.11).

The proportion of women with advanced maternal age of 35 years or more was 32.4%. The rate of women with advanced maternal age increased between Period 1 and Period 4, from 18.0% to 23.5%; p<0.001 (nulliparas from 9.9% to 14.7%; p<0.001 and multiparas 23.9% to 29.7%; p<0.001).

Of the women, 13.0% were obese. The rate of obesity increased from 11.4% during Period 1 to 15.1% during Period 4; p<0.001 (nulliparas from 9.6% to 12.9%; p<0.001 and multiparas 12.7% to 16.9%; p<0.001) (figure 1, online supplemental table S1).

OGTT was performed on 55.7% of the women during the study period. The frequency of testing for gestational diabetes increased from 42.5% in Period 1 to 66.1% in Period 4; p<0.001. Gestational diabetes occurred in 14.7% of the study population, the rate being 26.4% of the women who underwent OGTT. The diagnosis of gestational diabetes increased from 9.8% in Period 1 to 23.3% in Period 4; p<0.001 (nulliparas from 21.3% to 25.2%;
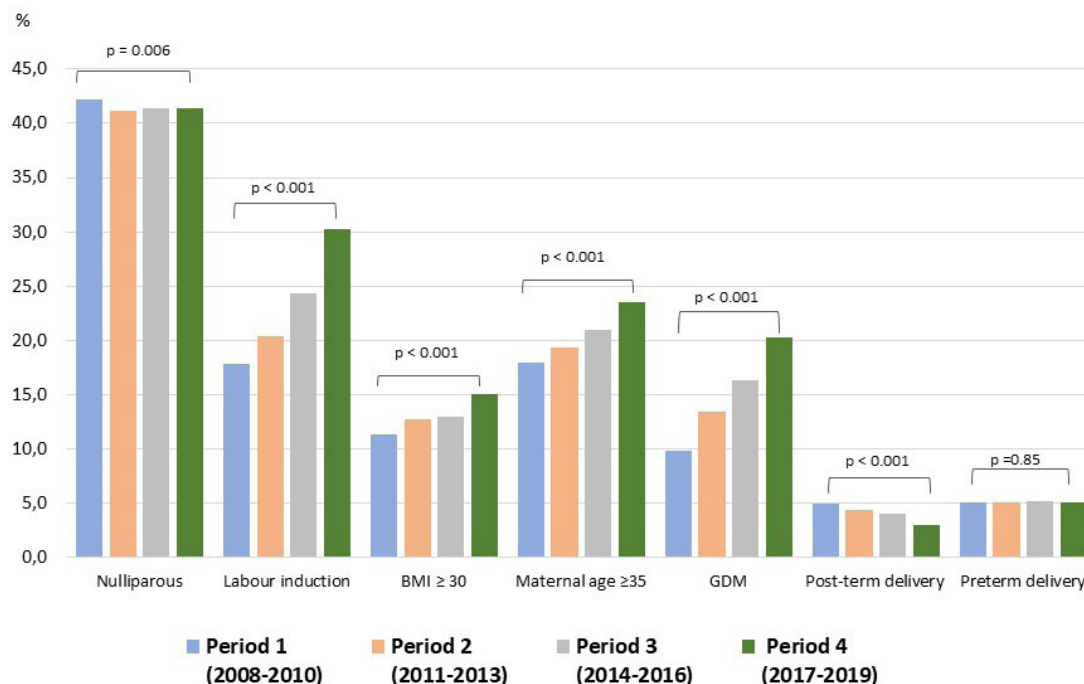
Figure 1 The changes in characteristics of the study population during the study period. BMI, body mass index; GDM, gestational diabetes mellitus.

p<0.001 and multiparas 39.5% to 59.4%; p<0.001). Of the women diagnosed with gestational diabetes, 13.3% were started on insulin treatment during pregnancy. The use of insulin among women with gestational diabetes decreased from 19.0% in Period 1 to 11.1% in Period 4; p<0.001 (nulliparas from 15.8% to 8.2%; p<0.001 and multiparas 5.5% to 8.2%; p<0.001) (figure 1, online supplemental table S1).

The total caesarean delivery rate during the study period was 16.5% (n=109 178). The proportions of planned, emergency and crash emergency CSs, and their respective rates in both nulliparous and multiparous women are presented in table 1. A minor increase of approximately 0.6% in the rate of caesarean deliveries is seen between Period 1 and Period 4 (from 16.3% to 17.0%; p<0.001) (table 1, figure 2A). The increase is observed in planned and emergency CSs, while a decrease in the rate of crash

emergency caesarean delivery is seen (1.22% in Period 1 vs 0.86% Period 4; p<0.001) (table 1).

The rate of caesarean delivery following IOL has remained the same or even slightly decreased (15.41% in Period 1 vs 15.35% in Period 4; p<0.001) (figure 2B). The same trend is seen in nulliparous women (23.8% in Period 1 vs 23.7% in Period 4; p<0.001) (table 1).

In multivariate logistic regression analysis, the risk for emergency caesarean delivery was the highest in preterm delivery (OR 3.42, 95% CI 3.34 to 3.50). Other risk factors associated with caesarean delivery were nulliparity (OR 1.93, 95% CI 1.91 to 1.96), advanced maternal age >35 years (OR 1.83, 95% CI 1.80 to 1.86), post-term delivery (OR 1.76, 95% CI 1.71 to 1.82) and obesity with BMI ≥30 (OR 1.73, 95 % CI 1.70 to 1.76). All these risk factors were significant unadjusted and remained significant after adjustment (table 2). IOL (OR 0.72, 95% CI 0.71
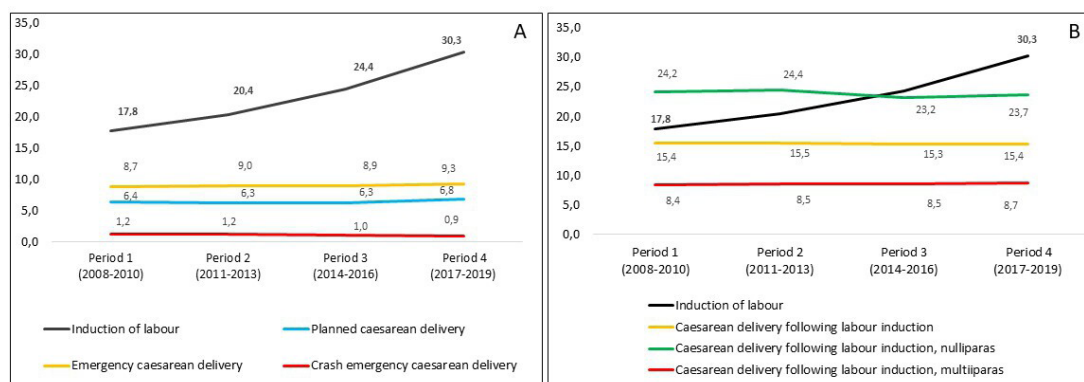

Figure 2 The proportions of labour induction and caesarean delivery in the total study population (A) and in the women who underwent induction of labour (B).

Table 2 Multivariate logistic analysis of risk factors associated with emergency or crash emergency caesarean delivery in Finland 2008–2019

	Unadjusted		Adjusted	
	OR	95% CI	OR	95% CI
Nulliparity	1.73	1.70 to 1.75	1.93	1.91 to 1.96
Induction of labour	0.90	0.88 to 0.91	0.72	0.71 to 0.74
Preterm delivery <37 gestational weeks	3.48	3.40 to 3.56	3.42	3.34 to 3.50
Post-term delivery ≥42 gestational weeks	1.52	1.47 to 1.56	1.76	1.71 to 1.82
Body mass index ≥30 kg/m^2	1.74	1.71 to 1.77	1.73	1.70 to 1.76
Maternal age ≥35 years	1.62	1.59 to 1.64	1.83	1.80 to 1.86
Gestational diabetes	0.62	0.1 to 0.64	0.71	0.69 to 0.72

Adjusted by year of birth, parity, induction of labour, gestational age, body mass index, maternal age and gestational diabetes.

to 0.74) and gestational diabetes (OR 0.71, 95% CI 0.69 to 0.72) were associated with a reduced risk for caesarean delivery (table 2). No difference in the risk factors was seen when excluding the IOL from confounding factors and only assessing background demographics (online supplemental table S2).

The perinatal outcomes are presented in online supplemental table S3. The overall perinatal mortality rate was 0.4% (n=2444/672 411) and the neonatal intensive care (NICU) admission rate was 10.3%. The perinatal mortality rate remained stable while the NICU admission rate increased from 10.3% in Period 1 to 10.9% in Period 4 (p<0.001). The median birth weight over the study period was 3220 g (IQR 3860 g) and the rate of macrosomia with birth weight ≥4500 g was 2.5%. A slight decrease in the rate of fetal macrosomia (2.5% vs 2.4%; p=0.005) was seen over the study period (online supplemental table S3).

DISCUSSION

This study was a national Medical Birth Register study over a 12-year period in Finland showing a steeply increasing rate of labour induction with a stable 16%–17% rate of caesarean delivery. While the rate of labour induction in Finland has increased by 70% (from 17.8% to 30.3%) over the study period, the rate of caesarean delivery has remained one of the lowest in the world. IOL was not associated with an increase in the rate of emergency caesarean delivery, but a stable or even slightly reduced rate of caesarean delivery following labour induction. The proportion of pregnant women with advanced maternal age, obesity and gestational diabetes have significantly increased over the study period, partly explaining the increasing labour induction rate.

The weakness of the study is not having the national data on indications for labour induction. Unfortunately, this factor is not collected in the national Medical Birth Registry data. However, in Helsinki University Hospital, comprising 30% of all deliveries, the main indications for labour induction are post-term pregnancy (30%),

pre-labour rupture of membranes (30%), gestational diabetes (10%) and hypertensive complications (10%).[9] The authors also regret not having access to all relevant individual data to assess individual risk factors, such as advanced maternal age, gestational diabetes or history of previous caesarean delivery, since this would have enabled further subanalyses whether the incidence of caesarean delivery changed in any of these individual risk groups although the overall caesarean delivery incidence in the study population remained stable. We also regret not having the data over metformin treated gestational diabetes, and not being able to separate dietary and medically treated types of gestational diabetes. The strength of this study is the extensive registry data covering all deliveries in Finland for over more than a decade. Furthermore, we examined the overall rate of caesarean deliveries, and separately the rate of caesarean deliveries in induced labour, and in nulliparous and multiparous women. Many retrospective studies approach the rate of CS by comparing labour induction to spontaneous onset of labour instead of expectant management of pregnancy, which may lead to exaggerated estimates of the risk of caesarean delivery.

Historically, IOL has been associated with an increase in CS rate compared with spontaneous labour at or beyond term,[10] but an abundance of more recent studies have demonstrated a reduction in the rate of CS following IOL at term compared with expectant management.[11–16] Similar result was seen in the current study of the national perinatal statistics of Finland; while inductions have almost doubled, the rate of caesarean delivery has increased by only 0.5%, which is a small difference, considering the significant increase in maternal risk factors, such as advanced maternal age, obesity and gestational diabetes, over the study period. The total rate of caesarean delivery has remained between 16% and 17% over the 12-year study period, being one of the lowest rates in the world. Furthermore, the rate of emergency caesarean delivery in induced labour has even decreased, and in multivariate logistic regression analysis IOL was

associated with a reduced risk for emergency caesarean delivery.

In our study, the risk factors associated with emergency caesarean delivery were preterm delivery, nulliparity, post-term delivery, obesity and advanced maternal age >35 years. In a previous retrospective registry-based study from Denmark, Finland, Iceland, Norway and Sweden, advanced maternal age was associated with an increased risk of CS among women undergoing IOL at term.[17] Obesity is a known risk factor for failed IOL, emergency caesarean delivery and perinatal complications.[18–20] In our study, more than every 10th woman were obese. Post-term pregnancy and nulliparity are known risk factors for induction failure and emergency caesarean delivery.[21 22] In our study, every 4th nulliparous woman undergoing labour induction delivered by CS, while in multiparous women the corresponding rate was less than every 10th woman.

The incidence of gestational diabetes, a risk factor for fetal macrosomia and perinatal morbidity, doubled over the study period, and currently more than every 5th pregnant woman in Finland is diagnosed with gestational diabetes. The increased incidence of OGTT, and gestational diabetes are partly explained by the national guideline changing from risk-based gestational diabetes screening to universal screening, and partly by the increasing maternal age and obesity. Gestational diabetes was associated with a reduced risk for emergency caesarean delivery, and the rate of fetal macrosomia slightly decreased over the study period. The authors assume this is due to more active screening and labour induction policies. Controversially, the proportion of insulin treated gestational diabetes decreased during the study, which may be explained by the increasing use of metformin treatment. Unfortunately, metformin treatment is not recorded in the Medical Birth Registry data. The authors speculate, based on institutional data of Helsinki University Hospital, that a third of women with gestational diabetes are treated either with metformin or insulin. The perinatal mortality rate remained 0.4% over the study period. A slight increase was seen in the rate of NICU admission over the study period. However, in the Finnish Medical Birth registry NICU admission includes both the intensive care unit admission and brief monitoring in the special care baby unit, which may explain some of the figures.

CONCLUSION

The almost doubled rate of labour induction in Finland has not led to a significant increase in the rate of caesarean delivery, which has remained one of the lowest in the world. The characteristics of pregnant women have changed over the decade, with pregnant women in Finland being more frequently obese, older and diagnosed with gestational diabetes. The increasing rate of maternal risk factors may partly explain the increase of the rate in labour induction. The increasing incidence

of labour induction was not associated with a significant increase in the rate of caesarean delivery over the study period. In contrast, after adjustment for birth year and background demographics, IOL was associated with a reduced risk for emergency caesarean delivery.

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