Archives of Public Health

RESEARCH Open Access

Previous or current infection with SARS-CoV-2 virus and its impact on maternal and neonatal health outcomes in Benin: a sero-epidemiological study in pregnant women

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Abstract

Background SARS-CoV-2 (COVID-19) has emerged as a significant global public health challenge, revealing critical vulnerabilities within health systems worldwide. While extensive data on COVID-19 is available from high-income countries, information remains scarce in lower-income regions, particularly regarding its impact on pregnant women. This study aims to evaluate the burden of COVID-19 among pregnant women and its effects on maternal and birth outcomes during the third wave in Benin.

Methods A cross-sectional, hospital-based survey was conducted from May 19 to September 19, 2022, at the Lagune Mother and Child Teaching Hospital. A standardized questionnaire was administered, and nasal swabs along with serological analysis were performed on 437 pregnant women. Multivariate logistic regression was used to assess risk factors and evaluate the impact of previous or current COVID-19 exposure on maternal and birth adverse outcomes.

Results SARS-CoV-2 was detected in less than 1% of pregnant women through PCR testing of nasal swab samples. Among the study population, 14.4% of women were vaccinated against COVID-19. A total of 81.1% of women tested positive for antibodies, suggesting prior exposure or infection to SARS-CoV-2 or vaccination. Notably, 78.6% of unvaccinated women had detectable antibodies, which serves as a more accurate proxy for infection prevalence. No significant association was found between prior COVID-19 exposure and adverse maternal and birth outcomes (aOR: 0.48, 95% CI 0.15–1.51).

Conclusions Although PCR testing revealed a low incidence of active SARS-CoV-2 infection, the high prevalence of IgG antibodies among pregnant women suggests widespread prior exposure or infection. Vaccination was identified as a strong predictor of detectable IgG antibodies. Notably, despite the presence of antibodies, no significant association was found between prior COVID-19 exposure and adverse maternal or birth outcomes. These findings highlight the need for further research to explore the potential long-term effects of COVID-19 infection on pregnancy outcomes and to better understand the relationship between antibody presence and maternal and fetal health.

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Keywords SARS-CoV-2, COVID-19 infection in pregnancy, Sero-prevalence, Poor maternal and birth outcomes, Benin

Text box 1. Contributions to the literature

- In Benin, as in many countries in sub-Saharan Africa, we still do not fully understand how COVID-19 spreads and affects people-especially those who are more at risk, like pregnant women
- To our best knowledge, this study is one of the few data available regarding COVID-19 during pregnancy in Benin, particularly regarding exposure, risk factors and effects on maternal and child health.
- This study gives important new information about how COVID-19 affects pregnant women, including the possible effects on their health and their babies' health at birth in Benin.

Background

SARS-CoV-2 (COVID-19) has emerged as a major global public health concern, resulting in millions of deaths worldwide. As of January 2024, over 774 million laboratory-confirmed COVID-19 cases and more than 7 million deaths had been reported globally, reflecting a case fatality rate of 0.9% [1]. African countries have also been affected, with 12,553,119 confirmed cases and 259,265 deaths [2]. Although Sub-Saharan Africa (SSA) appeared less affected than other regions, there was considerable variation between countries, likely due to limited testing and surveillance capacities [3].

While extensive COVID-19 data exists for high-income countries, information remains limited for lower-income regions, particularly regarding pregnant women [4]. Pregnant women are a vulnerable population with an elevated risk of SARS-CoV-2 infection, as well as other viral infections [5, 6]. Those infected with COVID-19 during pregnancy face a higher risk of preterm delivery, and their newborns are three times more likely to require hospitalization compared to infants born to uninfected mothers [7–9]. Although some studies indicate that fetal and neonatal mortality is rarely impacted by the infection and that vertical transmission rates are low [10], other research suggests that severe COVID-19 cases may be associated with additional morbidities [11, 12].

In Benin, 28,036 confirmed cases and 163 deaths had been reported. Of these cases, 47.3% were men and 52.7% were women, with the most affected age group being 15 to 45 years (65.5%) (Ministry of Health, Benin). The average positivity rate (positive cases/total tests) was 2.4%, with the Littoral region, which includes the economic capital, Cotonou, the most affected region [13]. Despite the availability of general COVID-19 data in Benin, there is a lack of specific information regarding the impact of the pandemic on pregnant women. Very few studies or comprehensive reports have been conducted to evaluate the prevalence, clinical outcomes, or healthcare challenges faced by this vulnerable group during the pandemic in the country. Generating more evidence in this context is crucial to support public health policy-making and to guide responses to future emerging diseases in such vulnerable populations. This study aimed to assess the prevalence of COVID-19 among pregnant women, investigate risk factors for infection, and examine its negative effects on maternal and child health during the third wave in Benin.

Materials and methods

Study design

A hospital-based cross-sectional survey was conducted from May 19 to September 19, 2022, at the Lagune Mother and Child Teaching Hospital (CHU-MEL) in Cotonou, Benin. Between May 31 to August 10 2022, all pregnant women who attended the CHU-MEL were systematically approached at any stage of pregnancy during antenatal care (ANC) visits and at the time of delivery to participate to the study. Eligible participants were over 18 years old, provided informed consent, and resided in or near the Cotonou district. Women presenting at the time of delivery were enrolled post-childbirth, provided both mother and infant were in good health.

A study from Cameroon reported that 6% of pregnant women experienced symptomatic COVID-19 infections, primarily around the time of delivery [14]. Based on this finding, a sample size of 400 pregnant women was determined to be adequate to determine the prevalence and historical exposure to COVID-19 in Beninese pregnant women, a 0.05 significance level, and an allowance for a 10% non-response rate.

Study procedures

A standardized questionnaire was administered by study midwives to all recruited pregnant women to collect maternal data, including: (i) socio-demographic information (age, profession, education, residence); (ii) clinical data (temperature measured using infrared frontal thermometer, blood pressure measured by electronic sphygmomanometer, gestational age assessed by either on the last menstrual period or the first ultrasound scan, gravidity, weight, pre-conceptional weight, recent fever history, and present/past COVID-19 symptoms); (iii) medical and obstetric history extracted from hospital records (chronic hypertension, history of preterm birth, diabetes, malaria status via rapid diagnostic test, delivery mode, and obstetric complications); (iv) malaria prevention strategies (use of intermittent preventive treatment in pregnancy); (v) knowledge, attitudes, and practices concerning COVID-19 (awareness of symptoms, transmission, and preventive measures); (vi) COVID-19 vaccination status self-reported and confirmed when possible

using vaccination cards; and (vii) contact history with suspected or confirmed cases during pregnancy.

Data on newborns included vital status, birth weight, length, head circumference, APGAR score, and any congenital anomalies. These data were obtained from hospital records. For women, nasal swabs and 4 mL EDTA peripheral blood samples were collected during ANC visits or after delivery. These samples were analyzed using polymerase chain reaction (PCR) assays for pathogen detection and enzyme-linked immunosorbent assay (ELISA) to assess IgG antibody levels. Additionally, all participants were tested for malaria using a rapid diagnostic test (Standard Q Malaria P.f Ag, SD Biosensor, Gyeonggi-do, Republic of Korea), regardless of symptom presentation.

Data management and statistical analysis

Data were collected using electronic forms on tablets and smartphones equipped with OpenDataKit (ODK) Collect, and submitted daily to a server hosted by the London School of Hygiene & Tropical Medicine (LSHTM). The data were then exported as a CSV file and converted into Stata format for analysis. All statistical analyses were conducted using STATA 18.0 software (StataCorp LP, College Station, TX, USA).

Descriptive statistics were used to compare characteristics between infected and uninfected pregnant women. The primary outcomes included the presence of active COVID-19 infection (detected via PCR) and prior infection (identified through serology). Adverse pregnancy outcomes were defined as low birth weight (LBW) for infants weighing less than 2500 g, preterm birth (PTB) for deliveries occurring before 37 weeks of gestation, and small weight for gestational age (SGA), defined as a birth weight below the 10th percentile for gestational age, based on INTERGROWTH-21st standards [15].

Household socioeconomic status was assessed using principal component analysis, incorporating indicators such as type of lighting, water source, roof and floor material, sanitation type, education level of the household head, household crowding, and asset ownership (e.g., motorbike, television, bicycle, radio, sheep, bed, or phone). The COVID-19 knowledge, attitudes, and practices survey consisted of twenty-seven questions (Appendix 1) across three domains: symptoms, transmission routes, and preventive measures, with response options of yes, no, or "don't know." A scoring system awarded one point for each correct response and zero points for incorrect or "don't know" responses [16], yielding a total possible score of 0 to 27. Based on Essi et al.'s criteria, COVID-19 knowledge was classified as good (scores > 18.9), moderate (13.5–18.8), inadequate (6.75–13.4), or poor (< 6.75) [17].

We used multivariate logistic regressions to assess risk factors and evaluate the impact of COVID-19 antibody presence on maternal and fetal adverse outcomes. Poor maternal and birth outcomes were a composite of LBWs, PTBs, SGAs, abnormal amniotic liquid, or dystocic delivery. To specifically examine the effects of antibodies resulting from recent infection, we excluded vaccinated women and limited the analysis to those recruited during the third trimester. Women with presence of SARS-CoV-2 antibody during the third trimester were assumed to have been recently infected, and therefore been in contact with the SARS-CoV2 virus during pregnancy [18]. Variables with p-values less than 0.2 in univariate analysis were included in the multivariate model and were subsequently eliminated through a stepwise backward selection process. Only variables with p-values below 0.05 were retained in the final model. For categorical variables with more than two levels, a global test p-value was reported.

Ethical statement

The study received ethical approval from the National Ethical Review Committee of the Ministry of Health in Benin (No. 051/MS/DC/SGM/CNERS/SA) and the Institutional Review Board of the London School of Hygiene and Tropical Medicine (No. 26397). Participation was voluntary, with written informed consent obtained from all participants following a verbal explanation of the study in the local language. For participants who were unable to read or write, fingerprint consent was collected in the presence of an impartial witness.

Results

During the study period, 540 pregnant women were approached for participation. Sixteen women were deemed ineligible (13 declined to provide consent, and 3 were under 18 years of age), while 24 were excluded due to duplicate records. Additionally, 63 women declined to undergo blood analysis, resulting in a final sample of 437 pregnant women, of which 243 were recruited during antenatal care (ANC) visits and 194 at delivery.

Table 1 provides an overview of general characteristics of the study population. Among all pregnant women, the most common age group was 25–29 years (39.5%), and 84.7% had received formal education. The majority of participants were multigravidae (71.6%), with 9% reporting a prior history of pregnancy-related hypertension. Up to 14% (63/437) of women were vaccinated against COVID-19, with most vaccinations occurring before pregnancy (87.3%). At delivery, 9% (17/194) of deliveries were dystocic. The overall proportion of women experiencing poor maternal and birth outcomes was 69.6% (135/194), including 28.9% (56/194) with low birth weight (LBW), 33.5% (65/194) with preterm birth

Table 1 General characteristics of Beninese pregnant women during antenatal care visits and at delivery; Lagune mother and child teaching hospital (CHU-MEL), May to September, 2022, Cotonou, Benin (*N* = 437)

		Total pregnant women (*n* = 437)		Women recruited during ANC visit (*n* = 243)		Women recruited at Delivery (*n* = 194)	
		%	n/N	%	n/N	%	n/N
Maternal characteristics							
Age (years)	< 25	28.3	100/354	27.2	56/206	29.7	44/148
	25–29	39.5	140/354	41.8	86/206	36.5	54/148
	30–34	18.4	65/354	18.9	39/206	17.6	26/148
	≥ 35	13.8	49/354	12.1	25/206	16.2	24/148
Education	No	15.3	67/437	9.9	24/243	22.2	43/194
	Yes	84.7	370/437	90.1	219/243	77.8	151/194
Socioeconomic status	Lowest	20.1	88/437	15.6	38/243	25.8	50/194
	Lower	19.9	87/437	18.1	44/243	22.2	43/194
	Average	20.1	88/437	25.1	61/243	13.9	27/194
	Higher	19.9	87/437	22.6	55/243	16.5	32/194
	Highest	19.9	87/437	18.5	45/243	21.6	42/194
Gravidity	Primigravidae	29.5	129/437	30.6	74/243	28.3	55/194
	Multigravidae	71.6	308/437	69.6	169/243	71.7	139/194
History of pregnancy-related hypertension	Yes	8.9	39/437	8.2	20/243	9.8	19/194
History of diabetes	Yes	1.8	8/437	2.5	6/243	1.0	2/194
History of pre-eclampsia	Yes	4.3	19/437	2.9	7/243	6.2	12/194
HIV infection	Yes	1.6	7/437	2.5	6/243	0.5	1/194
Vaccination against COVID-19	Yes	14.4	63/437	17.3	42/243	10.8	21/194
Timing of COVID-19 vaccine	Before pregnancy	87.3	55/63	85.7	36/42	90.5	19/21
	During pregnancy	12.7	8/63	14.3	6/42	9.5	2/21
Contact with people COVID-19 infected	Yes	3.9	17/437	5.4	13/243	2.1	4/194
Previous COVID-19 infection	Yes	15.8	69/437	20.9	51/243	9.3	18/194
Knowledge of COVID-19 disease	Poor	2.3	10/437	0.4	1/243	4.6	9/194
	Inadequate	1.6	7/437	0.8	2/243	2.6	5/194
	Moderate	5.9	26/437	3.3	8/243	9.3	18/194
	Good	90.2	394/437	95.5	232/243	83.5	162/194
Delivery characteristics							
Mode of delivery	Dystocic	-	-	-	-	8.8	17/194
Amniotic liquid	Abnormal	-	-	-	-	24.3	47/194
Low birth weight	Yes	-	-	-	-	28.9	56/194
Preterm birth	Yes	-	-	-	-	33.5	65/194
Small weight for gestational age	Yes	-	-	-	-	18.0	34/194
Poor maternal and birth outcomes*	Yes	-	-	-	-	69.6	135/194

* Poor maternal and birth outcomes were composite of LBWs, PTBs, SGAs, abnormal amniotic liquid, or dystocic delivery

(PTB), 18% (34/194) with small for gestational age (SGA), and 24.3% (47/194) with abnormal amniotic fluid. These characteristics were largely consistent between women enrolled during ANC visits and those recruited at the time of delivery.

SARS-CoV-2 was detected by PCR in only three pregnant women (0.7%); therefore, our analysis focused on IgG seropositivity. Only five participants were positive for IgM antibodies, providing limited evidence of recent SARS-CoV-2 infections. In contrast, more than 80% (81.1%, 354/437) tested positive for IgG antibodies, indicative of prior exposure or infection, with a median IgG antibody titer of 85 UI/L (IQR: 65–91). Among women who were not vaccinated, a comparable proportion (78.6%) exhibited IgG antibodies, suggesting a humoral response attributable to previous SARS-CoV-2 exposure or infection (Table 2). Only three vaccinated women were seronegative.

Maternal education (Tertiary, secondary, primary), primigravidity, and COVID-19 vaccination were significantly associated with the presence of anti-SARS-CoV-2 IgG antibodies among pregnant women (Table 3). Primigravidae women presented a higher prevalence of IgG antibodies (86.8%) compared to multigravidae women (78.6%). Vaccination emerged as the strongest predictor, with vaccinated women being over five times more likely

Table 2 Biological characteristics of the recruited Beninese pregnant women; Lagune mother and child teaching hospital (CHU-MEL), May to September, 2022, Cotonou, Benin (*N* = 437)

		% or median
PCR result (%)	Positive	0.7 (3/435)
SARS-CoV2 IgM antibody (%)	Presence	1.1 (5/437)
SARS-CoV2 IgG antibody (%)	Presence	81.1 (354/437)
	Median (IQR)	85 (65–91)
SARS-CoV2 IgG antibody among unvaccinated women	Presence	78.6 (294/374)
	Median (IQR)	84 (65–91)
SARS-CoV2 IgG antibody among women vaccinated	Presence	95.2 (60/63)
	Median (IQR)	90 (67–91)
Malaria rapid diagnostic test (%)	Positive	9.8 (43/437)

IQR: Interquartile range

Table 3 Factors associated with anti-SARS-CoV2 antibody presence during pregnancy; Lagune mother and child teaching hospital (CHU-MEL), May to September, 2022, Cotonou, Benin (*N* = 437)

Factors		% with presence of anti-SARS-CoV2 IgG antibody	Crude analysis		Adjusted analysis	
			OR (95% CI)	*P* value	aOR (95% CI)	*P* value
Maternal education	No	71.6%	1			
	Yes	82.7%	1.89 (1.04–3.43)	0.0358		
Gravidity	Multigravidae	78.6%	1		1	
	Primigravidae	86.8%	1.79 (1.01–3.20)	0.0470	1.79 (0.99–3.20)	0.0509
COVID-19 vaccination	No	78.6%	1		1	
	Yes	95.2%	5.44 (1.66–17.8)	0.0051	5.42 (1.65–17.8)	0.0053
Contact with people COVID-19 infected	No	80.5%	1			
	Yes	94.1%	3.88 (0.51–29.7)	0.1914		

OR: Odds ratio; aOR: adjusted odds ratio

to have detectable IgG antibodies (adjusted odds ratio [aOR]: 5.42; 95% confidence interval [CI]: 1.65–17.8; $p = 0.0053$) compared to their unvaccinated counterparts. In contrast, contact with individuals infected with COVID-19 did not remain significantly associated with antibody presence after multivariate adjustment.

Poor maternal and birth outcomes were observed in 74.2% of women without IgG antibodies and 64.8% of those with IgG antibodies among unvaccinated women recruited during the third trimester. Similar trends were noted for specific outcomes, including LBW, PTB, SGA, dystocic delivery, and abnormal amniotic fluid (Fig. 1). There was no significant association between adverse pregnancy outcomes and prior exposure to COVID-19 infection during pregnancy, as indicated by the presence of IgG antibodies (Table 4). However, maternal age (30–34 years), and lack of formal education were significantly associated with higher rates of poor maternal and birth outcomes.

Discussion

The present study provides valuable insights and contributes to the growing body of evidence regarding the burden of COVID-19 infection during pregnancy and its impacts on maternal and birth outcomes during the third wave in Benin– a region where such data has been notably limited to date. We observed that SARS-CoV-2 was detected in less than 1% of pregnant women via PCR, whereas 81.1% tested positive for IgG antibodies, indicating widespread prior exposure. Vaccinated women were significantly more likely to have detectable antibodies, confirming vaccination as a strong predictor. No significant association was identified between prior COVID-19 exposure and adverse maternal or birth outcomes.

COVID-19 vaccination was reported in 14.4% of participants, with the majority (87.3%) receiving the vaccine prior to pregnancy. This low vaccination coverage has also been observed elsewhere in other studies from Benin [19]. Despite robust evidence supporting the safety of COVID-19 vaccines during pregnancy [20, 21], only 10 out of 54 African countries had implemented policies recommending COVID-19 vaccination for pregnant women [22]. The relatively low vaccination rate observed in this study, compared to the general population (24.2%) [23], may reflect barriers such as vaccine hesitancy or limited access, particularly among pregnant women [24, 25]. Vaccination status was strongly associated with the presence of IgG antibodies, with vaccinated women being five time significantly more likely to have detectable antibodies, suggesting enhanced protection

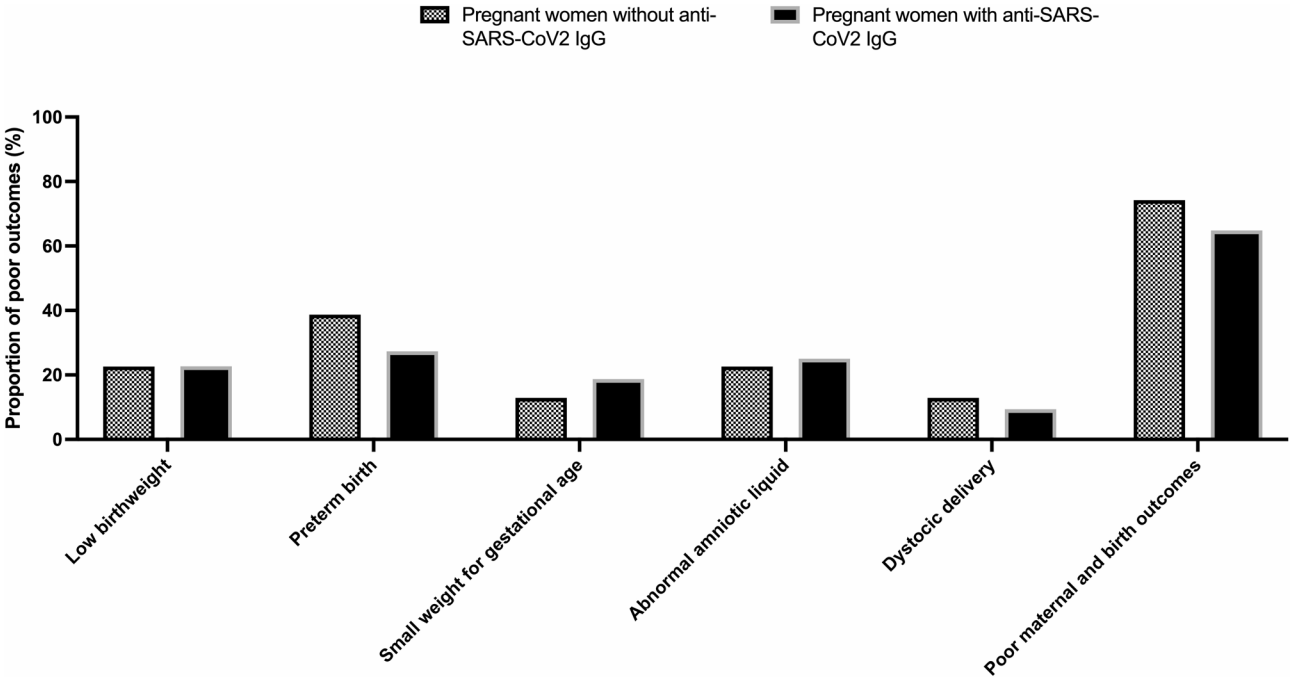

Fig. 1 Proportion of poor maternal and birth outcomes among pregnant women not vaccinated and recruited during the third trimester of pregnancy; Lagune Mother and Child Teaching Hospital (CHU-MEL), May to September, 2022, Cotonou, Benin

Table 4 Association between COVID-19 antibody presence on maternal and fetal adverse outcomes among Beninese pregnant women not vaccinated and recruited during the third trimester of pregnancy; Lagune mother and child teaching hospital (CHU-MEL), May to September, 2022, Cotonou, Benin (*N* = 159)

Factors		% of poor maternal and birth outcomes	Crude analysis		Adjusted analysis	
			OR (95% CI)	*P* value	aOR (95% CI)	*P* value
SARS-CoV2 IgG antibody	Absence	74.2%	1		1	
	Presence	64.8%	0.64 (0.26–1.55)	0.3242	0.48 (0.15–1.51)	0.2119
Maternal age	< 25	55.6%	1		1	
	25–29	60.0%	1.20 (0.49–2.91)		1.45 (0.57–3.73)	
	30–34	89.5%	6.80 (1.36–33.9)	0.0374	6.58 (1.23–35.1)	0.0816
	≥ 35	83.3%	4.00 (0.98–16.3)		3.74 (0.85–16.4)	
Maternal education	Yes	62.4%	1		1	
	No	82.3%	2.81 (1.08–7.29)	0.0335	3.94 (0.99–15.6)	0.0503
Socioeconomic status	Average	77.3%	1			
	Lowest	73.8%	0.83 (0.25–2.78)			
	Lower	69.7%	0.68 (0.19–2.34)			
	Higher	46.4%	0.25 (0.07–0.88)	0.1310		
	Highest	64.7%	0.54 (0.16–1.82)			
Gravidity	Multigravidae	70.2%	1			
	Primigravidae	57.8%	0.58 (0.28–1.19)	0.1372		
Short inter-birth interval	No	72.3%	1		1	
	Yes	53.2%	0.43 (0.21–0.88)	0.0210	0.38 (0.15–0.99)	0.0474

OR: Odds ratio; aOR: adjusted odds ratio

conferred by vaccination. This aligns with existing evidence demonstrating that vaccination substantially enhances humoral immunity against SARS-CoV-2 [26, 27]. The strong association between vaccination and the presence of IgG antibodies underlines the effectiveness of vaccination in enhancing the body's immune response against SARS-CoV-2, making it a critical tool for protecting pregnant women and their newborns. However, due to the limited number of vaccinated participants in this study, we were not able to determine whether vaccination offered superior active protection compared to natural active immunity among unvaccinated women.

Interestingly, a similar prevalence of IgG antibodies was observed among unvaccinated women (78.6%), indicating widespread prior exposure to SARS-CoV-2. This finding suggests high viral circulation among pregnant women in Benin, corroborated by a study conducted in the same region by Figueroa-Romero et al. [19]. Similarly, high SARS-CoV-2 antibody prevalence has been reported in East Africa [28, 29]. These findings raise important questions about the extent of prior infections within the community, particularly given the low detection rate of active SARS-CoV-2 infections via PCR. The data suggest that many women may have experienced asymptomatic infections or exposures before the study period, contributing to the development of natural immunity. This observation may also align with theories explaining why sub-Saharan African countries experienced a relatively less severe COVID-19 pandemic, potentially due to factors such as disease patterns, early herd immunity, cross-protective immunity with other endemic infections, population dynamics, climate conditions, lifestyle, and testing strategies [30]. The observed higher COVID-19 seropositivity rates among primigravid women may be partly explained by immunological changes associated with first pregnancies. Primigravid women typically exhibit a more pronounced pro-inflammatory state during early pregnancy, which could potentially increase their susceptibility to infections such as SARS-CoV-2 [31]. However, the direct immunological mechanisms linking primigravidity to an increased risk of SARS-CoV-2 infection remain poorly understood and warrant further investigation.

The study reports a concerning proportion of poor maternal and birth outcomes (69.6%). However, this potentially overestimated proportion could be partially explained by the study's setting in a referral hospital, which typically manages high-risk pregnancies and may not be fully representative of the broader population. These findings underscore the ongoing challenges in maternal and infant health, particularly in regions with high disease burdens, and highlight the complex interplay between maternal health and various socio-demographic factors [32].

Despite this, no significant association was found between the presence of IgG antibodies (indicating prior exposure to SARS-CoV-2) and adverse pregnancy outcomes. This suggests that, at least within the context of this study, prior COVID-19 infection or exposure did not significantly contribute to poor pregnancy outcomes, a finding consistent with studies showing minimal direct effects of past infections on maternal and neonatal health outcomes [33]. The lack of a significant association may also be explained by the relatively mild severity of infections among pregnant women, particularly those who were asymptomatic or experienced only mild illness [34]. Additionally, this study was unable to accurately determine whether COVID-19 exposure occurred during pregnancy or before. While we hypothesize that unvaccinated women with high antibody levels in the third trimester may have been infected during gestation, this remains uncertain and requires further investigation.

Women aged 30–34 years experienced higher rates of adverse birth outcomes. Advanced maternal age has long been recognized as a significant risk factor for complications such as preterm birth, gestational hypertension, and chromosomal abnormalities [35, 36]. Furthermore, women with lower levels of education exhibited higher rates of poor outcomes, likely reflecting disparities in health literacy, healthcare access, and socio-economic status [37]. These findings underscore the critical need for targeted public health education and interventions aimed at high-risk populations.

Several limitations must be considered when interpreting the results. The cross-sectional design of the study limits the ability to establish causal relationships between COVID-19 exposure and adverse outcomes. Furthermore, the low vaccination rate and the relatively small number of SARS-CoV-2 infections detected via PCR may not fully capture the virus's impact on pregnant women within this population. To better understand the long-term effects of COVID-19 exposure during pregnancy, as well as to compare the outcomes of vaccinated and unvaccinated women, further longitudinal studies are necessary. We recommend prioritizing COVID-19 vaccination for pregnant women, especially those at higher risk due to advanced age, lower education, or high gravidity. Public health campaigns should address vaccine hesitancy and improve access in underserved areas.

Conclusions

Although prior exposure to SARS-CoV-2, as indicated by the presence of IgG antibodies, did not correlate with poor pregnancy outcomes, vaccination was identified as a significant factor in enhancing immune protection. Adverse pregnancy outcomes were associated with maternal age, education, and gravidity, highlighting the crucial role of socio-demographic factors in maternal health. These findings contribute to the growing understanding of COVID-19's impact on pregnancy. Additional evidence are still needed to better understand the impact of emerging viral disease, such as COVID-19 during pregnancy, in order to inform targeted healthcare interventions aimed at improving maternal and fetal outcomes, particularly among high-risk populations.

Abbreviations

ANC	Antenatal care
CHU-MEL	Lagune Mother and Child Teaching Hospital
COVID-19	Coronavirus infection disease 2019
ELISA	Enzyme-linked immunosorbent assay
LBW	Low birth weight
LSHTM	London School of Hygiene and Tropical Medicine

PCR	Polymerase chain reaction
PTB	Preterm birth
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SGA	Small weight for gestational age
SSA	Sub-Saharan Africa
ODK	OpenDataKit

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13690-025-01633-0.

Supplementary Material 1

Acknowledgements
The authors gratefully acknowledge the study participants. We also thank the health community workers, local medical staff and community leaders of the Zou region for supporting the study and for agreeing to collaborate with the study investigators. We specially thanks midwifes from the study site for the data collection (Innocencia Assogba, Sylvie Azanmasso, Amélie Bidouzo, Morelle Falade, Laeticia Tchintchin, Claudine Tossa).

Author contributions
MA wrote the main study protocol and designed it with the support of JC, NP, and BH. MA performed the data analysis. LA, ED, PD, NW and MA supervised the study data collection. AY supervised laboratory analysis. MA, and MCA provided administrative support. MA wrote the original draft of the manuscript that was edited by PD, LA, AY, ED, NW, MCA, NP, BH and JC. All authors read and approved the final manuscript.

Funding
This research was supported by a grant to the London School of Hygiene and Tropical Medicine from COVID-19 response fund. The funders do not play a role in study design, collection, management, analysis and interpretation of data. They did not influence the writing of the report and the decision to submit it.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study received ethical approval from the National Ethical Review Committee of the Ministry of Health in Benin (No. 051/MS/DC/SGM/CNERS/SA) and the Institutional Review Board of the London School of Hygiene and Tropical Medicine (No. 26397).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 20 January 2025 / Accepted: 17 May 2025
Published online: 06 June 2025

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