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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

Heidi Kruit ,[1] Mika Gissler,[2] Seppo Heinonen,[1] Leena Rahkonen[1]

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[1]Obstetrics and Gynecology, Helsinki University hospital and University of Helsinki, Helsinki, Finland
[2]Finnish Institute for Health and Welfare, Helsinki, Finland

Correspondence to
Dr Heidi Kruit; heidi.kruit@hus.fi

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.

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.

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 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 ≥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%;

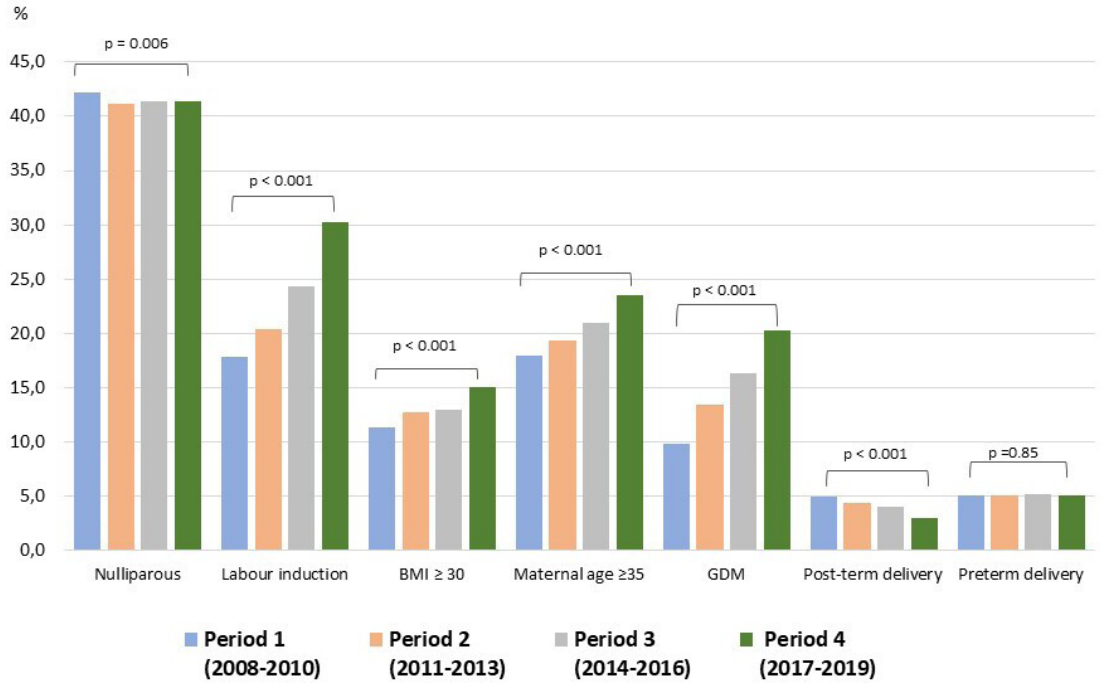

Figure 1 The changes in characteristics of the study population during the study period. BMI, body mass index; GDM, gestational diabetes mellitus.

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

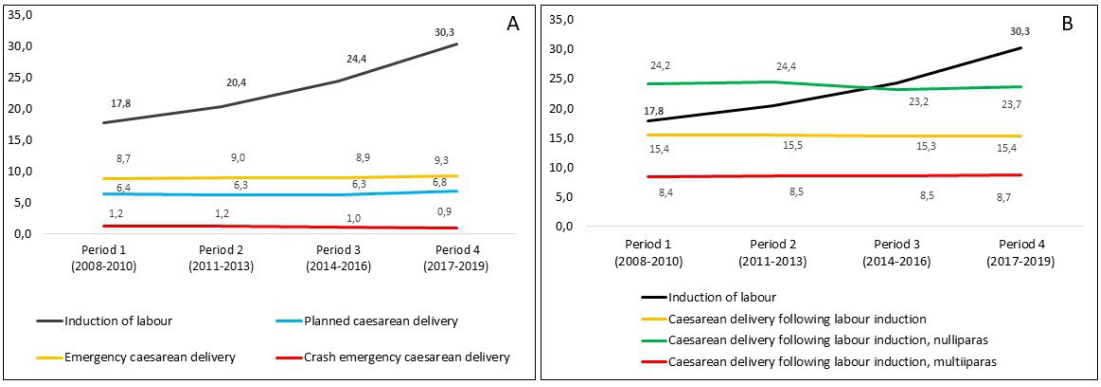

Figure 2 The proportions of labour induction and caesarean delivery in the total study population (A) and in the women who underwent induction of labour (B).

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.

Contributors HK and LR planned the study. LR and MG gathered and analysed the Medical Birth Register data. HK drafted the manuscript. SH edited the manuscript. All the authors have significantly contributed, and the authors agree with the content of the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. The contributors responsible for the overall content as guarantor are HK and LR. The guarantor accepts full responsibility for the work and/or the conduct of the study, had access to the data and controlled the decision to publish.

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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 applicable.

Ethics approval The National Institute for Health and Welfare, as a register keeper, gave the necessary authorisation required by national data protection legislation (THL/1200/5.05.00/2012). Due to the register based and retrospective nature of the study, written informed consent was waived by the Institutional Review Board according to national legislation (Medical Research Act 488/1999, chapter 2 a (23.4.2004/295), sections 5 and 10a).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. Data on official Statistics of Finland 'Perinatal statistics - parturients, delivers and newborns', Statistical Report 48/2020 are available in a public repository (https://thl.fi/en/web/thlfi-en/statistics-and-data/statistics-by-topic/sexual-and-reproductive-health/parturients-deliveries-and-births/perinatal-statistics-parturients-delivers-and-newborns).

ORCID iD

Heidi Kruit http://orcid.org/0000-0003-0350-7088

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Figure S1. The incidence of labour induction (%) according to parity and study period

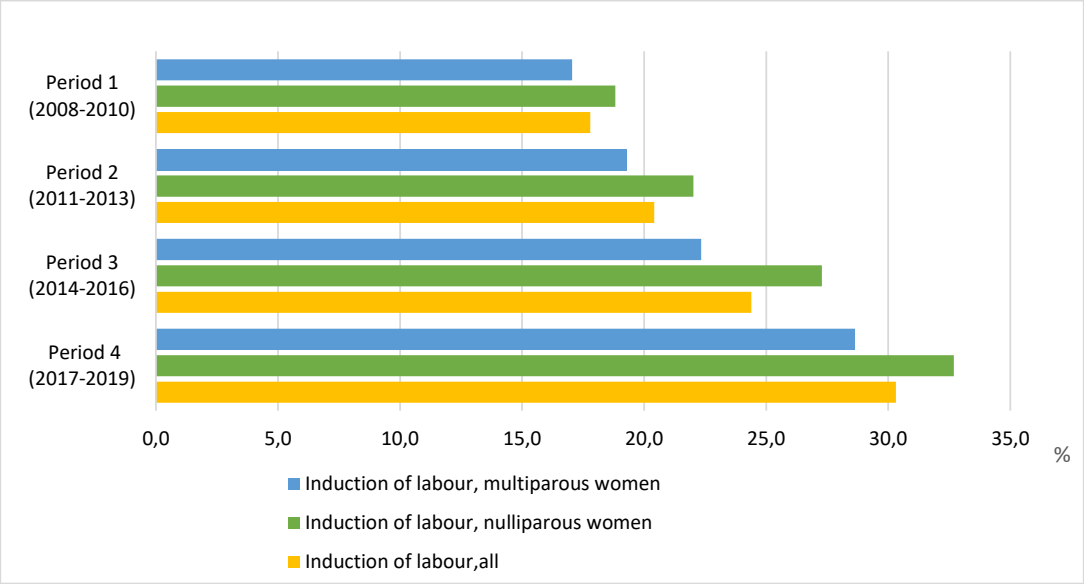

Table S1 Characteristics of study population

	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	663024		179265		176151		164896		142712		
Nulliparous women	275303	41.5	75560	42.1	72399	41.1	68272	41.4	59072	41.4	<0.001
Multiparous women	387721	58.5	103705	57.9	103752	58.9	96624	58.6	83640	58.6	
BMI ≥ 30	85883	13.0	20438	11.4	22421	12.7	21488	13.0	21536	15.1	<0.001
Maternal age ≥ 35 years	134594	20.3	32229	18.0	34173	19.4	34667	21.0	33525	23.5	<0.001
OGTT performed	369 147	55.7	76 172	42.5	99 201	56.3	99 497	60.3	94 277	66.1	<0.001
Gestational diabetes	97304	14.7	17738	9.9	23628	13.4	27022	16.4	28916	20.3	<0.001
Nulliparous											
BMI ≥ 30	30304	11.0	7265	9.6	7890	10.9	7530	11.0	7619	12.9	<0.001
Maternal age ≥ 35 years	32759	11.9	7475	9.9	7967	11.0	8624	12.6	8693	14.7	<0.001
OGTT performed	173486	63.0	12634	24.9	47250	65.3	46788	68.6	45522	77.1	<0.001
Gestational diabetes	38063	21.9	2688	21.3	9200	19.5	10677	22.8	11470	25.2	<0.001
Multiparous											
BMI ≥ 30	55579	14.3	13173	12.7	14531	14.0	13958	14.4	13917	16.6	<0.001
Maternal age ≥ 35 years	101835	26.3	24754	23.9	26206	25.3	26043	27.0	24832	29.7	<0.001
OGTT performed	195661	50.5	11827	65.3	51951	50.1	52709	54.5	48755	58.3	<0.001
Gestational diabetes	93399	47.7	5309	39.4	22628	43.6	26128	49.6	27979	57.4	<0.001

BMI; Body mass index, OGTT; oral glucose tolerance test, GDM; Gestational diabetes (percentage of all women with abnormal OGTT result)

Table S2 Multivariate logistic analysis of risk factors associated with emergency or crash emergency caesarean delivery in Finland 2008-2019 without induction of labour included in the model

	Unadjusted		Adjusted	
	OR	**CI 95 %**	**OR**	**CI 95 %**
Nulliparity	1.73	1.70–1.75	1.91	1.89–1.94
Preterm delivery < 37 gestational weeks	3.48	3.40-3.56	3.40	3.32–3.48
Post-term delivery ≥ 42 gestational weeks	1.52	1.47-1.56	1.51	1.46–1.55
Body mass index ≥ 30 kg/m2	1.74	1.71-1.77	1.67	1.64–1.70
Maternal age ≥ 35 years	1.62	1.59-1.64	1.81	1.78–1.84
Gestational diabetes	0.62	0.61-0.64	0.73	0.72–0.75

Adjusted by year of birth

Table S3 Perinatal outcomes

	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	672 411		181 963		178 639		167 178		144 631		
Perinatal mortality	2 444	0.4	730	0.4	596	0.3	617	0.4	501	0.4	0.01
NICU admission	67567	10.3	16097	9.1	18384	10.6	17672	10.9	15414	10.9	<0.001
Birthweigt (median; IQR)	3220	3860	3210	3860	3220	3870	3215	3860	3225	3865	
Birthweight ≥ 4500 g	16399	2.5	4583	2.6	4496	2.6	3889	2.4	3431	2.4	0.005
Nulliparous	275303	41.5	75560	42.1	72399	41.1	68272	41.4	59072	41.4	
Perinatal mortality	1046	0.4	300	0.4	243	0.3	272	0.4	231	0.4	0.85
NICU admission	35403	13.1	8501	11.4	9586	13.4	9277	13.8	8039	13.8	<0.001
Birthweigt (median; IQR)	3130	3760	3120	3750	3130	3768	3130	3760	3140	3770	
Birthweight ≥ 4500 g	4162	1.5	1162	1.6	1119	1.6	976	1.5	905	1.6	0.905
Multiparous	387721	58.5	103705	57.9	103752	58.9	96624	58.6	83640	58.6	
Perinatal mortality	1398	0.4	430	0.4	353	0.3	345	0.4	270	0.3	0.004
NICU admission	32164	8.4	7596	7.4	8798	8.6	8395	8.8	7375	8.9	<0.001
Birthweigt (median; IQR)	3286	3925	3285	3930	3290	3930	3284	3920	3288	3925	
Birthweight ≥ 4500 g	12237	3.2	3421	3.3	3377	3.3	2913	3.1	2526	3.1	0.02

NICU; Neonatal intensive care unit, IQR; interquartile range