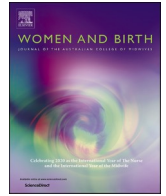




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Vaginal birth after caesarean section before and during COVID-19 pandemic. Factors associated with successful vaginal birth

P. Hidalgo-Lopezosa^{a,b,c,*}, A.M. Cubero-Luna^{a,b,c}, J. Huertas-Marín^{a,b,c},
M. Hidalgo-Maestre^{b,c}, A.J. De la Torre-González^{b,c}, M.A. Rodríguez-Borrego^{a,b,c}, P.
J. López-Soto^{a,b,c}

^a Maimónides Institut of Biomedic Research of Córdoba (IMIBIC), Avda. Menéndez Pidal s/n, 14004 Córdoba, Spain

^b Department of Nursing, Pharmacology and Physiotherapy, University of Córdoba, Avda. Menéndez Pidal s/n, 14004 Córdoba, Spain

^c University Hospital Reina Sofia, Avda. Menéndez Pidal s/n, 14004 Córdoba, Spain

ARTICLE INFO

Keywords:

Vaginal birth after caesarean
Birth
Caesarean section
COVID-19

ABSTRACT

Background: The ratio of caesarean has been increasing considerably in many countries. Planning a vaginal birth after a previous caesarean is considered an important option for women in a subsequent pregnancy.

Aims: To analyse obstetric and neonatal outcomes in women in labour after caesarean section before and during the COVID-19 pandemic, and to determine factors associated with successful vaginal birth after caesarean (VBAC).

Methods: Observational cohort study of women in labour with history of caesarean section who gave birth between March 2019 and December 2020 in a tertiary hospital in southern Spain. Consecutive sampling was performed using the maternal birth database and a descriptive and inferential analysis of the study variables was carried out. Socio-demographic, obstetric and neonatal variables were compared between the pre-pandemic and pandemic periods. Multiple logistic regression analysis was performed to determine variables associated with VBAC success.

Findings: The VBAC success rate was 67.4%. The caesarean section rate was significantly higher during the COVID-19 pandemic period. Factors associated with VBAC success were: birth before the pandemic (OR 0.32) and at night (OR 0.45), use of epidural analgesia (OR 2.14), and having had a previous vaginal birth (OR 1.98).

Conclusions: The success rate of VBAC was lower during the pandemic. Knowledge of the factors related to VBAC success is critical for practitioners when supporting women in decision-making about mode of birth after a previous caesarean section.

Statement of significance

Problem

The Covid-19 pandemic may have affected the obstetric and neonatal outcomes of women planning a VBAC.

What is already known?

Vaginal birth after caesarean (VBAC) seems to be a good option in women with a history of caesarean section, but it is not without risk. The VBAC success rate is around 70%, although with

significant variations. Several factors can influence this success.

What this paper adds?

The influence of Covid-19 pandemic on VBAC success and a better understanding of the factors affecting VBAC success.

1. Introduction

Caesarean section is the most common obstetric surgical operation in developed societies, as it is considered the safest procedure to resolve

* Corresponding author at: Facultad de Medicina y Enfermería, Avenida Menéndez Pidal s/n, CP 14004 Córdoba, Spain.

E-mail addresses: phlopezosa@uco.es, phlopezosa@gmail.com (P. Hidalgo-Lopezosa), z92culua@uco.es (A.M. Cubero-Luna), n22humaj@uco.es (J. Huertas-Marín), n12himam@uco.es (M. Hidalgo-Maestre), ajesus.torre.sspa@juntadeandalucia.es (A.J. De la Torre-González), en1robom@uco.es (M.A. Rodríguez-Borrego), n82losop@uco.es (P.J. López-Soto).

<https://doi.org/10.1016/j.wombi.2021.12.008>

Received 10 October 2021; Received in revised form 25 November 2021; Accepted 22 December 2021

Available online 24 December 2021

1871-5192/© 2021 The Author(s). Published by Elsevier Ltd on behalf of Australian College of Midwives. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

complications of vaginal birth and maintain foetal wellbeing [1,2]. However, the ratio of caesarean has been increasing considerably in developed countries, with general figures of around 20–25%, far above some institutions recommendations, which considers a threshold of 10–15% to be appropriate for the caesarean section rate [3]. The WHO recognises that caesarean section rates above 10% are not associated with a reduction in maternal and neonatal mortality rates and may lead to certain complications and disabilities [4,5]. For women planning a VBAC there is a risk of uterine rupture, which is associated with increased maternal and neonatal morbidity and mortality and a high perinatal mortality rate [6]. The risk of uterine rupture in women planning a VBAC is approximately 0.5% [7,8], while the risk of uterine rupture associated with elective repeat caesarean (ERC) is 0.03%, although risk rates of less than 0.02% have been found [8,9].

According to the European Perinatal Health Report (2015), the caesarean section rate in Spain for that year was 24.6%, with Cyprus being the country in Europe with the highest rate of caesarean sections, at 57%, while countries such as Finland, Iceland, Norway and the Netherlands maintain the lowest and most stable rates of caesarean sections [10]. Globally, many countries exceed the 50% caesarean section rate, especially in developing countries [11].

A woman with a history of a previous caesarean section has two options for the next birth, either to attempt a vaginal birth, or to schedule an ERC [12,13]. Attempting vaginal birth after caesarean (VBAC) appears to be the right choice for women who have no history of contraindications [14], as it is associated with shorter hospital stay, less blood loss, lower transfusion rate, lower risk of infection and lower risk of thromboembolism than ERC, whose risks exceed those of first caesarean section [9,15]. The VBAC rate vary in Europe, the north Europe has a VBAC rate of 45–55%, and in the rest of Europe this rate is 29–36% [16].

Success rates of VBAC vary among studies; however, many agree on a figure of over 70%, although there may be factors influencing this variation [7,8,17], such as a high body mass index, no previous spontaneous birth, or foetal distress as a caesarean indication [17]. A better understanding of the factors that affect the success of VBAC, as well as the risks associated with its practice, may make the decision easier for those women with a history of caesarean section who are candidates for a vaginal birth with a high likelihood of success and minimal risk of complications [7,8].

The COVID-19 pandemic has led to major changes in health systems in general, and in particular in obstetric services, which have also suffered from the consequences of the pandemic, including resource shortages [18] or interruptions in both prenatal and inpatient care [19]. These changes may have caused restriction of some procedures necessary for a good obstetric outcome and may have increased neonatal morbidity rates [20]. As this is a new infection, evidence about its consequences and management is still scarce, although it is known that women with Covid-19 are more likely to suffer serious complications [21]. In fact, Covid-19 infection in pregnant women has been associated with increased maternal and neonatal morbidity [22] and has especially been linked to an increased risk of preterm birth, as well as increased foetal mortality [23,24]. On the other hand, the results of studies on the relationship between Covid-19 infection and the type of birth are contradictory: although some studies found there was no difference in the rate of caesarean sections between the pre-pandemic and pandemic periods [25,26], others did find this association [27].

The aim of this study was to analyse obstetric and neonatal outcomes in women in labour after caesarean section and how these were related to the Covid-19 pandemic, and to determine factors associated with successful vaginal birth after caesarean (VBAC).

2. Methods

2.1. Study design and population

An observational cohort study was conducted using the medical records of women with a history of caesarean section who gave birth between March 2019 and December 2020 in a tertiary hospital in southern Spain.

2.2. Sample and inclusion criteria

Women were selected from the study hospital database using consecutive sampling. A total of 276 women (5% of the total women who gave birth during the study period) with a history of caesarean birth were included in the study. The inclusion criteria were women with one previous caesarean and low transverse uterine incision who had undergone trial of labour with a single foetus in cephalic presentation. Women with high-risk pregnancies were excluded. Based on the birth date, women who gave birth from March 2019 to February 2020 were included in the pre-pandemic period, while those who gave birth from March 2020 to December 2020 were included in the pandemic period.

2.3. Study variables

The sociodemographic variables were maternal age and period of labour (pre-pandemic/pandemic); the obstetric variables were gestational age (weeks), parity, history of vaginal birth, onset of labour (spontaneous/induced), use of oxytocin during labour, preterm rupture of membranes, artificial rupture of membranes, epidural analgesia, use of pethidine, presence of group B streptococcus (GBS), time of birth, maternal intrapartum fever ($\geq 38^\circ\text{C}$), duration of first stage of labour (h), cause of previous caesarean section, type of birth (normal/instrumental/caesarean), episiotomy, grade III-IV tear, uterine rupture and postpartum haemorrhage (>500 ml after birth); the neonatal variables were type of newborn (NB) resuscitation (basic/advanced), intrapartum stillbirth, Apgar at 1 and 5 min, umbilical cord arterial pH, NB weight, NB admission, NB sex, early skin-to-skin contact and early breastfeeding (within 2 h after birth).

2.4. Data analysis

The data analysis was carried out using the SPSS/PASW Statistic version 25 programme. A descriptive analysis of the variables was carried out, expressing categorical variables as number (n) and percentage (%), and quantitative variables were expressed as mean and standard deviations (SD). Subsequently, an inferential analysis was carried out using the Chi-square statistic, Fisher's exact test, and Student's t -test statistics. An error α of 5% ($p \leq 0.05$) was assumed and the exact p -values for each statistic were shown. Finally, a multiple logistic regression analysis (MLR) was carried out to determine the variables associated with successful vaginal birth after caesarean section, for which the dependent variable was considered to be having achieved a vaginal birth. For this purpose, we first performed a univariate analysis by calculating the crude OR and 95% confidence interval and then an adjusted analysis with the independent variables that showed greater significance. The Wald statistic was used to determine the effect of each covariate, considering those with a p -value < 0.05 as significant.

2.5. Procedure

The model of care of the Andalusian public health service, adopted by the study hospital, is based on coordination and continuity of care between the different levels of care. When a woman is admitted in labour, she is attended by a midwife, who is in charge of her process until two hours after the birth if this process goes normally. The midwife informs the obstetrician about the labour progress, and the obstetrician

intervenes if any complications arise.

2.6. Ethical considerations

This project was submitted to and approved by the Provincial Research Ethics Committee. All data were treated anonymously and confidentially.

3. Results

The descriptive analysis showed that the mean age of the women in the sample ($N = 276$) was 33.09 (± 5.34) years, with a minimum age of 18 years and a maximum age of 49 years. Of the total sample, 96 subjects (34.8%) belonged to the pre-Covid-19 period and 180 subjects (65.2%) to the pandemic period. The gestational age of the sample ranged from 28 to 42 weeks, with a mean of 39 (± 1.87) WG (weeks of gestation). Regarding obstetric history, 26.4% of the pregnant women had had a previous vaginal birth in addition to the previous caesarean section. The time elapsed between the current birth and the previous caesarean section ranged from one to seventeen years, with a mean of 4.71 (± 2.5) years. In the current birth, 77.4% of the women used epidural analgesia, while the remaining 22.6% delivered without epidural analgesia. Only 26.5% used pethidine (Dolantine®) as a pharmacological method of pain relief, regardless of the subsequent requirement for other analgesia.

Sixty-five percent went into labour spontaneously, while 34.3% went into labour through an induction process. Forty-nine percent had a normal birth, 18.1% in an instrumental birth (vacuum extraction in 10.9% and forceps in 7.2%), and 32.6% in caesarean section; all in all, 50.7% of births ended in dystocia, either instrumental births or by caesarean section, with the main reason for instrumental birth being the risk of foetal compromise (14.1%). The percentage of successful vaginal birth after caesarean section was 67.4%. Intrapartum oxytocin was required in 52.3% of the cases and not in the remaining 47.7%. Early amniotomy was performed in 35.9%. The duration of the first stage of labour ranged from less than 1 h to 17 h, with a mean of 5.56 (± 4.07) h.

In terms of maternal morbidity, 0.7% had uterine rupture, 1.1% had postpartum haemorrhage, episiotomy was performed in 26.1% and severe tears (type III-IV) occurred in 0.7%. Retention of placenta and amniotic membranes occurred in 1.1%. Anaemia during the puerperium occurred in 17.4% and puerperal fever in 1.1%. Of the two cases of uterine rupture, both women had 41 weeks gestation, epidural analgesia, induction of labour with prostaglandin and oxytocin, birth occurred at night, the children were born alive although they needed resuscitation. Both mothers recovered well after birth.

Considering neonatal variables, 5.8% of the newborns had an Apgar below 7 at 1 min of life and only 1.8% had an Apgar less than 7 at 5 min. Of the newborns, 0.7% ($n = 2$) died during the birth process, both during Covid-19 pandemic period, with induction of labour, 37 weeks'

Table 1
Differences in obstetric and neonatal outcomes according to the Covid-19 pandemic.

		Pre-pandemic $N = 96$ n (%)	Pandemic $N = 180$ n (%)	p	OR	
Start of labour	Spontaneous	63 (65.6)	117 (65.7)	0.986	0.99	0.59–1.67
	Induced	33 (34.4)	61 (34.3)			
Type of birth	Vaginal	80 (83.3)	106 (58.9)	<0.001	3.49	1.89–6.44
	Caesarean	16 (16.7)	74 (41.1)			
Dystocic birth	No	74 (77.1)	62 (34.4)	<0.001	6.40	3.63–11.28
	Yes	22 (22.9)	118 (65.6)			
Use of oxytocin	No	53 (57.0)	73 (42.7)	0.026	1.78	1.06–2.96
	Yes	40 (43.0)	98 (57.3)			
Start of labour	Spontaneous	63 (65.6)	117 (65.7)	0.986	0.99	0.59–1.67
	Induced	33 (34.4)	61 (34.3)			
Epidural	No	17 (18.1)	45 (25)	0.192	0.66	0.35–1.23
	Yes	77 (81.9)	135 (75)			
Duration 1st phase (h) ^a		5.41 (4.04)	5.64 (4.10)	0.652	0.51	–1.24–0.78
Intrapartum fever	No	92 (95.8)	170 (94.4)	0.777	1.35	0.41–4.43
	Yes	4 (4.2)	10 (5.6)			
Postpartum haemorrhage	No	94 (97.9)	179 (99.4)	0.278	0.26	0.02–2.93
	Yes	2 (2.1)	1 (0.6)			
Uterine rupture	No	95 (99.0)	178 (99.4)	1.000	0.53	0.03–8.62
	Yes	1 (1.0)	1 (0.6)			
Presence of GBS	No	80 (89.9)	152 (88.9)	0.805	1.11	0.48–2.56
	Yes	9 (10.1)	19 (11.1)			
PROM	No	25 (28.1)	74 (43.3)	0.017	0.51	0.29–0.89
	Yes	64 (71.9)	97 (56.7)			
Amniotomy	No	64 (71.9)	97 (56.7)	0.017	1.95	1.12–3.39
	Yes	25 (28.1)	74 (43.3)			
pH value	$\leq 7, 20$	16 (16.7)	38 (21.1)	0.375	1.34	0.68–2.66
	$> 7, 20$	80 (83.3)	142 (78.9)			
Apgar 1 min	< 7	2 (2.1)	14 (7.8)	0.054	3.96	0.88–17.2
	≥ 7	94 (97.9)	166 (92.2)			
Apgar 5 min	< 7	0 (0.0)	5 (2.8)	0.167	1.58	0.94–3.34
	≥ 7	96 (100.0)	175 (97.2)			
Intrapartum foetal death	No	96 (100.0)	178 (98.9)	0.545	0.65	0.59–0.70
	Yes	0 (0.0)	2 (1.1)			
Early breastfeeding	No	30 (34.9)	69 (40.8)	0.357	0.77	0.45–1.33
	Yes	56 (65.1)	100 (59.2)			
Episiotomy	No	72 (75.0)	132 (73.3)	0.764	1.09	0.61–1.92
	Yes	24 (25.0)	48 (26.7)			
Tear 3–4	No	96 (100)	178 (98.9)	0.545	0.65	0.59–0.70
	Yes	0 (0)	2 (1.1)			

GBS: Group B streptococcus; PROM: preterm rupture of membranes.

^a Data are mean (\pm standard deviation).

Table 2
Factors associated with the success of vaginal delivery after caesarean section.

Variable	Success of vaginal delivery after caesarean			Analysis	
	n (%) (95%)	Univariate p	OR crude CI	Multivariate p	OR adjusted CI (95%)
Maternal age (years) ^a	33.09 (±5.34)	0.844	1.01 (0.95–1.05)		
Gestational age(week) ^a	39 (±1.87)	0.927	1.01 (0.88–1.15)		
Start of birth					
Spontaneous	180 (65.7)	0.300	0.75 (0.44–1.28)		
Induced	94 (34.3)				
Use of oxytocin	138 (52.3)	0.047	0.58 (0.34–1.99)		
PROM	161 (61.9)	0.025	1.84 (1.08–3.14)		
Amniotomy	99 (38.1)	0.025	0.54 (0.31–0.92)		
Epidural analgesia	212 (77.4)	0.043	1.82(1.02–3.26)	0.020	2.14 (1.12–4.06)
Presence of GBS	28 (10.8)	0.228	0.61 (0.27–1.36)		
Intrapartum fever	14 (5.1)	0.799	0.86 (0.28–2.65)		
Time of birth					
Night (midnight–8.00)	74 (26.8)	0.020	0.47 (0.25–0.89)	0.017	0.45 (0.23–0.86)
Day (8.01–23:59)	202 (73.2)				
Pandemic period					
Pre-Covid	96 (34.8)	0.304	1.07 (0.94–1.22)	0.000	0.32 (0.17–0.60)
Covid-19	180 (65.2)				
Time since PC (years) ^a	4.71 (±2.59)	0.998	1.00 (0.90–1.11)		
History of vaginal birth	72 (26.1)	0.050	1.85 (1.01–3.41)	0.044	1.98 (1.02–3.86)
Weight of newborn (g) ^a	3292 (±501)	0.079	1.00 (0.99–1.01)		
Sex of newborn					
Boy	153 (55.4)	0.067	0.61 (0.36–1.03)		
Girl	123 844.6)				

GBS: Group B streptococcus; PC: previous caesarean. PROM: preterm rupture of membranes.

^a Data are mean (±standard deviation).

gestation, epidural analgesia, after advanced resuscitation, and mothers aged 32 and 42. Six percent required admission to the neonatal unit and 37.6% required paediatric assistance in the birth room. Fifty-three percent of the paediatric assistance in the birth room was associated with instrumental birth or caesarean section. Seventy-eight percent of the newborns were still breastfed at the time of discharge, 20.7% were formula-fed and 0.7% were fed with a combination of the two. Breast-feeding was initiated in the first two hours of life in 61.2% of the newborns.

The results show a higher VBAC success rate in the pre-pandemic period than in the pandemic period (83.3% versus 58.9%, $p < 0.001$), while the caesarean section rate was significantly higher in the pandemic period (41.1% versus 16.7%, $p < 0.001$). The rate of dystocia and instrumental and caesarean births was higher during the pandemic period (77.1% versus 34.4%; OR 6.40 95%CI: 3.63–11.28, $p < 0.001$). Oxytocin use during labour was also significantly higher in the pandemic period than in the pre-pandemic period (57.3% versus 43%; OR 1.78 95%CI:1.06–2.96; $p = 0.026$). Another variable with statistically significant differences was the premature rupture of membranes, with a lower rate during the pandemic period (56.7% versus 71.9%; OR: 0.51 95%CI: 0.29–0.89; $p = 0.017$). Similarly, a higher rate of amniotomy or artificial rupture of membranes was found during the pandemic period. The data are shown in Table 1.

The MLR analysis (Table 2) showed that factors associated with VBAC success were: birth during pre-pandemic period Covid-19, as there was a higher proportion of vaginal births in the pre-pandemic period and higher risk of caesarean births in the pandemic period ($p < 0.001$, OR 0.32 95%CI 0.17–0.60); birth at night ($p = 0.017$, OR 0.45 95%CI 0.23–0.86), with a higher proportion of vaginal births from midnight to 8.00 a.m. (78% versus 63%) and a higher risk of caesarean section during daylight hours (21.6% versus 36.6% caesarean sections, $p = 0.018$); the use of epidural analgesia, which was associated with a higher proportion of vaginal births ($p = 0.020$, OR: 2.14, 95%CI 1.12–4.06); and having had a previous vaginal birth ($p = 0.044$, OR:1.98 95%CI 1.02–3.86).

4. Discussion

The results obtained should be taken with caution due to the limitations of this study, including the heterogeneity of the professionals who record data in the medical records, which could distort some variables and may even cause data loss. In addition, it should be noted that the study was carried out in a single hospital, albeit covering a wide area of the province.

In the present study the success rate for VBAC was 67.4%, which represents the percentage of women who managed to deliver vaginally, regardless of whether instrumentation was required or not. Currently, most studies consider a VBAC success rate between 60% and 80% as high [28], while this figure is higher for women who have had a previous vaginal birth, in which case the success rate may exceed 80% [7,8,29]. A history of previous vaginal birth was found to be a factor associated with success. Thus, Mercer et al. concluded that a history of previous vaginal birth is the best predictor of successful VBAC [30]. The success rate can drop to as low as 40% for certain factors such as induction of labour, high BMI, high foetal weight or pelvic-cephalic disproportion [7,8,28]. Landon et al. established a success rate of 80% for spontaneous vaginal birth versus 68% for induced vaginal birth [31]. In the present study, no evidence was found to link the success of VBAC to the onset of labour.

Another factor associated with the success of VBAC in this study was the use of epidural analgesia during labour. Some authors also found that the success rate of VBAC is increased when this type of analgesia is used, and that its use is not associated with increased risk of uterine rupture or greater adverse outcomes in the mother or child [32]. However, it should be noted that the two cases of uterine rupture in this study occurred when epidural analgesia was used, although the differences were not significant.

The results of this study showed an increased rate of caesarean section during the pandemic period, which also coincided with an increased use of intrapartum oxytocin. Many studies link the use of oxytocin with shorter duration of labour, increased risk of caesarean section and instrumental birth, while it may also negatively affect foetal wellbeing,

reducing the rate of successful vaginal birth [29,30,33,34]. Here, our study evidenced a lower success rate for VBAC during the Covid-19 pandemic period. In this regard, a systematic review by Cuñarro Lopez et al. found a 10% increase in the rate of caesarean section compared to previous years [35], while another study in Spain by Carrasco et al. showed that the percentage of caesarean sections rose during the pandemic period [36]. Other authors also found similar results [27], although in some studies no difference in caesarean section rates were found between the pre-pandemic and pandemic periods [25,26]. Among the possible causes of this increase in the caesarean section rate may be the fact that caesarean section was considered a safer, quicker alternative to protect mother and child from the possible effects of the infection. However, a study by Martínez Pérez et al. found that caesarean sections increased the risk of complications in pregnant women affected by coronavirus, with 21.6% of pregnant women showing clinical deterioration after caesarean section compared to 4.9% of those who completed vaginally [37]. Our findings do not show increased maternal-neonatal morbidity, although Covid-19 infection has been associated with increased maternal morbidity and mortality in the third trimester of pregnancy, with higher rates of hospital admission to the ICU [38], in addition to an increase in prematurity [37,39,40] and more admissions to the neonatal ICU [40].

5. Conclusions

In conclusion, the overall success rate of VBAC was significant, at 67.4%, while there were major differences according to the Covid-19 pandemic, with a higher rate before the pandemic (83%) than during the pandemic (59%). The factors associated with success were having had a previous vaginal birth, birth taking place during the night, use of epidural analgesia, and birth taking place before the Covid-19 pandemic. The use of oxytocin appears to be associated with lower success rates.

Knowledge of the factors related to VBAC success is critical for practitioners when supporting women in decision-making about mode of birth after a previous caesarean section, and thus to avoid possible adverse effects and to achieve the best outcomes for mother and baby. More research is needed on factors that may affect the success of VBAC.

Authors' contribution

The first author conceived the idea of this study, performed the study design and data analysis, and drafted the manuscript. One co-author contributed to data extraction, data analysis and manuscript writing. Other co-author contributed to data extraction and review the data analysis. Other co-author contributed to manuscript writing and data extraction. Other co-author contributed to interpretation of the data and revised the manuscript for important intellectual content. Other co-author contributed to review the methodology and the interpretation of the data. Other co-author contributed to interpretation of the data and revised the manuscript for important intellectual content. All authors approved the final version of the manuscript and accept responsibility for the paper.

Authors' agreement stating

This article is the authors original work, and it has not received prior publication and is not under consideration for publication elsewhere; all authors have seen and approved the manuscript being submitted; the authors abide by the copyright terms and conditions of Elsevier and the Australian College of Midwives.

Ethical statement

This project was submitted to and approved by the Provincial Research Ethics Committee. All data were treated anonymously and

confidentially.

Funding

None declared.

Conflict of interest

None declared.

References

- [1] and the WHO Working Group on Caesarean Section, A.P. Betran, M.R. Torloni, J. Zhang, A.M. Gülmezoglu, WHO statement on caesarean section rates, *BJOG* 123 (2016) 667–670.
- [2] M. Lugones Botell, La cesárea en la historia, *Rev. Cubana Obstet. Ginecol.* 27 (1) (2021). Available from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0138-600X2001000100009 (Accessed 20 January).
- [3] Sociedad Española de Obstetricia y Ginecología (SEGO), Cesárea. Guía Práctica de asistencia. Prosego [Internet], 2015. Available from: <http://www.prosego.com/wp-content/uploads/2015/04/Ces-rea-2015-2.pdf> (Accessed 10 December 2020).
- [4] World Health Organization (WHO), Appropriate technology for birth, *Lancet* 2 (1985) 436–437.
- [5] Organización Mundial de la Salud (OMS), Declaración de la OMS sobre la tasa de cesáreas. Resumen ejecutivo. Departamento de Salud Reproductiva e Investigación, OMS, 2015. Available from: https://apps.who.int/iris/bitstream/handle/10665/161444/WHO_RHR_15.02_spa.pdf;sequence= (Accessed 10 December 2020).
- [6] D.L.A. Thisted, L.H. Mortensen, L. Hvidman, L. Krebs, Operative technique at caesarean delivery and risk of complete uterine rupture in a subsequent trial of labour at term. A registry case-control study, *PLoS ONE* (2017) 12, <https://doi.org/10.1371/journal.pone.0187850>.
- [7] P. Reif, C. Brezinka, T. Fischer, P. Husslein, U. Lang, A. Ramoni, et al., Labour and childbirth after previous caesarean section: recommendations of the Austrian Society of Obstetrics and Gynaecology (OEGGG), *Geburtshilfe Frauenheilkd* 76 (12) (2016) 1279–1286.
- [8] V.S. Talaulikar, S. Arulkumaran, Vaginal birth after caesarean section, *Obstet. Gynaecol. Reprod. Med.* 25 (7) (2015) 195–202.
- [9] J.M. Guise, K. Eden, C. Emeis, M.A. Denman, N. Marshall, R. Fu, in: *Quality AfHRA (Ed.), Vaginal Birth After Cesarean: New Insights. Evidence Report/Technology Assessment No. 191*, National Institutes of Health Consensus Conference, Rockville (MD), 2010.
- [10] Euro-Peristat Project. European Perinatal Health Report, Core Indicators of the Health and Care of Pregnant Women and Babies in Europe in 2015, November 2018. Available from: www.europeristat.com (Accessed 16 December 2020).
- [11] Organisation for Economic Cooperation and Development (OECD), *Health at a Glance 2019: OECD Indicators*, OECD Publishing, Paris, 2019.
- [12] B.-O. Committee on Practice, Practice bulletin no. 184: vaginal birth after caesarean delivery, *Obstet. Gynecol.* 130 (2017) e217–e233.
- [13] M. Ram, L. Hirsch, E. Ashwal, D. Nassie, A. Lavie, Y. Yogeve, et al., Trial of labor following one previous caesarean delivery: the effect of gestational age, *Arch. Gynecol. Obstet.* 297 (2018) 907–913.
- [14] American College of Obstetricians and Gynecologists (ACOG), ACOG practice bulletin: vaginal birth after previous caesarean delivery: clinical management guidelines, *Int. J. Gynecol. Obstet.* 54 (2004) 197–204.
- [15] Williams Obstetrics, *Prior Cesarean Delivery*, 2nd ed., McGraw-Hill, 2007 (Chapter 26).
- [16] N. Euro-Peristat, EUROPEAN PERINATAL HEALTH REPORT Health and Care of Pregnant Women and Babies in Europe in 2010, 2010.
- [17] A. Lazarou, M. Oestergaard, J. Netzl, J.P. Siedentopf, W. Henrich, Vaginal birth after caesarean (VBAC): fear it or dare it? An evaluation of potential risk factors, *J. Perinat. Med.* 49 (7) (2021) 773–782, <https://doi.org/10.1515/jpm-2020-0222>.
- [18] G.J. Melman, A.K. Parlikad, E.A.B. Cameron, Balancing scarce hospital resources during the COVID-19 pandemic using discrete-event simulation, *Health Care Manag. Sci.* 9 (2021) 1–19.
- [19] A. Khalil, P. von Dadelszen, T. Draycott, A. Ugwumadu, P. O'Brien, L. Magee, Change in the incidence of stillbirth and preterm delivery during the COVID-19 pandemic, *JAMA* 324 (2020) 705–706.
- [20] A.O. Docea, A. Tsatsakis, D. Albulescu, O. Cristea, O. Zlatian, M. Vinceti, et al., A new threat from an old enemy: re-emergence of coronavirus (Review), *Int. J. Mol. Med.* 45 (2020) 1631–1643.
- [21] K.M. Moore, M.S. Suthar, Comprehensive analysis of COVID-19 during pregnancy, *Biochem. Biophys. Res. Commun.* 538 (2021) 180–186.
- [22] A. Lankford, J. Berger, I. Benjenk, A. Jackson, H. Ahmadzia, M. Mazzeffi, Outcomes of cesarean delivery in obstetric patients with SARS-CoV-2 infection [published online ahead of print, 2021 Sep 12], *Int. J. Gynaecol. Obstet.* (2021), <https://doi.org/10.1002/ijgo.13927>.
- [23] T.D. Metz, R.G. Clifton, B.L. Hughes, G. Sandoval, G.R. Saade, W.A. Grobman, et al., Disease severity and perinatal outcomes of pregnant patients with coronavirus disease 2019 (COVID-19), *Obstet. Gynecol.* 137 (4) (2021) 571–580.
- [24] J. Allotey, E. Stallings, M. Bonet, M. Yap, S. Chatterjee, T. Kew, et al., Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus

- disease 2019 in pregnancy: living systematic review and meta-analysis, *BMJ* 370 (2020) m3320.
- [25] K. Noddin, D. Bradley, A. Wolfberg, Delivery outcomes during the COVID-19 pandemic as reported in a pregnancy mobile application: retrospective cohort study [published online ahead of print, 2021 Aug 24], *JMIR Pediatr. Parent.* (2021), <https://doi.org/10.2196/27769>.
- [26] N.H. Greene, S.J. Kilpatrick, M.S. Wong, J.A. Ozimek, M. Naqvi, Impact of labor and delivery unit policy modifications on maternal and neonatal outcomes during the coronavirus disease 2019 pandemic, *Am. J. Obstet. Gynecol. MFM* 2 (4) (2020) 100234.
- [27] R. Khoury, P.S. Bernstein, C. Debolt, J. Stone, D.M. Sutton, L.L. Simpson, et al., Characteristics and outcomes of 241 births to women with severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection at five New York City medical centers, *Obstet. Gynecol.* 136 (2) (2020) 273–282.
- [28] Y. Wu, Y. Kataria, Z. Wang, W.K. Ming, C. Ellervik, Factors associated with successful vaginal birth after a cesarean section: a systematic review and meta-analysis, *BMC Pregnancy Childbirth* 19 (1) (2019) 360.
- [29] C. Quesnel García-Benítez, M.J. López-Rioja, D.E. Monzalbo-Núñez, Parto después de cesárea ¿una opción segura? *Ginecol. Obstet. Mex.* 83 (2015) 69–87.
- [30] B.M. Mercer, S. Gilbert, M.B. Landon, C.Y. Spong, K.J. Leveno, D.J. Rouse, et al., Labor outcomes with increasing number of prior vaginal births after cesarean delivery, *Obstet. Gynecol.* 111 (2008) 285–291.
- [31] M.B. Landon, S. Leindecker, C.Y. Spong, J.C. Hauth, S. Bloom, M.W. Varner, et al., The MFMU Cesarean Registry: factors affecting the success of trial of labor after previous cesarean delivery. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network, *Am. J. Obstet. Gynecol.* 193 (2005) 1016–1023.
- [32] S. Grisaru-Granovsky, M. Bas-Lando, L. Drukker, F. Haouzi, R. Farkash, A. Samueloff, A. Ioscovich, Epidural analgesia at trial of labor after cesarean (TOLAC): a significant adjunct to successful vaginal birth after cesarean (VBAC), *J. Perinat. Med.* 46 (3) (2018) 261–269.
- [33] C.F. Krening, K. Rehling-Anthony, C. Garko, Oxytocin administration: the transition to a safer model of care, *J. Perinat. Neonatal Nurs.* 26 (1) (2012) 15–24.
- [34] P. Hidalgo-Lopezosa, M. Hidalgo-Maestre, M.A. Rodríguez-Borrego, Labor stimulation with oxytocin: effects on obstetrical and neonatal outcomes, *Rev. Lat. Am. Enfermagem* 24 (2016) e2744.
- [35] Y. Cuñarro López, P. Pintado Recarte, I. Cueto Hernández, C. Hernández Martín, M. P. Payá Martínez, Muñoz Chápuli MdM, et al., El perfil de las pacientes obstétricas con infección por SARS-CoV-2 según el país de origen de la publicación: revisión sistemática de la literatura, *Rev. Med. Clín.* 10 (2) (2021) 360.
- [36] I. Carrasco, M. Muñoz-Chapuli, S. Vigil-Vázquez, D. Aguilera-Alonso, C. Hernández, C. Sánchez-Sánchez, et al., SARS-COV-2 infection in pregnant women and newborns in a Spanish cohort (GESNEO-COVID) during the first wave, *BMC Pregnancy Childbirth* 21 (1) (2021) 326.
- [37] O. Martínez-Perez, M. Vouga, S. Cruz Melguizo, L. Forcen Acebal, A. Panchoaud, M. Muñoz-Chápuli, et al., Asociación entre el modo de parto en embarazadas con COVID-19 y los resultados maternos y neonatales en España, *JAMA* 324 (3) (2020) 296–299.
- [38] L.D. Zambrano, S. Ellington, P. Strid, Actualización: Características de las mujeres sintomáticas en edad reproductiva con infección por SARS-CoV-2 confirmada por laboratorio por estado de embarazo - Estados Unidos, 22 de enero al 3 de octubre de 2020, *MMWR Morb. Mortal. Wkly. Rep.* 69 (2020) 1641–1647.
- [39] M.F.I. Cruz, D.C. Gutiérrez, A.T. Morales, J.C.R. Ledezma, A.K.C. Pérez, J. R. Vázquez, Complicaciones por infección de Covid-19 en mujeres embarazadas y neonatos en el año 2020, *J. Neg. No Pos. Results* 6 (6) (2021) 881–897.
- [40] A. Ciapponi, Manifestaciones clínicas, factores de riesgo y resultados maternos y perinatales de COVID-19 en el embarazo, *Evid. Actual Pract Ambul.* 23 (4) (2020) e002094.