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# Variations over time in mode of birth and perinatal outcomes in women with one previous cesarean in the Netherlands: A 20-year population-based study

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## Abstract

**Background:** Globally, cesarean birth rates are rising, and while it can be a life-saving procedure, cesarean birth is also associated with increased maternal and perinatal risks. This study aims to describe changes over time about the mode of birth and perinatal outcomes in second-pregnancy women with one previous cesarean birth in the Netherlands over the past 20 years.

**Methods:** We conducted a nationwide, population-based study using the Dutch perinatal registry. The mode of birth (intended vaginal birth after cesarean (VBAC) compared with planned cesarean birth) was assessed in all women with one previous cesarean birth and no prior vaginal birth who gave birth to a term singleton in cephalic presentation between 2000 and 2019 in the Netherlands ($n = 143{,}146$). The reported outcomes include the trend of intended VBAC, VBAC success rate, and adverse perinatal outcomes (perinatal mortality up to 7 days, low Apgar score at 5 min, asphyxia, and neonatal intensive care unit admission ≥24 h).

**Results:** Intended VBAC decreased by 21.5% in women with one previous cesarean birth and no prior vaginal birth, from 77.2% in 2000 to 55.7% in 2019, with a marked deceleration from 2009 onwards. The VBAC success rate dropped gradually, from 71.0% to 65.3%, across the same time period. Overall, the cesarean birth rate (planned and unplanned) increased from 45.2% to 63.6%. Adverse perinatal outcomes were higher in women intending VBAC compared with those planning a cesarean birth. Perinatal mortality initially decreased but remained stable from 2009 onwards, with only minimal differences between both modes of birth.

**Conclusions:** In the Netherlands, the proportion of women intending VBAC after one previous cesarean birth and no prior vaginal birth has decreased markedly. Particularly from 2009 onwards, this decrease was not accompanied by a synchronous reduction in perinatal mortality.

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**KEYWORDS**
cesarean birth, obstetrics, vaginal birth after cesarean

## 1 | INTRODUCTION

Globally, cesarean birth (CB) rates have increased, reaching 21.1% of all births in 2018.[1] Although CB can be lifesaving, one-third are performed without a medical indication, despite the procedure being associated with increased maternal and perinatal risks, including in subsequent pregnancies.[1–6] The World Health Organization (WHO) aims to reduce the rate of such non-indicated cesarean births.[3] Although the greatest benefit is expected from preventing unnecessary first cesareans, offering birthing people a chance to attempt vaginal birth after cesarean (VBAC) is another strategy proposed by the WHO and in most guidelines to reduce the sequelae of repeated cesarean births.[3,7–9]

While a successful VBAC has the lowest rate of maternal complications at no increased perinatal risk, an unsuccessful intended VBAC results in an unplanned CB, which is associated with an increased risk of adverse maternal and perinatal outcomes when compared with a planned CB.[10,11] Moreover, a trial of labor may result in uterine rupture (uterine rupture rates: 35/10.000 after previous CB, 0.6/10.000 without previous CB[12]), a severe complication with substantial maternal and perinatal risks.[10,13,14] At the same time, repeated cesarean births substantially increase the risk of placenta previa, placenta accreta spectrum disorder, and postpartum hemorrhage in subsequent pregnancies[11,15–17] and are associated with increased risks of maternal mortality in the Netherlands compared with vaginal birth.[5]

There is considerable variation in VBAC rates among European countries, with relatively high rates in countries that have relatively low overall CB rates (e.g., Sweden, Finland, and the Netherlands). Inversely, relatively low VBAC rates occur in countries with high overall CB rates (e.g., Italy, Greece, and Ireland).[1,18–20] In the Netherlands, VBAC is considered a safe option for women with one previous CB in the presence of continuous fetal monitoring, immediate access to an operating room, and staff competent to perform neonatal resuscitation.[9] The patient decides upon the mode of birth after individualized counseling during antenatal care, in which the risks and benefits of both options are considered. A prediction model is often used to estimate the individual likelihood of a successful VBAC.[9,21]

No previous studies have comprehensively analyzed the trends of women intending VBAC and the VBAC success rate in the Netherlands or whether these trends are associated with changes in perinatal outcomes. Therefore, our primary aim was to describe changes in the mode of birth among women with one previous CB and no previous vaginal birth between 2000 and 2019. Our secondary aims were to assess the VBAC success rate and change over time in adverse perinatal outcomes.

## 2 | METHODS

### 2.1 | Study design

We conducted a nationwide population-based study using the Dutch Perinatal Registry (Perined) from 2000 to 2019.

### 2.2 | Setting

In the Netherlands, 3,436,258 women gave birth with a gestation of at least 24 weeks between 2000 and 2019, with an average of 171,812 births per year (in 2000, $n = 184{,}246$, in 2019, $n = 160{,}898$). In 2000, 64.5% of births took place in obstetrician-led care in the hospital, 9.5% in primary midwifery-led care at a low-risk birth unit in the hospital, and 25.2% at home, attended by primary care midwives. In 2019, these percentages were 72.7%, 14.5%, and 12.7%, respectively.[22] The overall CB rate was 15.4% ($n = 528{,}096$; planned and unplanned), with an increase from 13.2% in 2000 to 16.8% in 2015 (maximum), followed by a decrease to 15.8% in 2019. The CB rate increased, particularly among women with a previous CB. Of all women who gave birth by cesarean, the proportion of women with a previous CB and a singleton in cephalic presentation with a gestation of at least 37 weeks increased from 16.1% in 2000 to 25.7% in 2019. In the same period, the births of women in this group represented 6.2% of all births.[22]

In the Netherlands, women with a previous CB—without other risk factors—generally receive antenatal care from a midwife in primary care up to 34 to 36 weeks of gestation. The mode of birth is decided upon after individual counseling with the obstetrician. Women opting for VBAC are advised to give birth in obstetrician-led care in a hospital with intravenous access and continuous CTG monitoring.

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## 2.3 | Participants

Our study population consisted of women with one previous CB and no prior vaginal birth, pregnant with a singleton in cephalic presentation, and a gestation of at least 37 weeks who gave birth between January 1, 2000, and December 31, 2019.

## 2.4 | Data source

We obtained data from the Dutch Perinatal Registry (Perined, formerly *Perinatale Registratie Nederland [PRN]*). The Registry contains information on pregnancy, birth, and maternal and perinatal characteristics and outcomes for 97% of all births in the Netherlands.[23] All characteristics and outcomes were recorded routinely during the entire study period, except for birth asphyxia, for which registration commenced in 2008. Perined merges data on births in primary and hospital care using a validated linkage method.[24,25]

The Perined data set did not contain information on the number of previous cesarean births in women with a parity of two or more. This hampered the assessment of vaginal births after one previous CB and one or more vaginal births. Therefore, to ensure a homogeneous group of participants, we included only women with a parity of one and a previous CB ($n = 144{,}166$; 67.8% of all women with at least one previous CB and any number of previous vaginal births who gave birth to a singleton in cephalic presentation with a gestation of at least 37 weeks). We excluded women with[1] an unknown mode of birth ($n = 858$; 0.6% of women with parity one and a previous CB) and[2] an antepartum fetal death or unknown moment of death ($n = 162$; 0.1% of women with parity one, a previous CB, and a known mode of birth) from the analysis.

## 2.5 | Outcome measures

The primary outcome was the mode of birth (intended VBAC vs. planned CB) among women with one previous CB and no previous vaginal birth. Secondary outcomes were VBAC success rates and the rate of adverse perinatal outcomes (Apgar score < 7 after 5 min, asphyxia, neonatal intensive care unit (NICU) admission of at least 24 h, and perinatal deaths up to 7 days postpartum) among women with one previous CB and no prior vaginal birth intending a VBAC compared with a planned CB.

Comprehensive definitions of intended VBAC (i.e., trial of labor after cesarean, TOLAC), VBAC success rate, NICU admission of at least 24 h, asphyxia, and perinatal mortality can be found in Appendix. In addition, maternal and perinatal characteristics are described using international definitions and cut-off values and can also be found in Table A1.

## 2.6 | Statistical analysis

We used Microsoft Excel and R for Windows version 4.1.1.[26] Descriptive statistics (i.e., frequencies and percentages for categorical data) were used, and no data were imputed as missing data was negligible (<5%).

Trends over time in the mode of birth and perinatal outcomes are depicted in graphs. For the neonatal outcomes (low Apgar score at 5 min, asphyxia, and NICU admission of at least 24 h), we excluded patients of intrapartum death ($n = 24$).

We present our data as absolute numbers and percentages without statistical analysis, as our data are population-based and do not consist of a sample that requires extrapolation.

The numbers needed to treat are calculated using the absolute risk reductions in neonatal outcomes between the intended VBAC and planned CB groups. The number needed to treat equals the inverse of the absolute risk reduction (NTT = 1/ARR).

# 3 | RESULTS

Our study population consisted of 143,146 women with one previous CB and no prior vaginal birth who gave birth to a singleton in a cephalic presentation at term over the 20-year study period. Baseline characteristics are shown in Table 1 and compare women with a planned CB to those with an intended VBAC.

The CB rate (planned and unplanned) among women with one previous CB was 52.6% ($n = 75{,}325$, 2000–2019) and increased by 18.4% in 20 years, from 45.2% in 2000 to 63.6% in 2019. Women intended a VBAC in 68.8% of patients ($n = 98{,}505$, 2000–2019). While the proportion of women intending VBAC was relatively stable until 2008, it decreased markedly from 2009 onwards (Figure 1). The average VBAC success rate was 68.9% ($n = 67{,}821$, 2000–2019) and declined from 71.0% in 2000 to 65.3% in 2019.

In general, adverse perinatal outcomes remained relatively stable from 2000 to 2019, with a slight increase in low Apgar scores and NICU admissions and a slight decrease in perinatal mortality, which stabilized from 2009 onwards (Figure 2). Contributing maternal factors could be the increasing maternal age: From 2000 to 2009, the proportion of women 35 years of age and older increased by 4.7% (to 26.9%) and 8.6% (to 34.0%) in the intended VBAC and planned CB groups, respectively.

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**TABLE 1** Maternal characteristics and perinatal outcomes in women with one previous cesarean birth (and no previous vaginal birth) who gave birth to a term singleton in cephalic presentation.

| | | Planned cesarean birth | | Intended VBAC | | Total | |
|---|---|---|---|---|---|---|---|
| | | *N* | % | *N* | % | *N* | % |
| | **Total** | **44,641** | **100** | **98,505** | **100** | **143,146** | **100** |
| Maternal age (%) | <20 years | 57 | 0.1 | 199 | 0.2 | 256 | 0.2 |
| | 20–29 years | 10,941 | 24.5 | 27,019 | 27.4 | 37,960 | 26.5 |
| | 30–34 years | 19,367 | 43.4 | 45,608 | 46.3 | 64,975 | 45.4 |
| | 35–39 years | 11,992 | 26.9 | 22,774 | 23.1 | 34,766 | 24.3 |
| | >=40 years | 2284 | 5.1 | 2890 | 2.9 | 5174 | 3.6 |
| | Unknown | 0 | 0.0 | 15 | 0.0 | 15 | 0.0 |
| Gestational age (%) | 37+0–37+6 weeks | 2933 | 6.6 | 5309 | 5.4 | 8242 | 5.8 |
| | 38+0–38+6 weeks | 14,738 | 33.0 | 13,538 | 13.7 | 28,276 | 19.8 |
| | 39+0–39+6 weeks | 19,340 | 43.3 | 24,664 | 25.0 | 44,004 | 30.7 |
| | 40+0–40+6 weeks | 4037 | 9.0 | 31,655 | 32.1 | 35,692 | 24.9 |
| | >=41+0 weeks | 3593 | 8.0 | 23,339 | 23.7 | 26,932 | 18.8 |
| Hoftiezer percentile (%)[a] | <p5 | 1098 | 2.5 | 4048 | 4.1 | 5146 | 3.6 |
| | p5-p9.9 | 1169 | 2.6 | 4517 | 4.6 | 5686 | 4.0 |
| | p10-p89.9 | 31,244 | 70.0 | 75,052 | 76.2 | 106,296 | 74.3 |
| | p90-p96.9 | 5530 | 12.4 | 7870 | 8.0 | 13,400 | 9.4 |
| | >=p97 | 5134 | 11.5 | 5204 | 5.3 | 10,338 | 7.2 |
| | Unknown | 466 | 1.0 | 1814 | 1.8 | 2280 | 1.6 |
| ***Perinatal outcomes*** | | ***N*** | **‰** | ***N*** | **‰** | ***N*** | **‰** |
| Perinatal mortality | | 24 | 0.5 | 139 | 1.4 | 163 | 1.1 |
| | Intrapartum | .[d] | 0.0 | 23 | 0.2 | .[d] | 0.2 |
| | Early neonatal (1–7 days) | 11 | 0.2 | 87 | 0.9 | 98 | 0.7 |
| | Late neonatal (8–28 days) | 9 | 0.2 | 21 | 0.2 | 30 | 0.2 |
| | After 28 days | .[d] | 0.1 | 8 | 0.1 | .[d] | 0.1 |
| Apgar score 5 min[b] | <7 | 266 | 6.0 | 1399 | 14.2 | 1665 | 11.6 |
| NICU admission ≥24 h[b] | Yes | 316 | 7.1 | 803 | 8.2 | 1119 | 7.8 |
| Asphyxia[c] | Yes | 27 | 0.8 | 155 | 2.8 | 182 | 2.1 |

*Note*: These patients are included in the perinatal mortality trend analyses.

[a]For definitions see Appendix. Rates of Apgar score, NICU admission, and asphyxia are calculated as permilles of live births; asphyxia is registered from 2008 onwards (see Appendix).

[b]For Apgar score and NICU admission total $n=143.122$; planned CB $n=44.640$; intended VBAC $n=98.482$ (2000–2019).

[c]For asphyxia, total $n=88.645$; planned CB $n=32.474$; intended VBAC $n=56.171$ (2008–2019).

[d]Exact numbers—in accordance with Perined privacy regulations—were not published due to small numbers ($n<5$).

The trends of adverse perinatal outcomes (a slight increase in low Apgar scores and NICU admissions, a stable rate of asphyxia, and a slight decrease in perinatal mortality) were similar in the intended VBAC and the planned CB groups (Figure 3). No changes were observed over time within these two modes of birth in maternal complications (e.g., gestational diabetes or pre-eclampsia) or neonates with low or high birth weight (below the 10th percentile or above the 90th percentile).

The absolute number of adverse perinatal outcomes was low but slightly higher in women intending a VBAC compared with a planned CB from 2000 to 2019. Perinatal deaths occurred in 0.05% of women with a planned CB and 0.14% intending a VBAC. Based on these proportions, 1111 women would have to undergo a planned CB instead of intending a VBAC to prevent one perinatal death.

NICU admission rates were comparable in both groups; while low Apgar scores and asphyxia were uncommon, they occurred more frequently in women intending a VBAC (Table 1 and Figure 3). To prevent one NICU admission, one low Apgar score, or one case of asphyxia,

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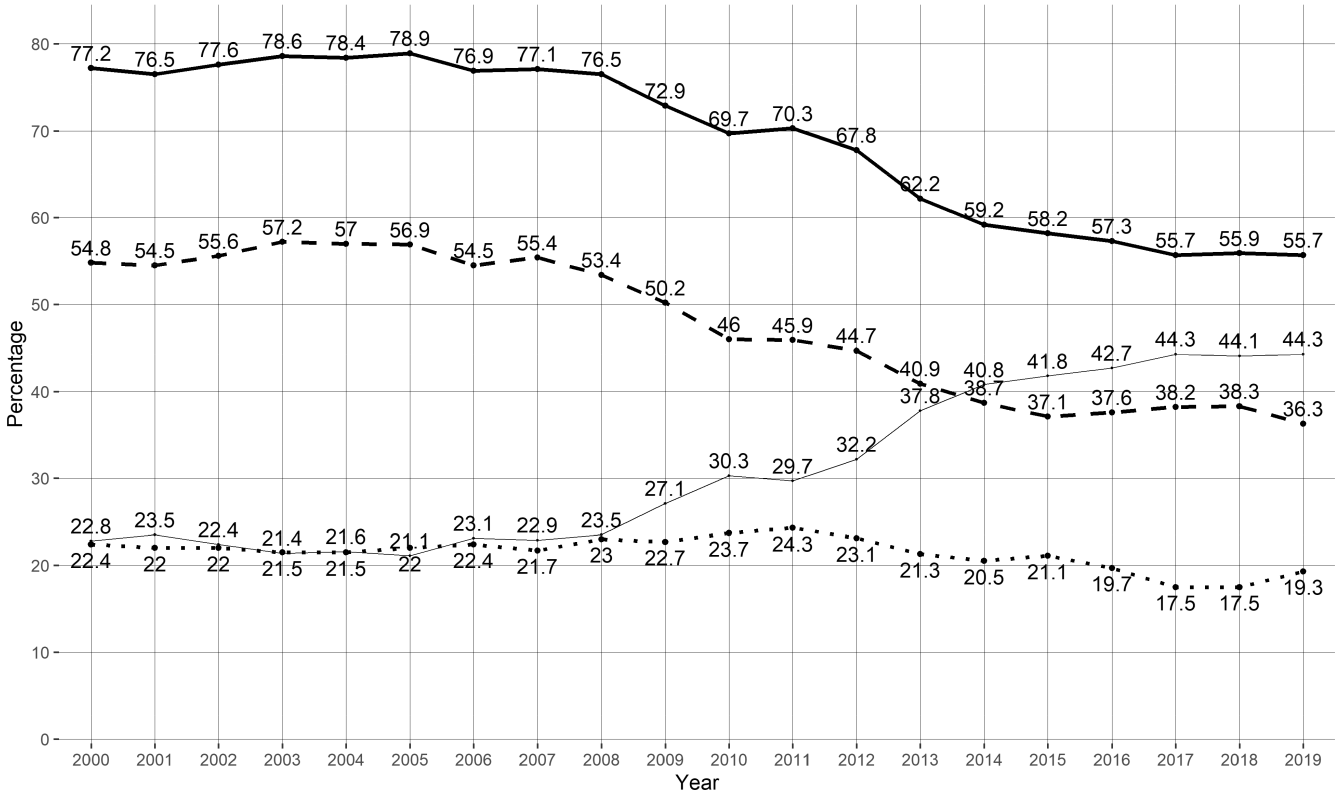


**FIGURE 1** Trends in the mode of birth in women with one previous cesarean (and no previous vaginal birth) who gave birth to a term singleton in cephalic presentation. Thick solid line = Intended VBAC; Dashed line = successful VBAC; Thin solid line = planned CB; Dotted line = unplanned CB/unsuccessful VBAC.

respectively, 909, 122, and 500 women would have to undergo a planned CB.

## 4 | DISCUSSION

### 4.1 | Main findings

The proportion of women with one previous cesarean birth and no prior vaginal birth intending a VBAC in the Netherlands was stable between 2000 and 2008, but from 2009 onwards, there was a steady and considerable decrease in VBAC attempts. Interestingly, this change in practice, with fewer women intending a VBAC and more women giving birth by planned cesarean after 2009, was not accompanied by a marked continued decrease in perinatal mortality in the second decade of the study period. Neither did the relative differences in perinatal morbidity rates change between the planned cesarean birth and the intended VBAC group.

### 4.2 | Strengths and limitations

The main strength of our study is the population-based design, which includes robust data on approximately 97% of all births in the Netherlands in the past 20 years.

Limitations are inherent in the retrospective nature of a registry set, and some underreporting and misreporting might have occurred. Especially non-mandatory items, such as maternal complications, are prone to underreporting and were therefore excluded. In addition, the registry did not include the option to analyze women with one previous CB who also had a previous vaginal birth. Finally, confounding by indication is likely to have occurred as indications for cesarean births were unknown, and high-risk pregnancies are more likely to end in planned CB. This outcome could have led to underestimating the differences in adverse neonatal outcomes. Adding to this fact, some confounding by indication is likely given that high-birthweight (≥90th percentile) neonates were more frequently born by cesarean (23.9% vs. 13.3% intended VBAC), and low-birthweight (<10th percentile) neonates were more frequently born by intended VBAC (8.7% vs. 5.1% planned CS) (Table 1).

### 4.3 | Interpretation of results

The unexpectedly large decline in intended VBAC indicates that it is less often the chosen mode of birth. The marked decrease from 2009 onwards is likely related to the publication of the EURO-PERISTAT report, which

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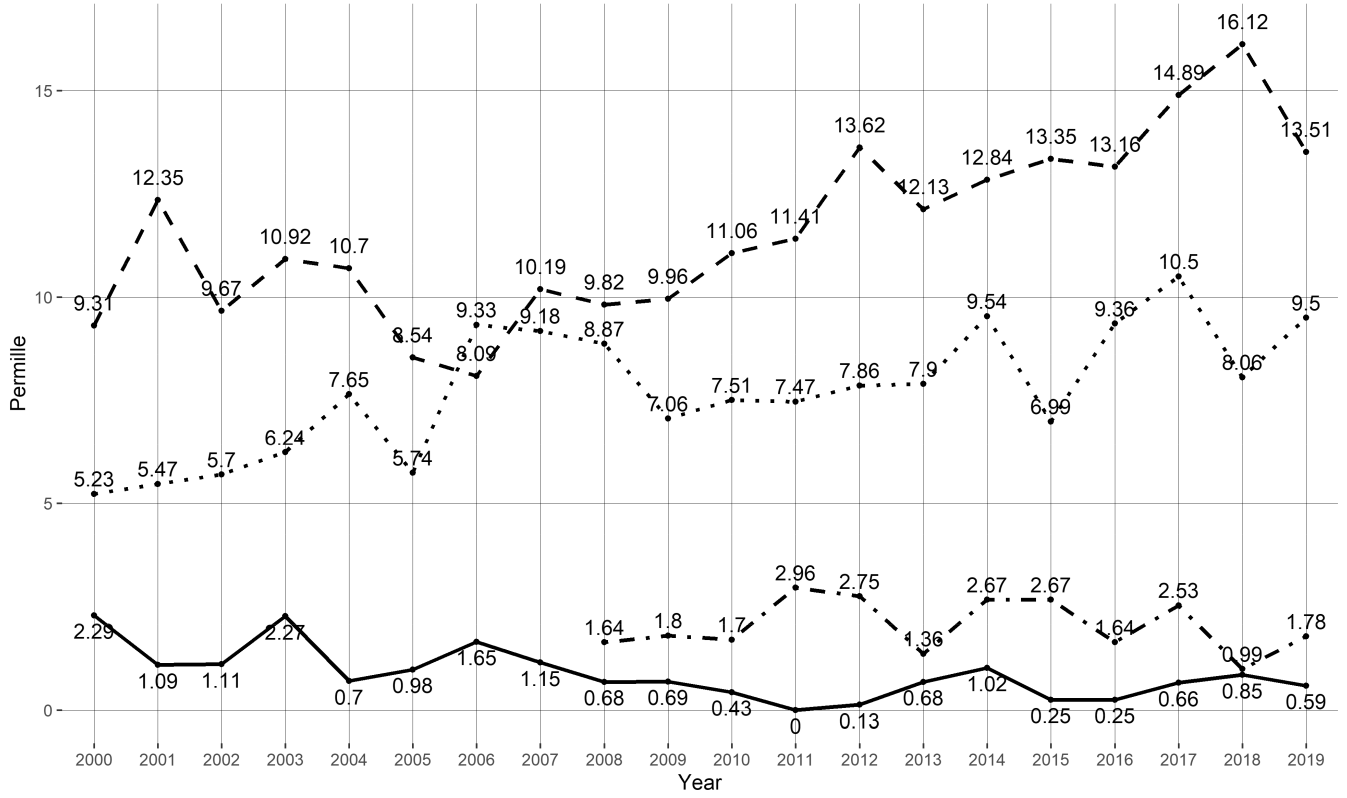


**FIGURE 2** Trends in perinatal outcomes in women with one previous cesarean (and no previous vaginal birth) who gave birth to a term singleton in cephalic presentation. Dashed line = low Apgar score; Dotted line = NICU admission ≥ 24 h; Dot-dash line = asphyxia; Solid line = early perinatal mortality up to 7 days postpartum.

showed relatively high numbers of perinatal mortality in the Netherlands compared with other European countries.[27] The report's publication was followed by the designation of a steering committee on perinatal care in 2009, which developed and implemented a perinatal mortality reduction strategy over the years. The emphasis on reducing perinatal mortality is likely to have caused more defensive obstetric practice, with clinicians attempting to minimize adverse perinatal outcomes in the short term rather than considering maternal or perinatal outcomes in subsequent pregnancies.

The trends in adverse perinatal outcomes were similar between the VBAC and the planned CB groups over the past 20 years. Although our study cannot address causality, and it is challenging to attribute value to the studied perinatal outcomes, the results of this study suggest the increase in planned CB rate has not led to a better selection of VBAC candidates, nor has it led to improved perinatal outcomes. If an increase in planned CB lowered adverse perinatal outcomes, we would expect between-group differences in adverse perinatal outcomes to have increased over time.

Perinatal outcomes are multifactorial, and although not adjusted for in our study, the increasing maternal age and increase in maternal obesity, and metabolic disorders (gestational diabetes and pre-eclampsia) worldwide with consequential fetal growth disorders are likely to contribute to the remaining differences between these groups.[28–31] In our population, we did not find trends over time in between-group differences for maternal age, birthweight, gestational diabetes, hypertension, and (pre-)eclampsia. While the offspring of women with a VBAC had consistently higher rates of perinatal mortality, low Apgar scores, and asphyxia compared with offspring born after a repeat cesarean, these outcomes must be interpreted in light of possible adverse outcomes for the woman herself and her future child(ren).[5,6,11,16,17]

Relatively fewer intended VBACs were performed without an increase in the VBAC success rate. The overall influence on the health system and rising healthcare costs related to these changes in obstetric practice must be considered. A policy aimed at providing VBAC is more cost-effective and associated with considerably lower CO2 emissions.[32]

Supporting VBAC has been suggested as a strategy to curb increasing CB rates and their adverse health consequences.[2] A recent study in Sweden demonstrated it is possible to turn the tide of decreasing VBAC within a similar obstetric culture and income setting as the Netherlands.[33] The Swedish study reported a rise in

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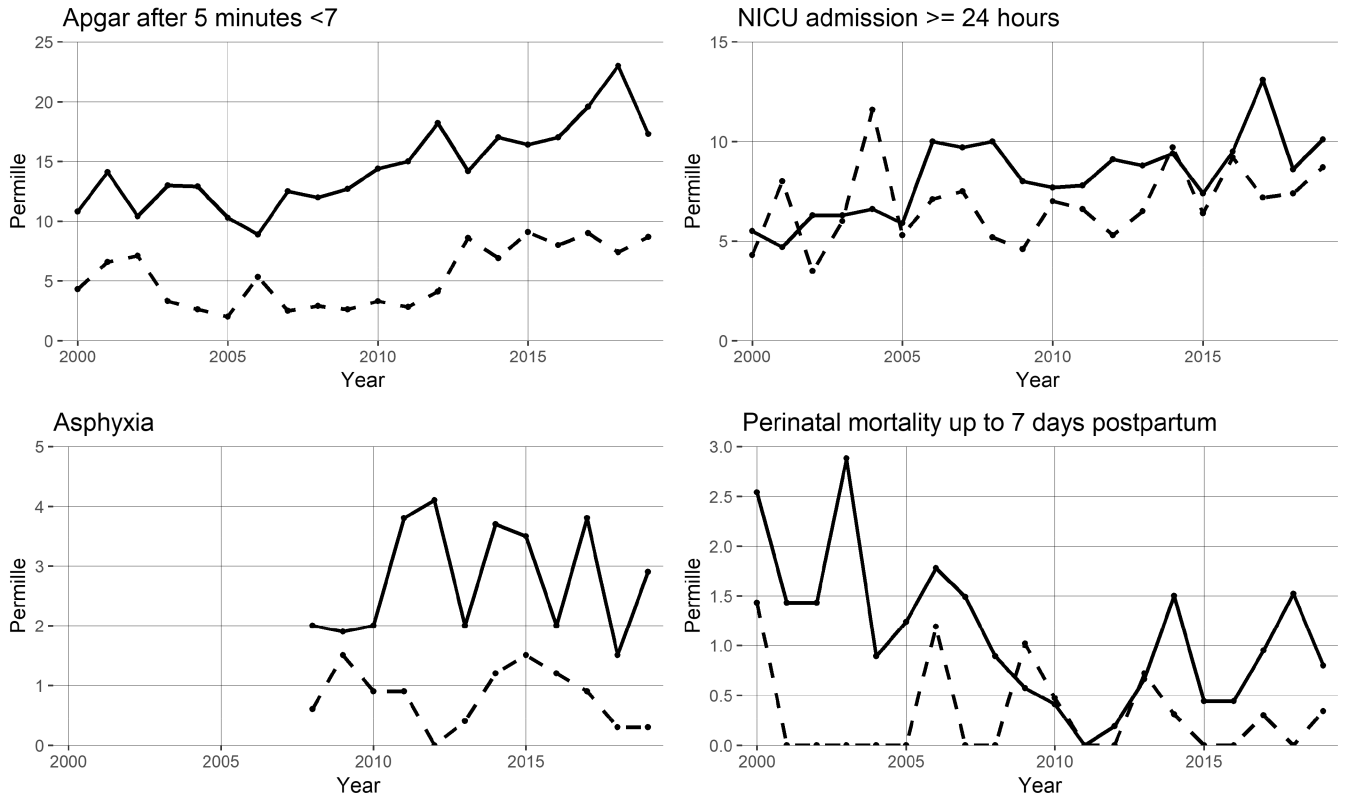


**FIGURE 3** Trends in perinatal outcomes in women with one previous cesarean (and no previous vaginal birth), who gave birth to a term singleton in cephalic presentation, and who underwent planned cesarean birth versus intended VBAC. Solid line = intended VBAC; dashed line = planned CB.

successful VBAC without an increase in adverse maternal and perinatal outcomes. The authors stated that a specialized antenatal team is the greatest contributor to the rise in successful VBAC by increasing the number of intended VBAC.[34]

In the Netherlands, a prediction model is often used for mode of birth counseling in women with one previous CB. While previous studies have demonstrated an area under the curve of 68%–71% for various VBAC success prediction models,[21] the described changes over time (less intended VBAC and no increase in VBAC success rate) have certainly undermined the validity of these models. The currently used tools to aid the decision-making process may, therefore, actually deter women and clinicians from intending VBAC. We, therefore, question whether these prediction models should be applied to the mode of birth counseling in the case of a previous CB.

If labor does not start spontaneously by 41 weeks gestation or when other obstetrical indications for birth occur, furthermore counseling is performed to choose between induction of labor or a repeat cesarean.[9] Some clinicians encourage intended VBACs but would not perform an induction of labor in this group. However, in line with the recent Swedish study, an antenatal team with experience in labor induction in women with a previous CB may allow for increased VBAC success rates.

We aim to raise awareness of the fact that there is a decrease in VBAC attempts in the Netherlands, which is not associated with improved clinical outcomes. We recommend that clinicians and policymakers contemplate the driving determinants behind the increase in CB rates and look for ways to counter this trend.

## 5 | CONCLUSIONS

In the Netherlands, the proportion of women intending a VBAC after one previous cesarean birth and no prior vaginal birth has decreased markedly from 2000 to 2019, particularly from 2009 onwards. However, this decrease was not accompanied by a synchronous reduction in perinatal mortality after that year, although perinatal morbidity remained slightly higher after VBAC compared with repeat cesarean birth. Since the increase in repeat cesarean births has the potential to negatively affect the birthing person and her future children, it is critical that clinicians and policymakers reflect on whether the ongoing rise in planned cesarean births is justified.

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None.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## APPENDIX

**TABLE A1** Definitions and calculation of items.

| Item | Definition | Description of calculation |
|---|---|---|
| Intended VBAC That is, Trial of labor after cesarean (TOLAC) | An intended vaginal birth in individuals with a uterine scar from one or multiple previous CS. | Dividing the total number of births minus the total number of planned CS by the total number of births. |
| Successful vaginal birth after cesarean (VBAC) | A successful vaginal birth after one or multiple previous CS. | Dividing the total number of births minus the total number of planned and unplanned CS by the total number of births. |
| VBAC success rate | The rate of successful VBAC. An intended VBAC results in either a vaginal birth (successful VBAC) or an unplanned cesarean section (failed VBAC). | Dividing the number of successful VBACs by the number of intended VBACs. |
| Planned CS (ERCS) | A cesarean section was considered a planned cesarean section or elective repeat cesarean section (ERCS) when no intention to give birth vaginally existed at the moment labor started. Therefore, ERCS also includes individuals with a contra-indication for vaginal birth. | – |
| Hoftiezer percentile | Based on birthweight curves designed to portray the optimal, gender-specific, birthweight for a certain gestational age based on a low-risk population.[35] | – |
| NICU admission of at least 24 h | A child was hospitalized for at least 24 h at a neonatal intensive care unit (NICU). | Combining NICU admission and a length of stay at an IC unit of at least 24 h. |
| Asphyxia | Conform to the definition used in the (executive summary of) the neonatal encephalopathy and neurologic outcome report.[36] | Asphyxia is registered as a diagnosis by the pediatrician or mentioned in the letter of discharge from the pediatrician; information about asphyxia is only available from 2008 onwards. |
| Perinatal death | A stillbirth (≥24 weeks of gestation) or an early neonatal death (within 7 days of birth). | To calculate the number of early perinatal deaths (up to 7 days postpartum after birth), intrapartum mortality, neonatal mortality within 24 h, and neonatal mortality between 1 and 7 days postpartum were combined. |

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