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Did we observe changes in obstetric interventions in SARS-CoV-2 infected pregnant women at the beginning of COVID-pandemic in Belgium? Results of a nationwide population-based study.

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ABSTRACT

Background: Pregnant women are more vulnerable to the severe effects of COVID-19 compared to their non-pregnant peers. Early in the pandemic, there was a rise in cesarean deliveries and preterm births among infected pregnant women. This study aims to evaluate whether there were any changes in obstetric interventions during the first two waves of the pandemic in Belgium.

Methods: Between March 2020 and February 2021, the Belgian Obstetric Surveillance System (B.OSS) conducted an extensive, nationwide population-based registry study, that included nearly all births to women with a confirmed SARS-CoV-2 infection within six weeks before hospitalization in Belgium. The perinatal outcomes of these women were analyzed and compared with pre-pandemic regional perinatal data.

Results: A total of 923 SARS-CoV-2 infected pregnant women were admitted to the hospital; 9.3 % were hospitalized for severe COVID-19, while the remaining were hospitalized for obstetric reasons. Infected women had a

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higher median BMI, a higher incidence of diabetes, and a greater proportion were overweight or obese compared to the reference group ($p < 0.001$). While the majority of women gave birth vaginally, symptomatic women and those with a severe infection had slightly higher rates of cesarean delivery, though not statistically significant after adjusting for confounders. Only severely ill women had an increased risk of preterm delivery (aOR 2.3; 95 %CI [1.2–2.5]; $p = 0.02$) and of induced labor (OR 1.8; 95 %CI [1.1–2.8]; $p = 0.01$). The use of general anesthesia for cesarean delivery was more common in the infected group (OR 2.6; 95 %CI [1.6–4.1]; $p < 0.001$).
Conclusions: Obstetric interventions, such as cesarean delivery and induction, remained at pre-pandemic levels. However, a SARS-CoV-2 infection appears to have increased medically induced preterm delivery and the use of general anesthesia for cesarean delivery.

Nomenclature

COVID-19	Coronavirus Disease 19
SARS-COV-2	Severe Acute Respiratory Syndrome coronavirus-2
ICU	intensive care unit
CS	cesarean section; cesarean delivery
PTB	preterm birth; preterm delivery
B.OSS	Belgian Obstetric Surveillance System
INOSS	International Obstetric Surveillance System
PCR	polymerase chain reaction
BMI	body mass index
REF	reference group
SPE	studiecentrum voor perinatale epidemiologie
CEpiP	centre d'epidémiologie périnatale
GA	gestational age
HIP	hyperglycemia in pregnancy
CI	confidence interval
INFECTED	B.OSS cohort of SARS-CoV-2 infected pregnant women who have been hospitalized
SEVERE	pregnant women with SARS-CoV-2 infection hospitalized for a severe infection
NON-SEVERE	pregnant women with SARS-CoV-2 infection hospitalized for an obstetric indication
aOR	adjusted odds ratio
OR	odds ratio
GenA	general anesthesia
EUROCAT	European platform on rare disease registration

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1. Background

Pregnant women are more susceptible to severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection. Compared with their age-matched nonpregnant counterparts, SARS-CoV-2-infected pregnant women require more ventilatory support and are more likely to be admitted to an intensive care unit (ICU) or die from the infection [1–8]. At the beginning of the pandemic, case series and case reports showed an increase in cesarean sections (CS) and preterm births (PTB) among pregnant women infected with SARS-CoV-2 [9]. More recent studies have shown that CS and (medically-induced) PTB are more likely to be associated with severe infections later in pregnancy. In contrast, the occurrence of mild or moderate COVID-19 and severe disease early in pregnancy poses a minimal risk [8,10].

The initial phases of the COVID-19 pandemic were characterized by a scarcity of evidence; guidelines were developed but they lacked uniformity and consistency [11]. Obstetricians facing this uncertainty and potentially influenced by anxiety, were left with the challenging task of making crucial decisions in their obstetric care. Nevertheless, the availability and quality of care during pregnancy, childbirth, and the postpartum period are of paramount importance [12]. The World Health Organization (WHO) recommends that healthcare should be safe, effective, timely, efficient, equitable, and person-centered [13]. Interventions, such as CS, medically-induced prematurity, and general anesthesia during CS, can be lifesaving in specific situations. However, if not necessary, they cause avoidable short- or long-term harm [14–16].

Our study aims to analyze whether there was a change in obstetric interventions for SARS-CoV-2 infected pregnant women during the first two waves compared to the pre-pandemic period. Were obstetric interventions during the early phase of the pandemic in Belgium as fair and appropriate as before the pandemic?

2. Materials and methods

From 1 March 2020 to 28 February 2021, the Belgian Obstetric Surveillance System (B.OSS) conducted a nationwide population-based observational registry of SARS-CoV-2 in pregnancy. The B.OSS has been registering and analyzing rare disorders and complications of pregnancy in Belgium since 2012, with the participation of all Belgian maternity units except one, covering 97.4 % of all births [17]. Each of the 101 participating maternity units has a staff member responsible for case ascertainment. At the start of the pandemic, the surveillance system collected data on pregnant women infected with SARS-CoV-2 in collaboration with the International Network of Obstetric Survey Systems (INOSS) [5]. Weekly reminders were sent by e-mail during the peak of the pandemic in Belgium, asking the designated person to report any case.

All women who were pregnant and had a confirmed diagnosis of SARS-CoV-2 infection through polymerase chain reaction (PCR) testing in the six weeks before hospitalization or before giving birth, were included. Hospitalization could be for any cause, including SARS-CoV-2 infection, pregnancy-related complications, or delivery. An online data collection form developed by INOSS was used to collect information on maternal characteristics, details of SARS-CoV-2 infection and its management, and pregnancy, maternal and neonatal outcome [4,6,7,18]. The list of all variables can be found in Supplementary files (Table S1). Calculation of body mass index (BMI) was based on the first recorded weight during the pregnancy. “Grand multiparity” was defined as a history of four or more births. Urgency of cesarean section was scaled according to the four-grade classification of Lucas et al. [19] (Table S1).

A total of 923 cases with completed registration forms were included. Exclusion criteria for this study were: no completed data collection form (n = 101); more than six weeks between the diagnosis of the infection and their hospitalization (n = 68); no confirmation of SARS-Cov-2 infection (n = 18); no hospitalization (n = 8); duplicates (n = 3); registration outside of the study period (n = 3) and PCR test known after delivery when SARS-CoV-2 infection was not suspected (n = 24). To ensure comparability, twin pregnancies (n = 20) and births under 22 weeks and with a birth weight of less than 500 g (n = 15) were excluded from this B.OSS cohort (Fig. 1). We categorized the B.OSS COVID cohort (referred as group = INFECTED) into two groups: admitted due to severe SARS-CoV-2 infection, based on clinical assessment (SEVERE group); and those hospitalized for obstetric reasons (NON-SEVERE group). This latter was further divided into two subgroups (asymptomatic and symptomatic).

To make a national comparison, a reference group (REF) was obtained from the Belgian perinatal data collected in 2019 (Fig. S1). Belgium comprises three regions from north to south: Flanders, Brussels and Wallonia. Perinatal data are analyzed at the regional level by the Studiecentrum voor Perinatale Epidemiologie (SPE) for Flanders and the Centre d’Epidémiologie Périnatale (CEpiP) for Brussels and Wallonia [20–22]. We used data of all singleton births, with a gestational age (GA) of at least 22 weeks or with a birthweight of at least 500 g, that occurred between January 1, 2019 and December 31, 2019 (representing the latest pre-pandemic period). To ensure comparability, we exclusively obtained data from hospitals that reported at least one case (n = 80), as socioeconomic characteristics can vary considerably between hospitals. Not all variables of the B.OSS cohort were available in REF.

The primary outcome of this study is to determine the proportions of each obstetric intervention among pregnant women with a confirmed SARS-CoV-2 infection compared to pre-pandemic regional perinatal data. Obstetric interventions include induction of labor, induced preterm birth, cesarean delivery, and the use of general anesthesia for cesarean delivery. Neonatal outcomes include birth weight, stillbirth, Apgar at 5 min, neonatal intensive care unit (NICU) admission, malformations, neonatal death.

Descriptive analyses were presented using numbers and proportions for categorical variables. Univariable comparisons with the reference group were made using the chi-square test or the Fisher exact test when appropriate for categorical variables. Statistical significance was defined as a p-value < 0.05.

To evaluate the association of a SARS-CoV-2 infection with PTB and mode of delivery, logistic regression was used to adjust for maternal age, region, BMI, parity, pre-existing and pregnancy-induced hypertension, and hyperglycemia in pregnancy (HIP). Crude and adjusted odds ratios with 95 % confidence interval (95 % CI) derived from the logistic regressions and the p-value of the Wald chi^2 test were presented. The Hosmer and Lemeshow test was used to check the goodness-of-fit of the model.

Statistical analyses were performed using STATA version 17 (Statacorp, TX, USA).

The study was approved by the central ethics committee of the University Hospital of Ghent (ref. number B670201526875), and local ethics committees.

3. Results

3.1. Sociodemographic and pregnancy characteristics

There were 923 cases included in the INFECTED group (Fig. 1). We divided the cohort according to the reason for admission: 86 of the pregnant women (9.3 %) were hospitalized due to severe SARS-CoV-2 infection (group SEVERE); the remaining (n = 837) were hospitalized for obstetric reasons (group NON-SEVERE) (Fig. 1). The reference group (REF) included 89 745 births from 2019. Maternal age was similar between INFECTED and REF women (Table 1). The majority of women were born in Belgium or Europe (64.0 %), while 13.8 % and 19.1 % of our cohort were from Africa and the Eastern Mediterranean Region, respectively. Only 16.9 % of births occurred in Brussels in the REF group, but the Brussels maternities contributed to 32.3 % of the INFECTED women.

The median BMI at booking in the INFECTED group was 25.9 kg/m^2

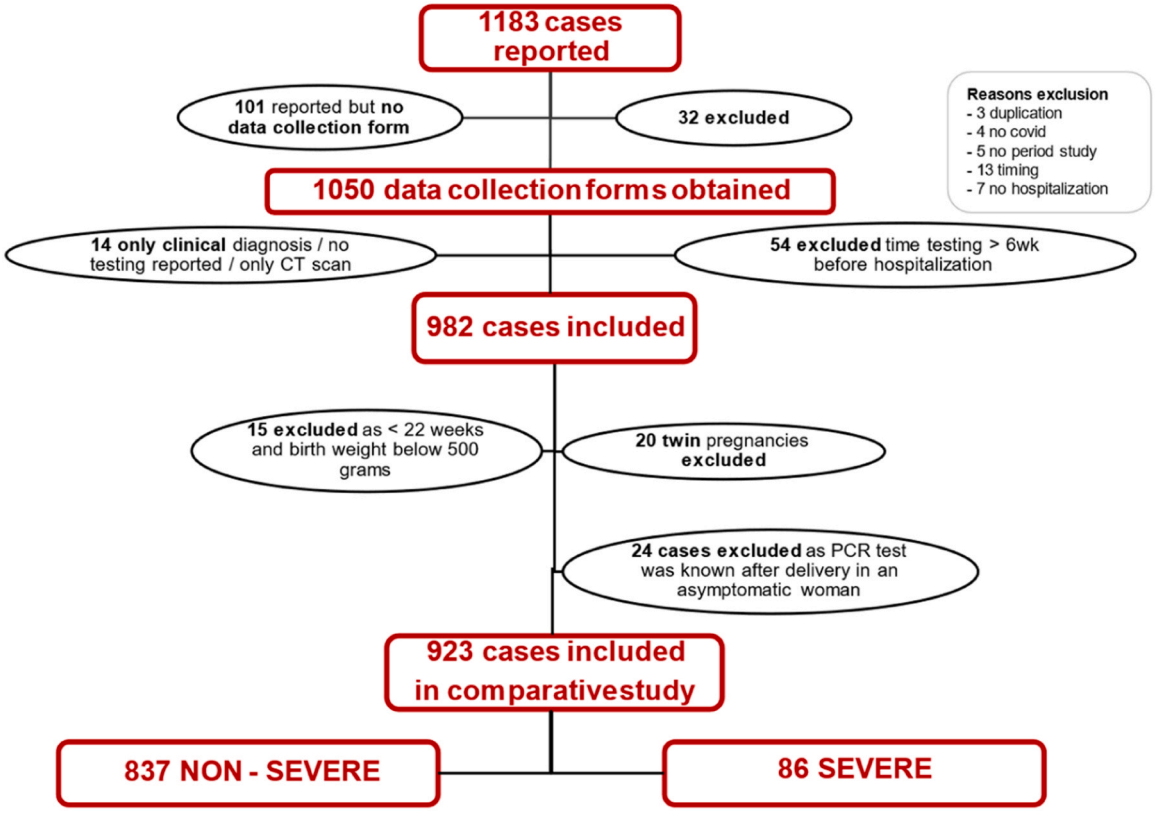

Fig. 1. Flowchart of the registered and included cases of the B.OSS register in the comparative study.

(min 14.5 – max 62.5). Of these women 20.1 % were obese (odds ratio OR 1.7; 95 % CI [1.4–2.0]) and 28.7 % (OR 1.4; 95 % CI [1.2–1.6]) were overweight, compared with 14.3 % and 24.3 %, respectively, in the REF group. An even higher proportion of women in the SEVERE group were overweight (37.8 %) or obese (30.5 %).

The most common pre-existing comorbidities in the INFECTED group were asthma (2.6 %) and hypertension (1.4 %). Additionally, 15.5 % of INFECTED women had HIP (either pre-existing or gestational) compared to 8.6 % in the REF group (OR 1.9; 95 % CI [1.6–2.3]). Proportion of pre-existing or gestational hypertension was similar between INFECTED and REF women. Compared to the REF group, the cohort had more multiparous or grand multiparous women (36.6 % nulliparous in INFECTED versus 44.2 % in REF).

3.2. Obstetrical outcome

3.2.1. Preterm delivery

A total of 8.5 % of INFECTED women delivered preterm, compared to 7.0 % in the REF group (Table 2). Within the severe cases (SEVERE), we observed a higher proportion (13.8 %) of PTB. The REF group had a higher proportion of spontaneous PTB (64.9 %), whereas the INFECTED group had a significantly higher proportion of medically induced PTB (60.5 %), especially in the SEVERE subgroup (63.6 %) (versus REF group 35.1 %).

After adjustment, PTB remains significantly associated with a SEVERE infection compared to the REF group (adjusted odds ratio [aOR] 2.3;,95 % CI[1.2–4.3]) (Table 3A).

3.2.2. Mode of delivery

A total of 706 out of 891 women (79.2 %) gave birth vaginally, which was similar to the REF group (Table 2). Regarding the indication for CS, respiratory deterioration was the reason for CS in 7/20 (35.0 %) in the SEVERE, compared to 3.5 % (2/58) in the symptomatic NON-SEVERE group. In the NON-SEVERE group, symptomatic women were more likely to undergo a CS (27.4 %) compared to asymptomatic women (17.9 %) and women in the SEVERE group (25.0 %) (Table 3B). After adjustment, we observed higher OR of CS for the NON-SEVERE symptomatic group compared to REF group but at the limit of signification (Table 3).

3.2.3. General anesthesia

In the INFECTED cohort, 11.8 % of patients required general anesthesia (GenA) during their CS (22/186) compared to 4.9 % in the REF group(OR 2.5; 95 %CI[1.6–3.8]); 35.0 % of women in the SEVERE group required GenA (versus 9.0 % in NON-SEVERE; $p = 0.004$). Among cases in INFECTED requiring general anesthesia, 40.9 % of women were in labor; 45.5 % had category-one emergency CS (immediate threat to the life of the woman or fetus) and 13.6 % had a category-two CS (Table S4). In six cases (27.2 %; 6/22), respiratory distress or deterioration due to COVID-19 necessitated a CS and influenced the choice of anesthesia. In five cases (22.7 %), the reason for the general anesthesia remains unexplained (Table S4).

3.2.4. Induction

No difference was observed in the induction rate (29.7 % in INFECTED; 27.9 % in REF) (Table 2). A higher induction rate was observed in the SEVERE group (40.7 %), with 34.4 % of women undergoing induction due to the progression of their SARS-CoV-2 infection.

3.3. Neonatal outcomes

There was no statistical difference in low birth weights at term or stillbirth rates in our cohort compared to REF (1.0 % in INFECTED; 0.6 % in REF; $p = 0.08$). Neonates born from the women in the SEVERE group had a lower Apgar score compared to REF (7.5 % <and 2.2 % respectively) (Table 2). A higher incidence of malformations was observed in INFECTED (3.2 %) compared to REF (0.9 %). Two neonatal

Table 1
Sociodemographic and pregnancy characteristics of hospitalized pregnant women infected with SARS-CoV-2 compared with the pre-pandemic reference group, and divided according to the reason for admission (SEVERE vs NON-SEVERE).

Characteristics	REF n = 89 745	INFECTED n = 923	OR (95 % CI)[1]	SEVERE n = 86	NON-SEVERE n = 837
SOCIO-DEMOGRAPHIC					
Maternal age (years)					
<20	1 253 (1.4)	15 (1.6)	1.2 (0.7 −2.0)	2 (2.3)	13 (1.6)
20 −34	70 091 (78.1)	715 (77.5)	1	61 (70.9)	654 (78.1)
≥ 35	18 400 (20.5)	193 (20.9)	1.0 (0.9 −1.2)	23 (26.7)	170 (20.3)
Country origin					
Belgian	-	425 (51.4)		38 (49.3)	387 (51.6)
European	-	104 (12.6)		9 (11.7)	95 (12.7)
African	-	114 (13.8)		14 (18.2)	100 (13.3)
East Mediterranean Region	-	158 (19.1)		12 (15.6)	146 (19.5)
Other	-	26 (3.1)		4 (5.2)	22 (2.9)
Region					
Flanders	50 861 (56.7)	416 (45.1)	1	27 (31.4)	389 (46.5)
Brussels	15 130 (16.9)	298 (32.3)	2.4 (2.1 −2.8)	30 (34.9)	268 (32.0)
Wallonia	23 754 (26.5)	209 (22.6)	1.1 (0.9 −1.3)	29 (33.7)	180 (21.5)
BMI (kg/m^2)					
< 18.5	4 189 (4.85)	32 (3.7)	0.9 (0.6 −1.3)	2 (2.4)	30 (3.9)
18.5 < 25	48 833 (56.6)	406 (47.5)	1	24 (29.3)	382 (49.4)
25 < 30	21 004 (24.3)	245 (28.7)	1.4 (1.2 −1.6)	31 (37.8)	214 (27.7)
≥ 30	12 308 (14.3)	172 (20.1)	1.7 (1.4 −2.0)	25 (30.5)	147 (19.0)
Single					
Current	-	53 (6.4)		5 (6.6)	48 (6.4)
Smoking					
Current	-	57 (6.9)		1 (1.3)	56 (7.4)
Pre-existing medical problem					
Asthma	-	23 (2.6)		4 (4.8)	19 (2.4)
Pulmonary disease	-	4 (0.5)		2 (2.4)	2 (0.3)
Cardiac disease	-	5 (0.6)		1 (1.2)	4 (0.5)
Hypertension	-	12 (1.4)		2 (2.4)	10 (1.2)
Diabetes	-	5 (0.6)		0	5 (0.6)
PREGNANCY					
Parity					
1	39 685 (44.2)	337 (36.6)	**1**	24 (28.2)	313 (37.5)
2 −3	42 776 (47.7)	443 (48.1)	1.2 (1.1 −1.4)	44 (51.8)	399 (47.7)
≥ 4	7 258 (8.1)	141 (15.3)	2.3 (1.9 −2.8)	17 (20.0)	124 (14.8)
Medical complications during pregnancy					
Gestational diabetes	-	135 (14.7)		13 (15.1)	122 (14.6)
Preeclampsia / Eclampsia / HELLP	-	24 (2.6)		1 (1.2)	23 (2.8)
Hypertension all (preexisting + gestational)	4 152 (4.6)	51 (5.7)	1.2 (0.9 −1.6)	7 (8.4)	44 (5.5)
Hyperglycemia in pregnancy (preexisting + gestational)	7 651 (8.6)	140 (15.5)	1.9 (1.6 −2.3)	13 (15.3)	127 (15.6)

CI = confidence interval
HELLP = hemolysis elevated liver enzymes and low platelets
NON-SEVERE = pregnant women with SARS-CoV-2 infection hospitalized for an obstetric indication
OR = odds ratio
REF = pre-pandemic reference group
SEVERE = pregnant women with SARS-CoV-2 infection hospitalized for a severe infection

deaths occurred in our cohort (2/883; 0.2 %), one within seven days of birth, and the other at 25 days of life. A total of 148 (16.9 %) of infants in the INFECTED group underwent PCR testing for SARS-CoV-2 infection; seven of them (7/148; 4.7 %) were positive. (Table 2).

4. Discussion

4.1. Main findings

The main findings of the study suggest that, after adjustment, obstetric management of pregnant women with non-severe SARS-CoV-2 infection was similar to pre-pandemic practice, with a minor difference in mode of birth and no difference in induction of labor. For general anesthesia during CS, we observed more than a twofold increase. Pregnant women with a severe SARS-CoV-2 infection were more likely to have induction of labor, medically-induced preterm birth, and an increased risk of general anesthesia during cesarean delivery. It is noteworthy that our cohort analyzed the early phase of the pandemic when data and guidelines for managing these cases were limited.

5. Limitations and strengths

Our population-based study, covering 97.4 % of births in Belgium in the pandemic's first year, offers a comprehensive overview of the impact of wild-type SARS-CoV-2 on obstetric outcomes pre-vaccination.

The presence of an INOSS network enabled the B.OSS group to utilize a standardized data collection form across multiple countries. Recent research by Bonet et al. suggests multinational and regional network involvement is key for effective maternal and perinatal research readiness and response, enabling swift access to care during future epidemics. [23].

The study has several limitations. Firstly, there was variation in testing availability and strategies during the early stages of the pandemic. These variations may have led to underreporting of asymptomatic and mild cases in particular. As a result, the cohort may not accurately reflect the true prevalence of COVID-19 among hospitalized pregnant women, and associations with SARS-CoV-2 infection may appear worse than they are in reality, if testing was biased toward severe cases.

Table 2
Obstetric and neonatal outcomes of pregnant women in the B.OSS cohort (INFECTED) compared with the pre-pandemic reference group (2019) (REF). The B.OSS cohort is divided into two subgroups: hospitalized for a severe SARS-CoV-2 infection (SEVERE) and those for an obstetric reason (NON-SEVERE).

Obstetric & neonatal outcome	REFERENCE n = 89 745	INFECTED n = 923	OR (CI 95 %)	SEVERE n = 86	NON-SEVERE n = 837
Delivery mode					
Spontaneous vaginal	63 358 (70.6)	623 (69.9)	1	50 (62.5)	573 (70.7)
Vacuum / Forceps	8 428 (9.4)	83 (9.3)	1.0 (0.8 –1.3)	10 (12.5)	73 (9.0)
Pre-labor cesarean	8 907 (9.9)	97 (10.9)	1.1 (0.9 –1.4)	12 (15.0)	85 (10.5)
Cesarean after labor onset	9 051 (10.1)	88 (9.9)	1.0 (0.8 –1.2)	8 (10.0)	80 (9.9)
All vaginal	71 786 (80.0)	706 (79.2)	1	60 (75.0)	646 (79.7)
All cesarean	17 958 (20.0)	185 (20.8)	1.0 (0.9 –1.2)	20 (25.0)	165 (20.3)
Preterm delivery (< 37 weeks)					
Yes, all	6261 (7.0)	76 (8.5)	1.0 (0.9 –1.2)	11 (13.8)	65 (8.0)
Spontaneous	4059 (64.9)	30 (39.5)	1	4 (36.4)	26 (40.0)
Medically induced	2193 (35.1)	46 (60.5)	**2.8 (1.8 – 4.5)**	7 (63.6)	39 (60.0)
Gestational age at delivery (in weeks)					
22 to 28	464 (0.5)	7 (0.8)	1.5 (0.7 –3.2)	1 (1.2)	6 (0.7)
28 to 32	533 (0.6)	12 (1.4)	2.3 (1.3 –4.1)	2 (2.5)	10 (1.2)
32 to 37	5 264 (5.9)	57 (6.4)	1.1 (0.8 –1.5)	8 (10.0)	49 (6.1)
≥ 37	83 483 (93.0)	815 (91.4)	1	69 (86.3)	746 (92.0)
Induction of labor	25 078 (27.9)	266 (29.7)	1.1 (0.9 –1.3)	33 (40.7)	233 (28.6)
Analgesia during cesarean					
Regional	17 073 (95.1)	163 (88.1)	1	13 (65.0)	150 (90.9)
General	875 (4.9)	22 (11.9)	2.5 (1.6 –3.8)	7 (35.0)	15 (9.1)
Birth weight					
< 2500 g	1 775 (2.1)	26 (3.2)	1.5 (1.0 –2.2)	2 (2.9)	24 (3.2)
2500 –4000 g	74 221 (88.9)	723 (88.7)	1	62 (89.9)	661 (88.6)
≥ 4000 g	7 481 (9.0)	66 (8.1)	0.9 (0.7 –1.2)	5 (7.2)	61 (8.2)
Stillbirth	509 (0.6)	9 (1.0)	1.8 (0.9 –3.4)	0	9 (1.1)
Apgar 5 min					
< 7	1 941 (2.2)	29 (3.3)	1.5 (1.1 –2.2)	6 (7.5)	23 (2.9)
≥ 7	87 486 (97.8)	852 (96.7)	1	74 (92.5)	778 (97.1)
Admission to NICU					
No	79 773 (88.9)	762 (86.5)	**1**	63 (78.8)	699 (87.3)
Yes	9 970 (11.1)	119 (13.5)	1.2 (1.0 –1.5)	17 (21.2)	102 (12.7)
Malformation	773 (0.9)	28 (3.2)	3.6 (2.5 –5.4)	4 (4.7)	24 (2.9)
Perinatal death					
No	89 618 (99.9)	881 (99.8)	1	79 (98.8)	802 (99.9)
Yes, within 7 days	127 (0.1)	1 (0.1)	0.9 (0.2 –3.5)	1 (1.2)	0

CI = confidence interval
NICU = neonatal intensive care unit
NON-SEVERE = pregnant women with SARS-CoV-2 infection hospitalized for an obstetric indication
OR = odds ratio
REF = pre-pandemic reference group
SEVERE = pregnant women with SARS-CoV-2 infection hospitalized for a severe infection

Table 3
Frequency, crude (OR) and adjusted odds ratios (aOR) with their confidence interval (CI 95 %) for the association between preterm delivery (Table 3A), cesarean delivery (Table 3B) and SARS-CoV-2 infection.

Table 3A					
Preterm delivery	**N (%)**	**OR (CI 95 %)**	**p- value**	**aOR (CI 95 %)**	**p-value**
REF	6291 (7.0)	1	***0.01***	1	***0.03***
NON SEVERE - Asymptomatic	42 (7.0)	1.0 (0.7 – 1.4)		1.0 (0.8 – 1.5)	
NON SEVERE - Symptomatic	23 (11.1)	**1.7 (1.1 – 2.6)**		1.5 (0.9 – 2.5)	
SEVERE	11 (13.8)	**2.1 (1.1 – 4.0)**		**2.3 (1.2 – 4.3)**	
Table 3B					
Cesarean delivery	**N(%)**	**OR (CI 95 %)**	**p-value**	**aOR (CI 95 %)**	**p-value**
REF	17958 (20.0)	1	***0.02***	1	*0.05*
NON SEVERE - Asymptomatic	108 (17.9)	0.87 (0.7 - 1.1)		0.9 (0.7 – 1.1)	
NON SEVERE - Symptomatic	57 (27.4)	**1.5 (1.1 – 2.0)**		**1.4 (1.0 – 2.1)**	
SEVERE	20 (25.0)	1.3 (0.8 – 2.2)		1.3 (0.8 – 2.2)	

Despite universal access to health care, there may be variability in the criteria for hospitalization of pregnant women with a severe SARS-CoV-2 infection, which could introduce selection bias. Similarly, there is variability in obstetric management practices between centers. We have addressed these potential sources of bias by using regression methods with covariate adjustment to mitigate their effects. However, due to the inherent design limitations of case registry studies, bias cannot be completely eliminated.

Another limitation is the risk of classification bias, resulting from the fact that the severity classification of COVID-19 cases was based on clinicians' observations and reports during their care, without specifying whether this assessment was based on standardized and uniform severity criteria, such as those defined by the WHO later in the pandemic [24]. We addressed this risk by performing an expert review of the medical records. For the records with available data (two-thirds of the cases), the clinical classification was validated to be consistent with WHO criteria. We performed a sensitivity analysis excluding the severe cases that were not validated (one-third of the cases), which showed no significant differences compared to the whole cohort.

Most women who were not hospitalized for a severe SARS-CoV-2

infection, were hospitalized for childbirth (84.3 % of cases). The remainder were hospitalized for an obstetric reason, although the exact reason was not recorded, preventing more detailed interpretation in the outcome analysis. Due to the limited number of cases in the subgroup of medically-induced PTB (an obstetric intervention), logistic regression was not feasible. Therefore, logistic regression was performed on the entire group for PTB.

There were differences in socio-demographic characteristics between the INFECTED and REF groups, but we adjusted for these variables in the logistic regression analysis.

The strength of our population-based study is that we used a nationwide population as a control group. We opted not to include a reference group with perinatal data from 2020 due to the fact that health care systems were overwhelmed and probably operated differently during the pandemic. In addition, we would have been unable to exclude infected women from reference group in 2020.

5.1. Interpretation in light of other studies

5.1.1. Risk factors of SARS-CoV-2 infection in pregnant women

Risk factors (clinical and social) for SARS-CoV-2 infection in pregnant women are less studied, even though they are well known in the general population [25–27]. A recent meta-analysis by Smith et al. showed that diabetes, hypertension, cardiovascular disease, HIV infection, pre-pregnancy underweight/obesity, and anemia were risk factors for severe COVID-19 infection in pregnant women [28]. Compared to the reference group, the women in our cohort were more likely to reside in the Brussels region, have higher parity, be overweight/obese, and have pre-existing or gestational diabetes. The higher risk associated with higher parity may be due to prolonged close contacts, especially within households, which has been identified as a primary transmission risk [29]. Racapé et al. found that social health determinants played a significant role in the excessive spread of COVID-19 in Brussels, particularly in precarious situations [26,27].

5.1.2. Neonatal outcomes

In the INFECTED group, we reported more fetal malformations (3.2 %) compared to REF. This could be attributed to more comprehensive reporting in the INFECTED cohort. EUROCAT's 2021 report cites a prevalence of 2.8 % in Europe [30].

5.1.3. Preterm delivery & induction

Our study also revealed a higher incidence of PTB, mainly medically-induced and associated with severe infection (aOR 2.3) and a higher risk of induction of labor in the severely ill women (OR 1.8). Notably, in the severe group, one in three women underwent induced labor due to worsening COVID-19 infection. This finding is consistent with Vousden et al.'s observation that women with severe infection had a higher rate of medically induced preterm delivery [31].

5.1.4. General anesthesia

Belgium has successfully achieved the Society for Obstetric Anesthesia and Perinatology's (SOAP) target of keeping GenA below 5 % [32], based on pre-pandemic data from 2019. However, among pregnant women infected with SARS-CoV-2, a higher percentage underwent GenA during their CS, especially SEVERE cases. Notably, 40.9 % of GenA cases were administered for category three or four emergency CS, which is not in line with current recommendations [16]. The SOAP COVID-19 registry in the USA reported that 8.7 % of infected women underwent GenA, compared with 2.6 % of non-infected women [33]. General anesthesia can lead to several complications, including aspiration, awareness during CS, and difficulties with intubation. In addition, the use of GenA during CS can interfere with subsequent skin-to-skin contact and consequently with mother-baby bonding. Interestingly, both the UK and Israel have managed to reduce their overall rates of GenA for CS during the pandemic [32,34]. While patients requiring intubation for respiratory distress should receive GenA during CS, but many women in our study received GenA for non-urgent CS without respiratory distress, which needs to be addressed. Adherence to clear recommendations is essential to avoid unnecessary GenA use, even during outbreaks.

6. Conclusions

Our findings suggest that clinicians in Belgium have not modified the standard management practices for non-severe SARS-CoV-2 infected pregnant women. In our cohort, a higher incidence of preterm delivery and induction of labor was observed in women with severe illness. The use of general anesthesia for cesarean section was increased in women infected with SARS-CoV-2, even when not justified by respiratory distress or emergency indications.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki, and approved by a central Ethics Committee of University Hospital Ghent (Ref. Number B670201526875) and local ethics committees gave their approval to the central ethics committee. Participants were asked consent to participate.

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CRediT authorship contribution statement

Charlotte Leroy: Writing – review & editing, Data curation. **Karolien Benoit:** Writing – review & editing, Project administration, Investigation, Data curation, Conceptualization. **Caroline Daelemans:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Sophie Alexander:** Writing – review & editing, Conceptualization. **Régine Goemaes:** Writing – review & editing, Data curation. **Michel Boulvain:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Jean-Christophe Goffard:** Writing – review & editing, Supervision, Data curation. **An Vercoutere:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sara Derisbourg:** Writing – review & editing, Investigation. **Griet Vandenberghe:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Mbiton Joel Zina:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Kristien Roelens:** Writing – review & editing, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Judith Racapé:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Elena Costa:** Writing – review & editing, Formal analysis. **Virginie Van Leeuw:** Writing – review & editing, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Consent for publication

Informed consent was obtained of each participant to the study.

Competing interests

The authors declare no conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.eurox.2024.100328.

References

[1.] Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T, et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: Living systematic review and meta-analysis. BMJ 2020:370.

[2.] Pierce-Williams RAM, Burd J, Felder L, Khoury R, Bernstein PS, Avila K, et al. Clinical course of severe and critical coronavirus disease 2019 in hospitalized pregnancies: a United States cohort study. Am J Obstet Gynecol MFM [Internet] 2020;2(3):100134. Available from: ⟨https://linkinghub.elsevier.com/retrieve/pii/S258993332030077X⟩.

[3.] Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and Neonatal Morbidity and Mortality among Pregnant Women with and without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pedia 2021;175(8):817–26.

[4] Vousden N, Bunch K, Morris E, Simpson N, Gale C, O'Brien P, et al. The incidence, characteristics and outcomes of pregnant women hospitalized with symptomatic and asymptomatic SARS-CoV-2 infection in the UK from March to September 2020: A national cohort study using the UK Obstetric Surveillance System (UKOSS). In: Farrar D, editor. PLoS One [Internet], 16; 2021, e0251123 (Available from), ⟨https://dx.plos.org/10.1371/journal.pone.0251123⟩.

[5.] Knight M, Bunch K, Vousden N, Morris E, Simpson N, Gale C, et al. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: National population based cohort study. BMJ 2020;Vol. 369.

[6.] Donati S, Corsi E, Maraschini A, Salvatore M, Arena MG, Boldrini R, et al. SARS-CoV-2 infection among hospitalised pregnant women and impact of different viral strains on COVID-19 severity in Italy: a national prospective population-based cohort study. BJOG Int J Obstet Gynaecol [Internet 2022;129(2):221–31. Available from: ⟨https://onlinelibrary.wiley.com/doi/10.1111/1471-0528.16980⟩.

[7.] Overtoom E, Rosman A, Zwart J, Vogelvang T, Schaap T, Akker T, et al. SARS-CoV-2 infection in pregnancy during the first wave of COVID-19 in the Netherlands: a prospective nationwide population-based cohort study (NethOSS). BJOG Int J Obstet Gynaecol [Internet 2022;129(1):91–100. Available from: ⟨https://onlinelibrary.wiley.com/doi/10.1111/1471-0528.16903⟩.

[8.] Engjom H, Aabakke AJM, Klungsøyr K, Svanvik T, Äyräs O, Jonasdottir E, et al. COVID-19 in pregnancy—characteristics and outcomes of pregnant women admitted to hospital because of SARS-CoV-2 infection in the Nordic countries. Acta Obstet Gynecol Scand [Internet] 2021;100(9):1611–9. Available from: ⟨https://onlinelibrary.wiley.com/doi/10.1111/aogs.14160⟩.

[9.] Di Mascio D, Khalil A, Saccone G, Rizzo G, Buca D, Liberati M, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. Am J Obstet Gynecol MFM 2020;2(2):100107.

[10.] Smith ER, Oakley E, Grandner GW, Ferguson K, Farooq F, Afshar Y, et al. Adverse maternal, fetal, and newborn outcomes among pregnant women with SARS-CoV-2 infection: an individual participant data meta-analysis. BMJ Glob Heal [Internet] 2023;8(1):e009495. Available from: ⟨https://gh.bmj.com/lookup/doi/10.1136/bmjgh-2022-009495⟩.

[11] Benski C, Di Filippo D, Taraschi G, Reich MR. Guidelines for Pregnancy Management During the COVID-19 Pandemic: A Public Health Conundrum. Int J Environ Res Public Health [Internet] 2020;17(21):8277 (Available from), ⟨https://www.mdpi.com/1660-4601/17/21/8277⟩.

[12.] Tunçalp, Were WM, MacLennan C, Oladapo OT, Gülmezoglu AM, Bahl R, et al. Quality of care for pregnant women and newborns-the WHO vision. BJOG [Internet] 2015;122(8):1045–9. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/25929823⟩.

[13] Tunçalp Ö, Were W, MacLennan C, Oladapo O, Gülmezoglu A, Bahl R, et al. Quality of care for pregnant women and newborns—the <scp>WHO</scp> vision. BJOG An Int J Obstet Gynaecol [Internet], 122; 2015. p. 1045–9 (Available from), ⟨https://onlinelibrary.wiley.com/doi/10.1111/1471-0528.13451⟩.

[14.] Sandall J, Tribe RM, Avery L, Mola G, Visser GH, Homer CS, et al. Short-term and long-term effects of caesarean section on the health of women and children. Lancet (Lond, Engl) [Internet] 2018;392(10155):1349–57. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/30322585⟩.

[15.] Chescheir N, Menard MK. Scheduled deliveries: avoiding iatrogenic prematurity. Am J Perinatol [Internet] 2012;29(1):27–34. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/21861252⟩.

[16.] Watson SE, Richardson AL, Lucas DN. Neuraxial and general anaesthesia for caesarean section. Best Pr Res Clin Anaesthesiol [Internet] 2022;36(1):53–68. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/35659960⟩.

[17.] Vercoutere A, Zina MJ, Benoit K, Costa E, Derisbourg S, Boulvain M, et al. Late miscarriage and stillbirth in asymptomatic and symptomatic hospitalised pregnant women in Belgium during the first and second waves of COVID-19: a prospective nationwide population-based study. BMC Pregnancy Childbirth 2023;23(1):356.

[18.] Engjom H, van den Akker T, Aabakke A, Ayras O, Bloemenkamp K, Donati S, et al. Severe COVID-19 in pregnancy is almost exclusively limited to unvaccinated women – time for policies to change. Lancet Reg Heal - Eur [Internet 2022;13(1)): 100313. Available from: ⟨https://www.nature.com/articles/s41467-022-30052-w⟩.

[19.] Lucas DN, Yentis SM, Kinsella SM, Holdcroft A, May AE, Wee M, et al. Urgency of caesarean section: a new classification. J R Soc Med [Internet] 2000;93(7): 346–50. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/10928020⟩.

[20.] Van Leeuw V.L.C. Santé périnatale en Wallonie [Internet]. 2020. Available from: ⟨https://www.cepip.be/pdf/rapport_CEPIP_Wal2019_2tma.pdf⟩.

[21.] Van Leeuw V.L.C. Santé périnatale en Région bruxelloise [Internet]. Bruxelles; 2020. Available from: ⟨https://www.cepip.be/pdf/rapport_CEPIP_Bxl2019_FR_2tma.pdf⟩.

[22.] Devlieger R., Goemaes R.L.M. Perinatale activiteiten in Vlaanderen 2020 [Internet]. Studiecentrum voor Perinatale Edidemiologie (SPE). 2020. Available from: https://www.zorg-en-gezondheid.be/sites/default/files/atoms/files/SPE_Perinatale activiteiten in Vlaanderen 2019_FINAL.pdf.

[23.] Bonet M, Babinska M, Buekens P, Goudar SS, Kampmann B, Knight M, et al. Maternal and perinatal health research during emerging and ongoing epidemic threats: a landscape analysis and expert consultation. BMJ Glob Heal [Internet] 2024;9(3):e014393. Available from: ⟨https://gh.bmj.com/lookup/doi/10.1136/bmjgh-2023-014393⟩.

[24.] Engjom HM, Ramakrishnan R, Vousden N, Bunch K, Morris E, Simpson N, et al. Perinatal outcomes after admission with COVID-19 in pregnancy: a UK national cohort study. Nat Commun [Internet] 2024;15(1):3234. Available from: ⟨https://www.nature.com/articles/s41467-024-47181-z⟩.

[25.] Mahamat-Saleh Y, Fiolet T, Rebeaud ME, Mulot M, Guihur A, El Fatouhi D, et al. Diabetes, hypertension, body mass index, smoking and COVID-19-related mortality: a systematic review and meta-analysis of observational studies. BMJ Open [Internet] 2021;11(10):e052777. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/34697120⟩.

[26.] Racape J, Noel A-C, Lurel J, Dauby N, Coppieters Y, Goffard J-C, et al. Social and clinical risk factors associated with hospitalized COVID-19 patients in Brussels's deprived and multiethnic areas. PLOS Glob Public Heal [Internet] 2023;3(7): e0002039. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/37450479⟩.

[27.] Racape J, Dauby N, Goffard J-C, Abdellaoui K, Radulescu C, Coppieters Y, et al. Distinct socioeconomic profile of patients hospitalised with severe COVID-19 and prepandemic respiratory infections in Brussels's deprived areas: a case-control study. BMJ Open [Internet] 2023;13(7):e072914. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/37479511⟩.

[28.] Smith ER, Oakley E, Grandner GW, Rukundo G, Farooq F, Ferguson K, et al. Clinical risk factors of adverse outcomes among women with COVID-19 in the pregnancy and postpartum period: a sequential, prospective meta-analysis. Am J Obstet Gynecol [Internet] 2023;228(2):161–77. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/36027953⟩.

[29] Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z, et al. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. Lancet Infect Dis [Internet] 2020;20(8):911–9 (Available from), ⟨https://linkinghub.elsevier.com/retrieve/pii/S1473309920302875⟩.

[30.] EUROCAT. No Title.

[31.] Vousden N, Ramakrishnan R, Bunch K, Morris E, Simpson N, Gale C, et al. Management and implications of severe COVID-19 in pregnancy in the UK: data from the UK Obstetric Surveillance System national cohort. Acta Obstet Gynecol Scand [Internet] 2022;101(4):461–70. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/35213734⟩.

[32.] Ring L, Landau R, Delgado C. The Current Role of General Anesthesia for Cesarean Delivery. Curr Anesth Rep [Internet] 2021;11(1):18–27. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/33642943⟩.

[33.] Katz D, Bateman BT, Kjaer K, Turner DP, Spence NZ, Habib AS, et al. The Society for Obstetric Anesthesia and Perinatology Coronavirus Disease 2019 Registry: An Analysis of Outcomes Among Pregnant Women Delivering During the Initial Severe Acute Respiratory Syndrome Coronavirus-2 Outbreak in the United States. Anesth Analg [Internet] 2021;133(2):462–73. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/33830956⟩.

[34.] Landau R, Bernstein K, Ring LE. Anesthesia Considerations for Pregnant People With COVID-19 Infection. Clin Obstet Gynecol [Internet] 2022;65(1):179–88. Available from: ⟨http://www.ncbi.nlm.nih.gov/pubmed/35045039⟩.