

'We are not going to shut down, because we cannot postpone pregnancy': a mixed-methods study of the provision of maternal healthcare in six referral maternity wards in four sub-Saharan African countries during the COVID-19 pandemic

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ABSTRACT

Introduction Referral hospitals in sub-Saharan Africa are located in crowded urban areas, which were often epicentres of the COVID-19 pandemic. This paper prospectively assesses how maternal healthcare was provided in six referral hospitals in Guinea, Nigeria, Tanzania and Uganda during the first year of the COVID-19 pandemic.

Methods Mixed-methods design using three data sources: (1) qualitative data from repeated rounds of semi-structured interviews conducted between July 2020 and February 2021 with 22 maternity skilled health personnel (SHP) on perceptions of care provision; (2) quantitative monthly routine data on caesarean section and labour induction from March 2019 to February 2021; and (3) timeline data of COVID-19 epidemiology, national and hospital-level events. Qualitative and quantitative data were analysed separately, framed based on timeline analysis, and triangulated during reporting.

Results We identified three periods: first wave, slow period and second wave. The first wave was challenging for SHP given little knowledge about COVID-19, lack of infection prevention and control training, and difficulties reaching workplace. Challenges that persisted beyond the first wave were shortage of personal protective equipment and no rapid testing for women suspected with COVID-19. We noted no change in the proportion of caesarean sections during the pandemic, and a small increase in the proportion of labour inductions. All hospitals arranged isolation areas for women suspected/confirmed with COVID-19 and three hospitals provided care to women with suspected/confirmed COVID-19. Breastfeeding was not discouraged and newborns were not separated

Key questions

What is already known?

- Restriction measures used to curb the spread of COVID-19 interrupted the provision of maternal healthcare services and led to adaptations across the entire continuum of care including antenatal care, intrapartum and postnatal care.
- Maternity skilled health personnel (SHP) were at the forefront of implementing regularly updated guidelines and faced many challenges during the COVID-19 pandemic.
- Referral maternity wards in sub-Saharan Africa are mostly located in crowded urban areas which were often epicentres of the COVID-19 pandemic, and some of them assumed the role of healthcare provision for pregnant women suspected or confirmed with COVID-19.

from mothers confirmed with COVID-19. Care provision was maintained through dedication of SHP, support from hospital management and remote communication between SHP.

Conclusion Routine maternal care provision was maintained in referral hospitals, despite first wave challenges. Referral hospitals and SHP contributed to guideline development for pregnant women suspected/confirmed with COVID-19. Maternity SHP, women and pregnancy must always be included in priority setting when responding to health system shocks, including outbreaks.

Key questions

What are the new findings?

- ▶ Maternity wards in referral hospitals and maternity SHP advocated for the inclusion of pregnant women in the planning and response to the COVID-19 pandemic at the national level, including leading and contributing to guideline development and training of lower-level facilities.
- ▶ Routine care provision was dynamically adapted to include infection prevention and control measures, such as reducing the number of allowed visitors and reducing the length of hospital stay after birth; no changes to indications of caesarean sections and labour inductions were reported.
- ▶ Care provision to women suspected/confirmed with COVID-19 was challenging as a result of lack of rapid testing for women in labour, confusion of symptoms of COVID-19 with those of obstetric complications, and lack of guidelines and training.

What do the new findings imply?

- ▶ Concrete efforts must be put in place to increase staffing levels in maternity wards, alleviate crowding, make rapid testing for COVID-19 available for women in labour and ensure a sustained supply of protective equipment.
- ▶ Essential healthcare services, including maternity care, and front-line maternity SHP must be prioritised in planning and response as the COVID-19 pandemic continues to evolve, and in upcoming healthcare system shocks.

INTRODUCTION

COVID-19 was declared a pandemic on 11 March 2020 by the World Health Organization (WHO). As of 19 October 2021, over 240 million confirmed cases of COVID-19, and around 5 million deaths, were reported globally.¹ Out of those, more than 8 million cases and almost 216,000 deaths were reported in Africa.² Governments and health systems struggled globally to respond to the rapid spread of a new disease. In maternity care, evidence regarding the effect of SARS-CoV-2 infection during pregnancy and childbirth was inconclusive for a long period of the pandemic. This uncertainty was accompanied by reorganisation of care provision models and introduction of mitigation measures that were not supported by evidence, such as separation of mothers confirmed with COVID-19 from newborns and not allowing breastfeeding.^{3 4} Currently, there is evidence that women diagnosed with COVID-19 have higher risk of eclampsia/pre-eclampsia, maternal mortality, stillbirth, preterm birth and congenital birth defects.⁵⁻⁹ A multinational cohort study showed that delivery by caesarean section, but not breastfeeding, was associated with an increased risk of SARS-CoV-2 transmission to newborns.⁸ The WHO recommends that for women confirmed with COVID-19, labour induction and caesarean section should only be undertaken when medically indicated, and that breastfeeding should be encouraged.¹⁰

The impact of the pandemic is not limited to affecting women diagnosed with COVID-19. During the early days of the pandemic, between 8.3% and 38.6% increase in maternal deaths per month were projected across 118

countries as a result of disruptions in service provision and access.¹¹ There is evidence that there have been significant increases in stillbirths and maternal deaths in low- and middle-income countries¹² mostly driven by COVID-19 restriction measures such as lockdowns and travel bans, which limited the availability of and women's access to quality services. Provision of antenatal and postnatal care was reportedly disrupted in over one-third of countries, while a quarter reported disruptions in facility-based births (n=121).¹³ Aside from interruptions to care provision, many adaptations were implemented, the implications of which on the quality of care remain unknown. Those include care provision with telemedicine, attempts to minimise the duration women spend in hospitals (either by labour induction or by discharging early after birth), changes in anaesthesia practices and reduction in the number of allowed companions during birth.¹⁴⁻¹⁶ In an effort to minimise negative consequences, international and national guidelines were developed, modified and adapted for maternal health service provision across the entire continuum of care including antenatal care, intrapartum and postnatal care.¹⁷⁻²¹

Maternity skilled health personnel (SHP)—including doctors, nurses and midwives—were at the forefront of implementing these regularly updated guidelines and faced many challenges during the COVID-19 pandemic.³ In a global context of shortage of personal protective equipment (PPE), pre-existing shortage of SHP, and lack of clear information and guidelines,^{22 23} maternal and newborn SHP worried about their own health and were concerned over occupational exposure to COVID-19 in the workplace, and transmitting the infection to patients, family and friends.^{3 24-27} A meta-analysis shows that stress disorders, depression, anxiety, and insomnia are highly prevalent among SHP during periods of epidemics and pandemics, including COVID-19.²⁸ A recent study in Ghana and Kenya shows significant declines in job satisfaction and increase in stress and burnout among frontline healthcare workers during the COVID-19 pandemic.²⁹ In Nigeria, maternal and newborn healthcare providers worried about stigmatisation or discrimination as a result of their potential exposure to COVID-19, and 87% experienced work-related burnout because of the COVID-19 pandemic.²⁶

In sub-Saharan Africa, large tertiary referral hospitals are designed to primarily provide care for women with high-risk pregnancies, however they also serve large numbers of low-risk women who prefer to seek care in high-level facilities.^{30 31} In addition, these referral hospitals take care of the most complicated obstetric cases, provide outpatient and inpatient care to thousands of women and newborns annually, conduct critical research, and train the next generation of SHP, including obstetricians, midwives, and nurses. The majority of these hospitals are located in crowded urban areas with large catchment population. COVID-19 largely spread and was highly concentrated in large cities in many countries, and cities like Lagos, Nairobi and Johannesburg have all

been the epicentres of their respective countries.² During the COVID-19 pandemic, some of these facilities have assumed the role of healthcare provision for pregnant women suspected or confirmed with COVID-19.³² In addition, these facilities have led training, guideline and protocol development and testing of service adaptations in the sub-region.

Townsend *et al.* document a gap in the literature on maternity care provision during the COVID-19 pandemic in low- and middle-income countries, particularly in sub-Saharan Africa,¹⁶ as the majority of the papers published from these contexts quantitatively describe changes in service utilisation.^{33–37} A comprehensive, in-depth, quantitative and qualitative assessment of situation from the perspective of maternal SHP is lacking from the region. This paper is part of a larger study that presents an in-depth description of maternity care in six large maternity referrals in four sub-Saharan African countries (Guinea, Nigeria, Tanzania and Uganda) throughout the first year of the COVID-19 pandemic. The objective of this paper is to prospectively assess the effect of the COVID-19 pandemic on the provision of maternal health services in six large referral hospitals, using a mix of deductive and inductive approaches to allow a flexible and iterative process in exploring the topic at hand.

METHODS

Study design

This study uses a mixed-methods design, relying on three main types of data: qualitative data from key-informant interviews, quantitative routine hospital data, and timeline data of national and hospital-level events and trends during the COVID-19 pandemic. Data from the quantitative and qualitative strands were collected in parallel, analysed separately and framed in light of the timeline analysis. Findings from the qualitative and quantitative strands were triangulated at the reporting stage which allowed for a cross-comparison between the reports of key-informants and the routinely collected statistics.³⁸

Hospital selection and profiles

We purposively selected six hospitals to be included in this study, with a focus on including hospitals with large referral maternity wards in urban areas from four sub-Saharan African countries (Guinea, Nigeria, Tanzania, Uganda). The selection ensured diversity of healthcare systems in sub-Saharan Africa. Online supplemental table S1 describes in detail the characteristics of each hospital and maternity ward. The participating hospitals are Hôpital National Ignace Deen (HNID) and Hôpital Régional de Mamou (HRM) in Guinea, Lagos University Teaching Hospital (LUTH) in Nigeria, Muhimbili National Hospital (MNH) in Tanzania, Kawempe National Referral Hospital (KNRH) and Mulago Specialised Women's and Neonatal Hospital (MSWNH) in Uganda.

Data

Timeline data

We captured and summarised key events that could influence service provision at the level of participating hospitals during the period between 1 January 2020 and 28 February 2021, through biweekly team meetings and insights from principal investigators (PIs) and co-PIs. Such events include presentation of the first COVID-19 positive obstetric case, periods of closure of maternity services, opening of COVID-19 isolation centre, modifications in service provision and requirements for patients or their relatives, and deployment of new guidelines. On the national level, we sourced key events from the Oxford COVID-19 Government Response Tracker.³⁹ These include periods of national lockdown(s), night-time curfews, domestic travel bans and mask mandates, among others. The initial data were verified for accuracy and expanded with contextual details by the country teams and through a desk review of weblinks describing the national events. The events were laid over a timeline of the numbers of cases and deaths due to COVID-19 at the national level, collected from 'Our World in Data'⁴⁰ and validated on the WHO COVID-19 dashboard.¹ Global events were sourced from the WHO panel.

Routine data

Monthly aggregated routine health statistics covering the period between 1 January 2019 and 28 February 2021 (24 data points for 24 months) were collected from each of the participating maternity wards. For this analysis, we included two routine indicators representing two aspects of care provision and content of care: caesarean section and labour induction. Indicator definition and data sources by maternity ward are included in online supplemental table S2. When multiple data sources for the same indicator were available, data were collected from all sources and validated against each other. In case of discrepancy, the researchers included values from the most reliable source according to hospital staff and data clerks.

The fieldwork to collect the monthly aggregate data occurred between 1 June 2020 and 28 March 2021, and was conducted by clinical researchers in collaboration with clinicians and data clerks or record officers from the participating hospitals. Aggregated monthly values of indicators were entered into a standardised Excel sheet, and a thorough data review and verification exercise was conducted (at least twice for each hospital). This exercise allowed for detection of outliers and missing values and ensuring data quality and completeness in all six hospitals. We conducted descriptive analysis of each indicator for a period of 24 months, divided into two 12-month time periods: from March 2019 to February 2020 labelled as *pre-COVID-19*; and from March 2020 to February 2021 labelled as *during COVID-19*. We displayed the results as frequencies and percentages in combined bar and line charts. Changes were explored and compared between the two time periods and were triangulated against findings from qualitative interviews.

Table 1 Number of skilled health personnel interviewed and number of interviews per respondent, by hospital

Hospital (country)	Respondent	Number of interviews
HNID (Guinea)	A	2
	B	3
	C	4
	D	3
	E	1
	F	1
HRM (Guinea)	A	3
	B	4
	C	4
	D	4
LUTH (Nigeria)	A	3
	B	3
	C	3
	D	1
MNH (Tanzania)	A	1
	B	3
	C	2
	D	1
KNRH (Uganda)	A	1
	B	1
MSWNH (Uganda)	A	1
	B	1
Total	22	50

HNID, Hôpital National Ignace Deen; HRM, Hôpital Regional de Mamou; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital; MNH, Muhimbili National Hospital; MSWNH, Mulago Specialised Women's and Neonatal Hospital.

Key-informant interviews with maternity SHP

We conducted semi-structured interviews between July 2020 and February 2021 through repeated rounds of data collection with two to six maternity SHP in each maternity ward. Each hospital's PI suggested a list of potential key-informants, purposively selected to ensure maximum variation in the experiences of SHP, including from various seniority levels (junior and senior staff), cadres (medical doctors, midwives and nurses) and genders. If the selected SHP expressed interest in participating, their contact information was shared with ND and LB. The researchers randomly selected some of the key-informants on the list, and invited them to participate in

the interview. Informed consent was administered by ND and LB for respondents in Guinea, Nigeria and Tanzania, and by the PI in Uganda. Recruitment stopped when data saturation was reached for each round of data collection. Respondents were compensated for their time and use of mobile data after each interview. In total, 22 SHP were interviewed, and 50 interviews took place (table 1).

We used a semi-structured interview guide, allowing us to consistently and comprehensively capture changes in the processes of care provision across all hospitals over the study period. The guide included questions and probes on SHP's perceptions of changes in care inputs (staff, equipment, supplies, beds, training, information materials), care processes (e.g. which services are available, how the wards are organised), and any observations on effectiveness of measures taken to prepare or care for women and newborns with COVID-19. Interviews were conducted by two researchers virtually using Zoom for Nigeria, Tanzania and Uganda (LB), and face-to-face in Guinea (ND). Interview duration ranged between 20 and 120 min. Interviews were recorded and transcribed in the language of the interview (English or French languages), de-identified using a coding scheme and imported into the computer-assisted qualitative data analysis software Dedoose. Analysing the qualitative data was an iterative process and started concurrently with data collection allowing the researchers to adapt the interview guide in the repeated interview rounds based on respondents' answers to the previous rounds and to the country situation.

Data analysis was conducted using the framework method which belongs to the family of qualitative content analysis.⁴¹ Three researchers (ND, AS and LB) familiarised themselves with the data by re-listening to the recordings and reading the transcripts. The researchers then coded independently six interviews from which new codes and themes were identified (inductive analysis) keeping the structure of the interview guide in mind (deductive). Codes were grouped in categories into a tree diagram (with parent codes and child codes up to three levels). The coding tree was refined during the analysis by adding, merging and deleting codes as appropriate. The coding tree was applied to the 50 interviews systematically by one researcher and checked by another (ND, AS, LB). We mapped the themes and examples emerging from these interviews into a matrix by period (first wave, slow period, second wave—table 2) and by three key dimensions (healthcare worker experiences, changes in the provision of routine maternity care and care for

Table 2 Identified time periods and their respective dates per country

Country	First wave	Slow period*	Second wave*
Guinea	From March to August 2020	From September 2020 to January 2021	--
Nigeria	From March to June 2020	From July to October 2020	From November 2020 to January 2021
Tanzania	From March to June 2020	From July to November 2020	From December 2020 to January 2021
Uganda	From March to June 2020	From July to September 2020	From October 2020 to January 2021

*The last time periods' end date was selected as the end of the study period: January 2021.

women confirmed with COVID-19, that is, women who had a positive PCR test result during their stay in the hospital) separately for each maternity ward. These extensive notes in the matrix were shared with hospital PIs to confirm objective statements related to the timeline, for example, dates of service closures or introduction of new guidelines. The themes were further summarised to capture similarities and differences across the three time periods and six hospitals, and to identify relationships between the main themes and sub-themes in the data. Illustrative quotes were added to the results to give examples of the themes and sub-themes in the data; respondents are referred to by randomly assigned codes for confidentiality purposes.

Triangulation and synthesis

This research project was based on principles of stakeholder analysis, self-reflection, supportive cross-country learning and support to junior researchers in the team. The triangulation and synthesis of data from the three data sources was conducted in an iterative, prospective and collaborative manner, by sharing and discussing findings during 21 biweekly research team meetings between May 2020 and March 2021, and upon completion of all data collection in April–July 2021. Triangulation involved summarising the qualitative and quantitative data by the three identified time periods. Time trends observed in the routine data indicators were compared against findings from the qualitative data, including SHP's perceptions and views on content of care provision, to identify and discuss alignment and/or differences between the two data sources over time.

RESULTS

We identified three time periods based on the timeline analysis with key events, the epidemiological data described by Salyer *et al*¹² and through regular communication with country teams (table 2). The results of the key-informant interviews and the routine data are reported in an integrated manner against the three identified time periods, starting with a description of the key events related to care provision by the three identified time periods (figure 1).

Timeline of key hospital, national and global events

The extracted national timeline data show that in Guinea, the first wave extended from March to August 2020, when national restriction measures were initiated, including travel restrictions, night-time curfew, domestic travel ban and bans on mass gatherings. At the hospital levels, staff were reorganised into 24-hour teams and interns were put on mandatory leave since 26 March 2020. In HNID (Guinea), all team communications were moved to WhatsApp; and in HRM (Guinea), a COVID-19 response committee was established. During the slow period, from July to January 2020, a COVID-19 treatment centre opened in Mamou, and the first obstetric case with COVID-19 was received at HNID (Guinea). Interns returned from the mandatory leave in November 2020 in HRM, and in December 2020 in HNID.

In Nigeria, the first wave extended from 30 March 2020 until July 2020. During this period, a night-time curfew, school closures, mandate on face masks in public and a ban on gatherings of more than 50 people were instituted at the national level. The Society of Gynaecology and Obstetrics of Nigeria recommended guidelines for service provision on 27 March 2020. At the hospital level, antenatal care started to be provided as a hybrid model (in-person and telemedicine consultations) as of 23 March 2020, and the maternity service closed between 6 May and 1 June 2020 due to shortage in maternity SHP following diagnosis with COVID-19. A LUTH (Nigeria) isolation centre started operating from 7 April and the first obstetric case with COVID-19 in LUTH (Nigeria) was received on 25 April 2020. The slow period extended between July and October 2020, during which only a night-time curfew and mask mandate continued to be applied. The second wave started in November 2020, with a sharp rise in the number of COVID-19 cases in January nationally.

In Tanzania, the first wave extended between March and June 2020. During this period, schools closed, there was a ban on mass gatherings and travel restrictions were applied at the national level. In MNH (Tanzania), antenatal care visits were spaced for women of low-risk, an isolation centre opened, and limitations were applied to hospital visitations by relatives and attendance of health worker meetings. The first obstetric COVID-19 case was received at MNH (Tanzania) on 13 April 2020. By 4 July 2020, the government declared that the pandemic was over in Tanzania indicating the start of the slow period. No new confirmed cases of COVID-19 were added to the country total of 509 after this. In December 2020, we noted from the country team and respondents the beginning of an increase in the spread of the virus nationally, indicating the beginning of the second (undeclared) wave, when no national restriction measures were witnessed.

In Uganda, the first wave extended between March and June 2020, a period during which a night-time curfew was instituted. This period also witnessed the implementation of school closures, mask wearing mandate, travel restrictions, ban on mass gatherings and domestic travel bans. At the level of the hospitals, guidelines limited the number of relatives allowed to visit to one, outpatient clinics closed, and elective surgeries were limited or stopped. The first obstetric case with COVID-19 was diagnosed on 12 April 2020. The national-level mitigation measures continued to be implemented during the slow period, between July and September 2020, except for the curfew. In October 2020, the number of COVID-19 cases nationally started to rise, indicating the beginning of the second wave, with a peak reached in December 2020. During this period, two floors at MSWNH (Uganda) were dedicated strictly to COVID-19 treatment.

On 1 June 2020, the WHO issued guidance on maintaining essential services, including maternal and newborn services.

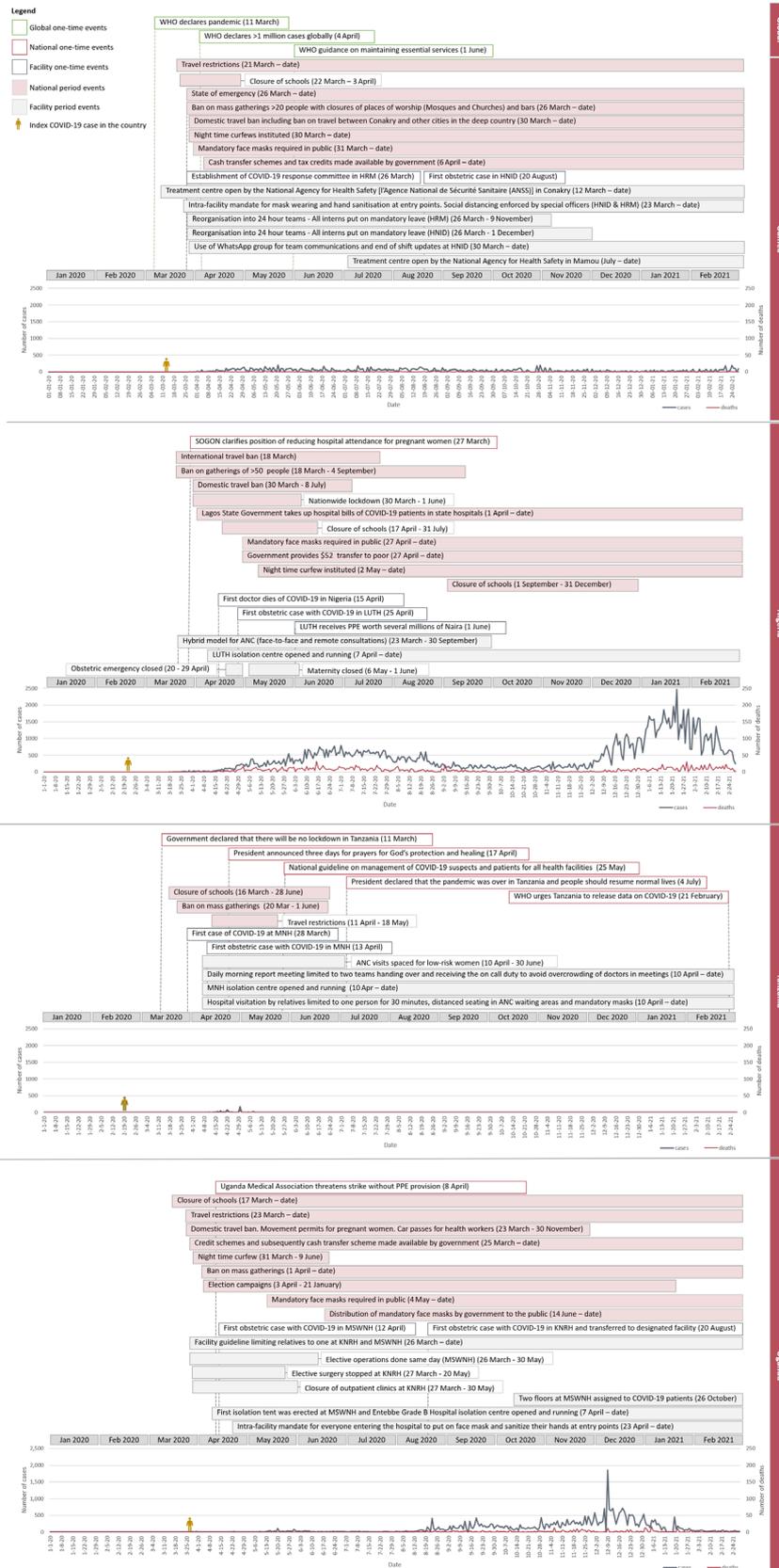


Figure 1 Timeline of key events and COVID-19-confirmed cases and deaths in Guinea, Nigeria, Tanzania and Uganda. ANC, antenatal care; HNID, Hôpital National Ignace Deen; HRM, Hôpital Régional de Mamou; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital; MNH, Muhimbili National Hospital; MSWNH, Mulago Specialised Women's and Neonatal Hospital; PPE, personal protective equipment; SOGON, Society of Gynaecology and Obstetrics of Nigeria.

The results from the interviews and the analysis of routine data are reported with illustrative quotes and/or numbers and figures. The findings are summarised into three main themes: SHP's experiences; changes in provision of routine maternal care and caring for women with COVID-19.

Maternity SHP's experiences with care provision

Three sub-themes were identified during the first wave. First, SHP reported being stressed and fearful, predominantly due to lack of knowledge about the transmission of the new virus and best ways to protect themselves from infection on the job and consequently protect their families. Respondent B in LUTH (Nigeria) expressed: *'the first thing that happened was fear, until the hospital started training us and we got an understanding of the disease condition. Before [that] we were all scared.'* In Uganda, respondents additionally reported being negatively affected by what they described as a shock from the unexpected total lockdown. The second theme, closely linked to stress and fear, was related to working in an environment with a shortage of COVID-19-related PPE (especially high-grade face masks and hand sanitisers), not knowing which type of PPE was needed in different clinical encounters and having to purchase own PPE. Third, respondents described severe, often pre-existing, staff shortages in maternity wards which were exacerbated during COVID-19 due to infections and exposure among SHP, inability to travel during lockdown and lack of help from medical interns following their exclusion from staff rosters. Within this theme, respondents highlighted how staff went above and beyond their duty to continue providing maternity care; examples included sleeping in hospitals to ensure sufficient staffing or volunteering to provide care to COVID-19-positive pregnant women: *'despite the fact that there was hardship in travelling to come and reach work, the staff at Kawempe worked willingly. Some of them even slept over and woke up in the morning and continued work [...]'* (Respondent A, KNRH).

In the slow period and the second wave, respondents noted that they felt less stressed than during the first wave of COVID-19. This was related to improved availability of knowledge on SARS-CoV-2 transmission, and more clarity on the protective measures needed, especially after receiving training and protocols relevant to PPE use and rationing in most hospitals. In some hospitals, the improved availability of PPE, including as a result of transferring additional cost of PPE onto patients, also contributed to relieving stress among respondents. Nonetheless, issues with PPE availability continued during the slow period and second wave as Respondent B from MNH (Tanzania) explained during the slow period: *'Even now, we still don't have enough protective equipment. [...] they give you three face masks but you have to use them for one month, three for one month.'* Additionally, SHP worried about relaxation of uptake of protective measures on the community level (opening of churches, crowding in public transport, etc.) and lax adherence to rules on wearing masks and hand

hygiene among patients and visitors in the hospitals. This worry escalated in the second wave when COVID-19 cases were increasing in several countries, and new variants started to emerge globally. In Tanzania, respondents were reporting fear due to increase in the number of patients with COVID-19-like symptoms in the hospital while on the country level, it was impossible to understand the epidemic situation: *'in this country, it [COVID-19] has not been taken as a serious problem, so, people are just... life as usual'* (Respondent C, MNH).

Across all three periods and all maternity wards, we noted several differences in the experiences by cadre. For example, midwives in two Uganda hospitals did not receive a sufficient number of travel stickers to enable movement during lockdown compared with doctors; lower availability of PPE in the second and third time period was noted by midwives compared with doctors in MNH (Tanzania) and LUTH (Nigeria); and changes in staff shift duration to 24 hours in Guinea effectively resulted in only midwives being on duty at night while doctors went home.

Changes in provision of routine maternity care

Despite a few interruptions to service provision during the first wave, all hospitals continued to provide routine maternal care throughout the study period. This was made possible by the implementation of infection prevention and control (IPC) measures, and by adopting a set of adaptations and changes to pre-existing guidelines and protocols, to staffing and communication, and to care availability and content. Respondent D from Nigeria explained: *'when the pandemic started, almost all outpatient clinics of the hospitals were shut down, except the maternity service. We were the only people who said 'We are not going to shut down because we cannot postpone pregnancy' and some of these women, we have cared for them from the beginning, we cannot just turn our back on them. [...] but we had to modify our protocol and try to make the working environment safer.'*

Infection prevention and control

Respondents from Guinea, Nigeria and Tanzania indicated that many of the IPC measures that were implemented, and the preparedness related to preventing the spread of the infection, were inspired by lessons learnt from previous responses to Ebola virus disease (EVD) outbreaks. This included retraining the same personnel responsible of IPC, and the re-establishment of the same infectious disease committees in HRM (Guinea), LUTH (Nigeria) and MNH (Tanzania). In HNID (Guinea), hand washing stations that were functional during EVD outbreaks were reactivated as of the first wave.

All hospitals had initially established a temperature screening station at the main gate and maternity ward entry, required patients and their attendants to wear masks, and introduced strict rules on hand hygiene either by washing hands or using disinfecting solution. Many of the adaptations related to hand hygiene were highly appreciated by respondents and considered

as positive changes to potentially keep implementing even after the end of the COVID-19 pandemic, such as the installation of more hand washing stations closer to care points and with elbow closing. Nonetheless, these measures and patients' and visitors' compliance reportedly declined in the slow period. In the second wave, it was difficult to reintroduce these precautionary measures with increasing patient numbers, particularly in Tanzania considering the government's declaration that there is no COVID-19 in the country as of July 2020. A SHP in MNH (Tanzania) explained: *'If you come right now to the ward, you won't see anything special, you won't see any changes, the wards are full, women are there, they are not even wearing their masks, they don't even want to wear their masks sometimes'* (Respondent C, MNH).

Additionally, it was challenging for SHP to provide care with implementing distancing measures and spacing of beds and separating patients from one another, as hospitals suffered from crowding and lack of space availability even before the pandemic. Space constraints continued to exist and became serious concerns during the pandemic as they made physical distancing difficult to implement in practice: *'The guidelines are not hard to put in practice but the situation you are in, is what makes it difficult. [...] [reducing the number of labouring women in the ward] is still hard because of the lack of space we have at the moment'* (Respondent A, KNRH).

Guidelines and protocols

Adaptations to guidelines and protocols were reported in most hospitals throughout the three periods, and SHP mostly struggled with the applicability of these changes in resource-limited contexts. Care protocols before the COVID-19 pandemic did not allow birth companions in the maternity ward due to privacy issues, yet having visitors in inpatient wards was necessary to support women, bring them food and medication, clean laundry, etc. During the first wave, in all hospitals except in MNH (Tanzania), the number of allowed visitors in the postnatal period was reduced to one person as it was not possible to ban visitors altogether considering that they provide essential amenities to women during their hospital stay. These restrictions were lifted during the slow period and there were attempts to reintroduce them during the second wave. In MNH (Tanzania), reducing the number of visitors to two was gradually implemented in January 2021, which was further reduced to one visitor in February 2021; relatively late compared with the other hospitals. In all hospitals, SHP reported difficulties in enforcing the one-visitor rule, such as in Guinea due to cultural norms: *'This [crowding due to visitors] is one of the big problems of the service because people have the culture of coming in large numbers with the patients and people tend not to take the disease [COVID-19] into account in order to change this mentality. You still see 3 to 4 [visitors], so it's hard for us'* (Respondent D, HNID).

Before the COVID-19 pandemic, postnatal length of stay was relatively short to alleviate crowding, ranging

between 6 and 24 hours after a vaginal birth (table 1). During the study period, SHP reported that shortening the length of stay in hospitals after childbirth was not officially implemented as a change in guidelines and protocols and was not systematically applied. However, length of stay might have effectively reduced if the wards were crowded or upon women's request to leave the hospital early in fear of becoming infected with the virus: *'Before COVID-19, we tend to do 48 hours because the paediatricians want to do serum bilirubin on the baby before the woman goes home. Serum bilirubin is done 48 hours after birth, but now they go home [after] 24 hours, they can come from home to do it, or they teach them how to check for it once you see a sign of it just come'* (Respondent C, LUTH).

Staffing and team communication

Respondents in all hospitals reported changes in maternity ward staffing patterns during the first wave. These adaptations included changes in the number and type of cadres per shift and in shift duration to reduce number of staff on duty at any given point and to avoid contacts between different teams. Another factor that contributed to the reduction in the number of staff was the reassignment of maternity SHP to COVID-19 treatment centres in MNH (Tanzania) during the first wave: *'when COVID-19 was at its peak, most of the healthcare workers were taken from different wards and stationed in places where there were confirmed cases of COVID-19. [...] In the end there were only a few health workers left who had now to take care of the many patients who are not COVID-19'* (Respondent B, MNH). Additionally, the banning of medical students or interns from most hospitals contributed to staff shortage during the first wave and extended to the slow period in some hospitals.

The continuity of implementation of these measures over time varied by hospital. Some of these measures were relaxed in the slow period but remained in place and were reintroduced during the second wave. In Uganda, shortage of staffing was reported in the second wave because of lack of medical students/interns, and because of staff having to isolate: *'That is a stressful moment around the hospital now, because some staff get tested and are positive and have to stay off work more than 14 days [...] and we are facing hardship covering for this. It is very hard, but it is happening'* (Respondent A, KNRH).

On the other hand, respondents from Guinea reported that teaching and training of medical students and interns had to resume as soon as the situation allowed, in order to prevent the exacerbation of pre-existing shortages in SHP in the country: *'There are certain measures that need to be taken to adapt to the situation so as not to hinder the functioning of the hospital. We have lost a year of teaching of specialists, Guinea needs gynaecologists, we need to train them'* (Respondent C, HNID). The return of interns was perceived positively by SHP who reported starting to feel exhausted before interns were allowed to return to maternity wards.

Clinical team communication transitioned to virtual communication, predominantly WhatsApp group chats, during the first wave, and remained partly on this basis over the whole study period. This was most prominent in LUTH (Nigeria), where even maternal death review committee meetings were conducted virtually: *‘WhatsApp groups include all the doctors, all the nurses, the cleaners and the theatre technicians are part of it. Apart from the group one, we have sub-groups. [...] it is very very helpful, and it’s cost effective compared to trying to call, and the beauty of it, you can call in the poor network, once the person gets the [message] and even if it’s late they can respond’* (Respondent D, LUTH). Virtual communication was least used in MNH (Tanzania), where respondents reported that staff meetings continued to take place in person. Respondents reported that they were not reimbursed for the additional cost of working by accessing mobile data, and this was particularly noted as financially burdensome by nurses and midwives. Still, many respondents in Guinea mentioned that this virtual mode of communication was practical and worth continuing beyond COVID-19.

Care availability and modality

During the first wave, the provision of outpatient antenatal care in LUTH (Nigeria) and KNRH (Uganda) was severely affected by clinic closures. In order to reduce crowding in clinics, hospitals instituted longer time periods between antenatal visits, and/or replaced some outpatient care visits (antenatal, postnatal) with telemedicine appointments, such as in LUTH (Nigeria). The hybrid model of telemedicine and in-person antenatal care was appreciated by SHP in LUTH (Nigeria) as a positive adaptation that can be carried forward beyond the pandemic. Whereas respondents from hospitals in Guinea and Uganda reported not using telemedicine due to lack of connectivity, low levels of literacy among patients or lack of reimbursement to SHP of associated telecommunication costs. Respondents in several hospitals also commented that the quality of in-person consultations with women during the first wave was sub-optimal as health workers attempted to keep distance and shorten the duration of the interaction; for example, by asking about fetal movements as opposed to measuring fetal heart rate with a Pinard stethoscope: *‘[...] ‘Madam is your baby still moving, can you perceive the movement of the baby?’ The woman says ‘yes’. They just document that the baby is fine. And we know that that is not enough’* (Respondent C, LUTH).

In most hospitals, the provision of inpatient care was restricted to emergency cases, and all elective obstetric procedures were suspended during the first wave. In MNH (Tanzania), referrals were rerouted and transferred to another facility during the first wave. However, the decision to suspend elective surgeries was not officially supported by the hospital’s management considering the denial of the disease at the national level. SHP took the matter in their own hands as they informally tried to reduce the number of elective surgeries booked

in the operating theatre, given the risky environment in the theatre that promotes the spread of infection (closed space with bad ventilation). In Uganda, the availability of maternity care could have been compromised by the national health authorities’ proposal of designating MSWNH (Uganda) as a COVID-19 treatment centre. Nonetheless, the hospital’s management successfully negotiated that the hospital keeps its original function of providing care to women, and only dedicated two floors for the management of COVID-19 patients as of November 2020.

Routine care provided to women without COVID-19

Regarding the provision of routine care, respondents did not report any changes to the indications for caesarean section and labour induction. In the routine data, the proportion of caesarean sections was similar during the pandemic compared with the previous year in most hospitals, except for some increases noted in MSWNH (Uganda) during the majority of the pandemic period, and in MNH (Tanzania) in November 2020 (figure 2). The percentage of labour inductions out of all deliveries was highly variable month to month in all hospitals and did not exceed 7% in HNID and HRM (Guinea) but rose up to 14%–16% in LUTH (Nigeria) and MNH (Tanzania) (figure 3). Overall, a *small* increase in the proportion of labours induced was noted in most hospitals during the pandemic; in HNID (Guinea) starting in June 2020; in HRM (Guinea) as of November 2020; in LUTH (Nigeria) between May and November 2020; and in MNH (Tanzania) between March and August 2020. In Uganda, the proportion of labours induced was relatively constant throughout both years in KNRH (Uganda), and data were not available from MSWNH (Uganda).

Caring for women with COVID-19

Three of the hospitals participating in our study provided care to pregnant women suspected or confirmed with COVID-19 (table 3). The total number of confirmed cases ranged from 4 in MSWNH (Uganda), 5 in MNH (Tanzania) and 23 in LUTH (Nigeria) during the study period. From the interviews, five subthemes were mentioned and discussed by SHP: organisation of space; planning and coordination of hospital roles; symptom and case identification; lack of specific guidelines and training; and content of care; these are illustrated using quotes in online supplemental table S3.

Organisation of space

Despite an acute pre-COVID-19 lack of space and crowding, respondents described that all hospitals managed to set-up an isolation space during the first wave, whether it was a separate room or a curtained off area within the maternity ward. These isolation spaces had been used and retained throughout the study period in all hospitals except for MNH (Tanzania), where it was temporarily discontinued in the slow period and reinstated in another location during the second wave.

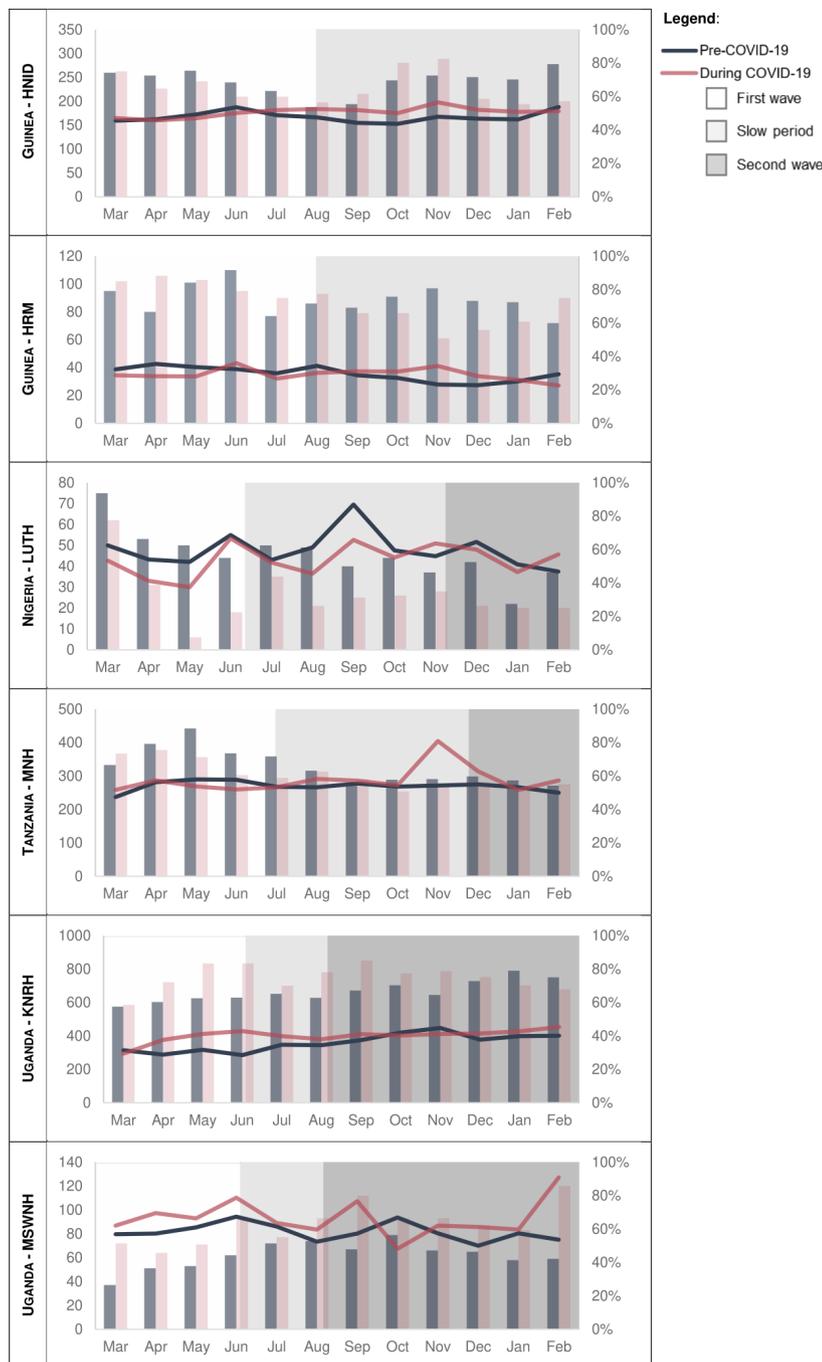
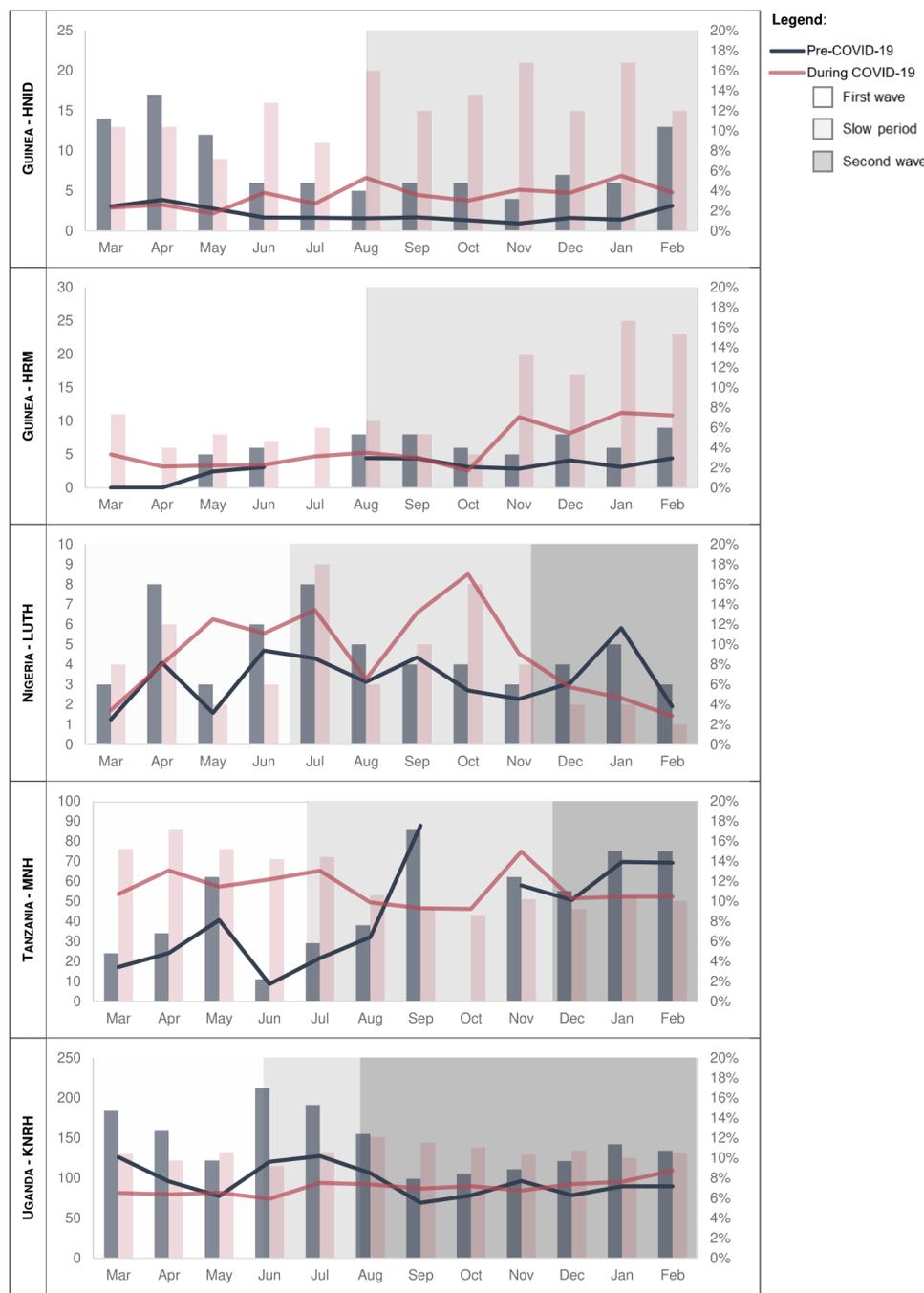


Figure 2 Number (left y axis—bars) and percentage (right y axis—lines) of caesarean sections out of all deliveries by month in each referral hospital before and during the COVID-19 pandemic. HNID, Hôpital National Ignace Deen; HRM, Hôpital Regional de Mamou; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital; MNH, Muhimbili National Hospital; MSWNH, Mulago Specialised Women’s and Neonatal Hospital.

Planning and coordination of hospital roles

During the first wave, respondents highlighted the importance of the maternity team’s preparedness for the first case of a woman admitted with suspected or confirmed COVID-19 infection, and the processes of care surrounding this case. This was complicated by the fact that in several settings, pregnant women with COVID-19 were not considered in the preparation plans, in terms of specialised staff and equipment in the dedicated

COVID-19 treatment centres; but neither were they expected to be cared for in regular maternity wards (e.g., no negative pressure operating theatres, insufficient staffing, no COVID-19 training to obstetric SHP). This gap resulted in somewhat last-minute planning and accommodation when a first case was admitted, and reluctance of SHP, even those who initially volunteered for COVID-19 teams, to provide care to women with COVID-19 symptoms. Respondents mentioned that receiving support



Data not available from Mulago Specialized Women's National Hospital (MSWNH) in Uganda

Figure 3 Number (left y axis—bars) and percentage (right y axis—lines) of labour inductions performed out of all deliveries by month in each referral hospital before and during the COVID-19 pandemic. HNID, Hôpital National Ignace Deen; HRM, Hôpital Régional de Mamou; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital; MNH, Muhimbili National Hospital.

from the hospital management enabled preparedness for and care provision to the first COVID-19 obstetric case. For example, in LUTH (Nigeria), a member of the team caring for the first obstetric COVID-19 case successfully communicated and advocated for the team's needs: *'in a short while [the hospital management] were able to fix whatever we needed them to fix in the theatre, they got us every kind of PPE we wanted, just to give confidence to the team'* (Respondent D, LUTH).

Challenges related to linkages to other health facilities and organisation of the referral system for women with confirmed COVID-19 were frequently mentioned by respondents. Respondents reported being confused about where women with COVID-19 symptoms should be referred and the role played by COVID-19 treatment centres in care for pregnant and postpartum women. This was discussed in light of the absence of obstetric teams in COVID-19 treatment centres in case a woman suspected

Table 3 Total number of women with suspected or confirmed COVID-19 from March 2020 to February 2021, per hospital

	Number of women with suspected COVID-19	Number of women with confirmed COVID-19
HNID (Guinea)	0	0
HRM (Guinea)	0	0
LUTH (Nigeria)	6	23
MNH (Tanzania)	50	5*
KNRH (Uganda)	0	0
MSWNH (Uganda)	13	4

* All five cases were recorded before May 2020
HNID, Hôpital National Ignace Deen; HRM, Hôpital Regional de Mamou; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital; MNH, Muhimbili National Hospital; MSWNH, Mulago Specialised Women's and Neonatal Hospital.

or confirmed with COVID-19 is imminently giving birth or suffering from an obstetric emergency. According to our respondents, this system requires efficient communication and coordination between hospitals, which was not always the case. This element seems to have improved somewhat over the study period, with clarifications on roles of hospitals and teams, processes, transfers, referrals; although this was continuing to occur in a context of critical shortages of staff, ambulances, space and oxygen.

Symptom and case identification

Two topics about women suspected with COVID-19 were mentioned by respondents in all three time periods of this study. First, in day-to-day work, they struggled with the difficulty in distinguishing symptoms such as fever, difficulty breathing and cough, which are similar between obstetric complications (e.g., pulmonary embolism, postpartum sepsis) and other common illnesses (e.g., malaria) and COVID-19. Second, in situations where a woman with such non-specific symptoms was admitted in maternity wards, SHP noted that lack of rapid testing for COVID-19 during the entire study period in all hospitals (24–48 hours of waiting times for test results were reported) contributed to increased potential exposure to COVID-19 among SHP and other patients and caused critical delays in providing care to women.

Lack of guidelines, support and training

Health workers highlighted the importance of having clear guidelines in place for the provision of care to women with suspected/confirmed COVID-19. This was achieved completely in LUTH (Nigeria) by the second wave, with regular updates being included in the guidelines and communicated to SHP, according to international recommendations. In Guinea, the hospitals regularly received updated guidelines from the Ministry of Health, but no official training on the management

of COVID-19 obstetric cases was conducted. In MNH (Tanzania), guidelines were developed but not officially approved, this was a key gap noted by respondents, and resulted in women with COVID-19 symptoms receiving care in the same spaces and by same staff as those without suspected COVID-19: 'we still have some dilemmas at the time of management, like when you see a pregnant woman [...], is it COVID-19 patient? And we don't know at what time you have to deliver the woman and so forth. So, sometimes, in terms of guideline, I think we have not reached to that point yet' (Respondent D, MNH).

Content of care

In terms of content of care to women confirmed with COVID-19 and their babies, none of the respondents reported that breastfeeding was discouraged, or that newborns were separated from their mothers, unless the mothers were extremely unwell. Respondents in HNID (Guinea) reported augmenting or speeding up labour among women with COVID-19 symptoms, and respondents at LUTH (Nigeria) commented that most women with COVID-19 gave birth by a caesarean section but this was required by the women's clinical condition rather than a result of trying to shorten labour or duration spent in the maternity ward.

Synthesis of findings on maternity care provision during the COVID-19 pandemic: challenges, facilitators and care provision over time

Figure 4 summarises the themes and sub-themes identified in the interviews and routine data analysis and displays them by study period, highlighting the extent and nature of challenges that maternity SHP faced and the adaptations and strengths that enabled care provision to continue. Overarching themes that were mentioned in most of the referral hospitals are included in the figure, as well as some themes which are specific to certain hospitals/countries. The name of the hospital and/or country is specified in parentheses next to each of these country-specific themes. The majority of challenges and barriers appeared during the first wave and were overcome as the slow period began. These 'short-term' challenges include maternity SHP's lack of knowledge about COVID-19, lack of training on IPC and inability to reach the workplace, among others. Other challenges persisted during the slow period and/or second wave, such as lack of PPE, lack of rapid testing for women suspected with COVID-19 and difficulties in distinguishing COVID-19 symptoms from symptoms of obstetric complications. Two challenges appeared in the slow period and continued during the second wave, and those were linked to a decline in the national-level and community-level commitment to acknowledge the pandemic and actively prevent its spread. Noteworthy, challenges that maternity wards faced before the COVID-19 pandemic, such as shortage in SHP and crowding in maternity wards, were exacerbated throughout the study period and negatively affected care processes.

	Pre-COVID-19	First wave	Slow period	Second wave
Challenges / barriers		<ul style="list-style-type: none"> Shortage in skilled health personnel in maternity wards Crowding and lack of space in hospitals and maternity wards 		
Adaptations / facilitators		<ul style="list-style-type: none"> Lack of knowledge on COVID-19 mode of transmission and prevention Lack of training on infection prevention and control for maternity skilled health personnel Travel restrictions prevent skilled health personnel from reaching workplace Skilled health personnel in isolation because of infection/suspicion to have COVID-19 Perceived decline in quality of in-person care because of prevention measures and fear of infection among skilled health personnel Not accounting for pregnant women when planning for COVID-19 preparedness and response Unclear linkages with other facilities / unclear roles of maternity wards in the response to COVID-19 <p><u>Country/Hospital specific themes:</u></p> <ul style="list-style-type: none"> Sudden application of strict national lockdown (Uganda) Re-assignment of maternity skilled health personnel to COVID-19 wards (Tanzania) Closure of outpatient clinics (LUTH – Nigeria / KNRH – Uganda) 	<ul style="list-style-type: none"> Interns and medical students excluded from care provision teams Lack of knowledge on use and rationing of personal protective equipment Restricting inpatient services to essential emergency services (cancellation of elective surgeries) 	<ul style="list-style-type: none"> Relaxation of the infection prevention measures at the community and hospital level Denial of the COVID-19 pandemic at the country level (Tanzania)
Care provision		<ul style="list-style-type: none"> Previous experiences in responding to infectious disease outbreaks (particularly response to Ebola virus disease outbreaks) Infection prevention and control measures implemented at the hospital / maternity ward among patients and visitors 	<ul style="list-style-type: none"> Transition to virtual communication among team members Changes in the numbers and cadres of skilled health personnel during shifts Skilled health personnel's dedication to care provision during the pandemic and volunteering to assist in care provision to confirmed cases Support from hospital management for providing care to obstetric cases with confirmed COVID-19 (LUTH - Nigeria) 	
Care to women with COVID-19		<ul style="list-style-type: none"> No change in indications for labour inductions No change in indications for caesarean section 	<ul style="list-style-type: none"> Reduced number of allowed visitors in maternity/postnatal ward to 1 or 2 Shorter length-of-stay depending on the crowding level and women's requests Providing some antenatal care visits with telemedicine in a hybrid model (LUTH - Nigeria) 	
Routine maternity care		<ul style="list-style-type: none"> No separation of mother and newborn Breastfeeding encouraged when mother feeling well Women confirmed with COVID-19 mostly gave birth by caesarean section Designated space in hospitals for women with suspected/confirmed COVID-19 Labour induction conducted for women with COVID-19 symptoms to speed up labour (HNID - Guinea) 		

Figure 4 Challenges, adaptations, and care provision before and during the COVID-19 pandemic. HNID, Hôpital National Ignace Deen; KNRH, Kawempe National Referral Hospital; LUTH, Lagos University Teaching Hospital.

The majority of the identified adaptations and facilitators were 'long-term', initiated during the first wave and continued to be applied in the second wave, such as virtual communication between SHP, dedication and commitment of maternity SHP to provide care under difficult circumstances, and support received from the hospital management. The implementation of these adaptations fluctuated dynamically based on resources and epidemiological situation.

DISCUSSION

This paper explores how maternity care was provided between March 2020 and February 2021, during the first year of the COVID-19 pandemic, in six referral maternity wards in sub-Saharan Africa, using three data sources. Our findings show that the provision of routine maternal care, particularly childbirth care, was generally maintained in these hospitals, despite few interruptions during the first wave. Staffing shortages, lack of PPE, and absence of guidelines and training for maternity staff were some of the factors that led to stress among SHP and contributed to perceived declines in care quality. Nonetheless, maternity wards were able to successfully address most of these challenges during the slow period and second wave. According to SHP, some of the implemented IPC measures negatively affected the quality of care. However, routine procedures and guidelines were

mostly preserved in the four countries, and no substantial changes in the proportions of caesarean sections and labour inductions were observed during the COVID-19 pandemic compared with the year before. On a national level, pregnant women were excluded from the response planning early in the pandemic, but the referral hospitals and SHP actively advocated for their inclusion and contributed to guideline development for pregnant women suspected/confirmed with COVID-19. Three of the six hospitals reportedly provided care to pregnant or birthing women confirmed with COVID-19, and they all continued to encourage breastfeeding and were against separation of mother and newborn throughout the study period.

Based on the timeline analysis, the interviews and the discussions with country teams, this paper prospectively documents how challenges, adaptations and facilitators evolved over three time periods. We identified short-term challenges to care provision that were resolved during or just after the first wave. Most of these challenges were linked to the novelty of the disease, such as the little available knowledge about it initially, and the surprise factor resulting from the sudden implementation of restriction measures. Therefore, these initial challenges were easily addressed as the global and local communities became more familiar with COVID-19. In the case of the six hospitals, they also benefited from previous experiences

with infectious disease outbreaks to overcome these challenges efficiently. Nonetheless, the short duration of these challenges should not undermine their impact on care provision and on the well-being of maternity SHP. Several studies have documented an increase in stress levels, anxiety and depression among frontline workers during the COVID-19 pandemic, and a systematic review shows that PPE shortage, inconsistent information and long working hours are associated with SHP's experiences during pandemics and epidemics globally.^{28 29} Maternity SHP must be included in the priority setting when responding to health system shocks as they constitute a pillar of the WHO's quality of care model.^{43 44} Importantly, women and pregnancy should always be included during the early planning and response to health system shocks, including outbreaks.

Long-term or persistent challenges were also identified, and two of them (shortage in SHP and crowding in maternity wards) existed before the COVID-19 pandemic. These are systemic challenges requiring high-level commitment from health authorities, preparedness, planning and resource availability. Concrete efforts must be put in place to increase staffing levels, alleviate crowding in maternity wards, make rapid testing for COVID-19 available for women in labour and ensure a sustained supply of PPE.

The triangulation of three data sources allowed to visualise how national-level factors coincide with implementing/not implementing adaptations at the hospital level, and how this differed between countries and hospitals. For example, countries' decisions to allocate specific COVID-19 treatment centres can dictate the level of involvement required from maternities in the response, such as the specialisation in treating obstetric cases confirmed with COVID-19, as was the case in Nigeria.³² The epidemiology of COVID-19 at the national levels, which was driving decision-making on IPC mandates, was also reflected in the experiences of SHP and their morale over time. The higher the number of diagnosed COVID-19 cases in the community, the higher the chance of having pregnant women confirmed with COVID-19 in the maternity ward. As such, SHP in HRM (Guinea) did not describe any interactions with women confirmed with COVID-19. In Tanzania, the lack of acknowledgement of the disease on a national level was perceived as a difficulty in responding to COVID-19 at MNH (Tanzania), since no clear facility roles or referral systems were implemented, nor were any official guidelines on the management of women confirmed with COVID-19 approved after June 2020.

The cross-country comparison shows how the impact of COVID-19 on provision of maternity care depends on the extent of the epidemiological situation, but most importantly on the pre-existing health system infrastructure and preparedness. For example, in Uganda, SHP faced difficulty in implementing the recommendations due to logistical and resource-related constraints, such as the difficulty in keeping a distance 1.5 m between

women when the maternity wards are crowded and there is not enough space. Country, hospital and ward specificities should be taken into consideration when developing international guidelines and recommendations in response to health system shocks. Voices from low- and middle-income countries should contribute to the guideline development process in a way to ensure that adaptations are achievable within the local circumstances.⁴⁵

Previous experience with the 2014 EVD outbreak is also one of the national-level factors that could have influenced the response during the COVID-19 pandemic. In Guinea, we noted a rapid and efficient revival of response committees which were functioning during the EVD outbreak at the hospital levels. Nationally, a multidisciplinary scientific committee for the COVID-19 responses was established, and this committee was chaired by a woman, a gynaecologist, and two vice-chairmen, an anthropologist and a virologist⁴⁶; which could have contributed to maintaining maternity care as a priority during the pandemic. Additionally, many of the challenges to care provision during the COVID-19 pandemic were common with those experienced during the EVD outbreak, such as travel restrictions, facility closure, exclusion of pregnant women from services and fear among SHP.⁴⁷ Nonetheless, our prospective analysis shows that these challenges did not extend beyond the first wave of COVID-19, possibly showing how health systems in the region have retained lessons from the EVD response and applied them rapidly during the COVID-19 pandemic. Last, in our study, we document how SHP went above and beyond their duties to continue to provide care during the pandemic, and how they volunteered to care for the first women confirmed with COVID-19 in their wards. This dutifulness and sense of responsibility among maternity SHP was also paralleled during the 2014–2016 EVD outbreak in Sierra Leone.⁴⁸

Through this research study, we document key events at the level of the maternity ward that shaped the ability to provide maternal care during the COVID-19 pandemic, and we show how these measures fluctuated over time. Such measures include service closures, referrals to other facilities including COVID-19 treatment centres, new guidelines on changes in visiting rules, on mask wearing mandates, on patients paying PPE costs, among others. These hospital-level mitigation measures were also factors in determining trends in utilisation of maternity healthcare services including antenatal and postnatal care.⁴⁹ Unlike national-level key events for which a number of databases were set up immediately, hospital and maternity ward-level events do not seem to be reported or recorded systematically. The documentation and proper communication of these measures to other health facilities (including lower-level referring facilities and higher-level facilities) and to patients are important for the national coordination of provision of essential healthcare services. We additionally documented gaps in the communication between some maternity wards and COVID-19 treatment centres after referring women

who were diagnosed with COVID-19. There is a need to enhance these communication channels and bridge the gap in order to ensure that all women receive adequate respectful maternity care.

This is an in-depth description of maternity care provision during the COVID-19 pandemic in four different low-resource settings. The strength of this study lies in the prospective nature which allowed to capture a wide diversity in the pandemic progression, which was unpredictable at the beginning of the research and some elements would have been impossible to capture retrospectively. On the other hand, some limitations of this research include a delay in receiving ethical approval from Uganda, which led us to cover the early wave of the pandemic retrospectively in the interviews, and to recruit only two SHP per maternity ward. The number of respondents may seem small compared with the number of eligible participants in each maternity ward. This is a result of the purposive sampling strategy, aiming to ensure maximum variation in reporting, rather than to ensure representativeness. Additionally, we gathered information from the research team (junior and senior researchers who are clinicians) which was triangulated with the qualitative interviews and aided interpretation. Data on the timeline of COVID-19 were gathered at the national level without disaggregation by regions/districts, although the pandemic spread differently and restrictive measures were not uniformly applied across regions of the same country. Additionally, the international travel ban instituted at the time of data collection meant that in-person field visits were not possible, and the majority of the interviews were conducted online. Nonetheless, the extensive collaboration and team engagement allowed for continuous sharing and iterative discussion of the findings. As a result of the lack of a unified documentation of the numbers of COVID-19 suspected/confirmed obstetric cases, it was challenging for the research team to collect these numbers on a monthly basis. Often these data were not recorded systematically in the hospitals, and were available only informally from PIs or heads of department. Finally, our study did not present women's perspectives on adaptations to care provision and any changes in perceptions of quality of care. Future research exploring women's views is recommended.

CONCLUSION

This study prospectively documents the evolution of challenges, facilitators and adaptations to maternal care provision in six referrals hospitals in sub-Saharan Africa over the first year of the COVID-19 pandemic. By triangulating three data sources, we identified that hospital-level adaptations coincided with national-level mitigation measures, with notable differences between countries. We identified short-term challenges to care provision that were resolved during or just after the first wave, and long-term or persistent challenges including some that existed before the start of the pandemic. Systemic

challenges to care provision, such as staff shortages and crowding, must be addressed with comprehensive planning, preparedness and commitment of health authorities. This study also documents the indispensable role played by maternity wards in referral hospitals and maternity SHP advocating for the inclusion of pregnant women in the planning and response to the COVID-19 pandemic, including leading and contributing to guideline development and training of lower-level facilities. Essential healthcare services, including maternity care, and frontline healthcare providers must be prioritised in planning and response as the COVID-19 pandemic continues to evolve, and in upcoming healthcare system shocks.

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Ethics approval This study involves human participants and was approved by: Institutional Review Board at the Institute of Tropical Medicine in Belgium (ID: 1372/20); Comité National d'éthique pour la Recherche en Santé (CNERS) in Guinea (ID: 058/CNERS/20); Lagos University Teaching Hospital Health Research and Ethics Committee in Nigeria (ID: LUTHHREC/EREV/0520/35); MUHAS Senate Research and Publication Committee (ID: MUHAS-REC-6-2020-282E); Muhimbili National Hospital Ethics Committee (ID: MNH/IRB/I/2020/016); National Institute for Medical Research (ID: NIMPR/HQ/R.8a/Vol.IX/3479); Makerere University School of Medicine Research Ethics Committee (ID: 2020-150); Uganda National Council for Science and Technology (ID: HS907ES). Participants gave informed consent to participate in the study before taking part.

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Data availability statement Data are available upon reasonable request. Data sharing agreements will be required prior to making the data available. These data include pseudonymised interview transcripts and aggregate monthly routine data indicators on caesarean section and labour induction. Data requests can be sent to the study PI Professor Lenka Benova at lbenova@itg.be and the ethics committee at the Institute of Tropical Medicine at irb@itg.be.

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S1 Table - Characteristics of the participating hospitals and maternity wards before the COVID-19 pandemic

Abbreviation/Acronym	GUINEA		NIGERIA	TANZANIA	UGANDA	
	HNID	HRM	LUTH	MNH	KNRH	MSWNH
Hospital name	<i>Hôpital National Ignace Deen (Ignace Deen National Hospital)</i>	<i>Hôpital Regional de Mamou (Mamou Regional Hospital)</i>	<i>Lagos University Teaching Hospital</i>	<i>Muhimbili National Hospital</i>	<i>Kawempe National Referral Hospital</i>	<i>Mulago Specialised Women's and Neonatal Hospital</i>
Hospital						
Owner/Operating authority	Ministry of Health of Guinea	Ministry of Health of Guinea	Federal Government of Nigeria	Government of Tanzania	Government of Uganda	Government of Uganda
Year of establishment	1892	1908	1961	1910	1962 [^]	2019
Total number of beds	467	90	761	1500	170	425
Hospital designation	Tertiary teaching hospital	Regional hospital	Tertiary teaching hospital	Tertiary teaching hospital	Maternity/women's care and neonatal care	Maternity/women's care and neonatal care
Catchment population	Receives referrals from all of Guinea (approximately 12.7 million population)	Receives referrals from Mamou regions and also neighbouring towns (approximately 400,000)	Serves all communities in Lagos State and nearby states such as Ogun State; total of approximately 25 million	Dar es Salaam Region (especially Amana, Temeke, Mwananyamala Regional Referral Hospitals; Sinza, Mbagala Rangitatu, Vijibweni, Mnazimoja - Upgraded Health Centres). Population of 6 million; Coastal Region (Bagamoyo, Kisarawe, Tumbi-Kibaha, Mkuranga District Hospitals). Population 1.2 million; But can receive women referred from all over Tanzania. Population 60 million.	Kampala District, surrounding Wakiso, Mpigi and Mukono districts (5-6 million) but also referrals from all over the country (44 million)	Kampala District, surrounding Wakiso, Mpigi and Mukono districts (5-6 million) but also referrals from all over the country (44 million)
Financing	Mainly governmental funding, supported by funding from partner institutions	50% from central administration and 50% from district administration	Mix of user fees and federal government subsidies	Government financing of staff salaries; running costs mostly come from user fee and health insurance reimbursements	Mainly central government and user fees, some performance-based financing	Predominantly user fees (98%) and central government for patients referred from KNRH who are unable to pay
Private services offered	No	No	Yes	Yes	Yes	Yes (charges for all patients, and also Silver and Gold private services)
Blood bank	Not available (have emergency blood kits; blood obtained from blood bank external to hospital)	Not available (have emergency blood kits; blood obtained from blood bank external to hospital)	Yes	Yes	Yes	Yes
Maternity services and infrastructure						
Routine outpatient ANC	Not provided (only consultations for complicated cases)	Yes	Yes	Yes	Yes	Yes
Childbirth care	Yes	Yes	Yes	Yes	Yes	Yes
Routine outpatient PNC	No	No	Yes	Yes	Yes	Yes
Caesarean sections	Yes	Yes	Yes	Yes	Yes	Yes

Abbreviation/Acronym	GUINEA		NIGERIA LUTH	TANZANIA MNH	UGANDA	
	HNID	HRM			KNRH	MSWNH
Dedicated caesarean section theatre	Yes	Yes	Yes	Yes	Yes (There is one theatre with 2 theatre beds for emergency obstetrics; 98% caesarean sections and other emergencies such as surgical management of post-partum haemorrhage, there is other theatre with 3 beds that is used for elective caesarean sections and other ob/gyn operations)	Yes (There are two theatre beds for emergency obstetrics; 98% caesarean sections and other emergencies such as surgical management of post-partum haemorrhage, there are other theatres that are for all other ob/gyn operations)
HDU or ICU for women	No (referred to HNID intensive care unit)	No (referred to HNID)	Yes (hospital ICU admits obstetric patients)	Yes (both) + pre-eclampsia room	Yes (HDU with 7 beds), those who need ICU are referred	Yes (ICU), Yes (HDU with 11 beds)
NICU	No	No	Yes (2 NICUs, total of 24 functional incubators)	Yes	Yes (28 incubators of which 22 functioning)	Yes (22 incubators in total)
Dedicated phone line in maternity ward	No	No	No	Yes,	Yes, dedicated mobile but sometimes there is no airtime	Yes, dedicated mobile
Private maternity services offered	No	No	Yes	Yes	Yes	Yes
Maternity ward						
Number of outpatient ANC visits (2019)	--	1,148	5,860	23,048	35,169	5,216
Number of deliveries (2019)	5,927	3,468	933	7,385	21,778	1,163
Number of caesarean sections (2019)	2,835	1,093	564	4,018	7,614	673
Number of beds in labour/delivery room(s)	4 beds for first stage of labour and 4 beds for second stage of labour	2 beds for first stage of labour and 4 beds for second stage of labour	9	4 rooms with 18 beds in total	36 (32 public, 4 private)	50 rooms (of which Gold: 4)
How often does the number of women exceed the number of delivery beds?	A few times per year	About once per week	About once per month	Very rarely	Everyday	Never
Staff: Medical doctors* (total) Of which: Consultant obstetricians/gynaecologists	35 12	16 2	103 14	154 25	176 25	161 41
Staff: Midwives/nurse-midwives (including enrolled)	16	14	16	126	203	249
Shift composition: Weekday daytime	Midwives 2 Professor (on call) 1 Assistant head of clinic 2 Residents 3-4 Interns 2 Anaesthetists 1 Cleaners 3	Midwives 4 Matron 1 Medical doctor 1 Intern 2	2 midwives, 3 senior registrars, 2 registrars and 2 – 4 intern medical officers, health assistant – 1, cleaners – 2	6 Midwives, 1 Obstetrician, 6 Theatre staff, 4 Anaesthetists, 2 Resident doctors, 4 Interns doctors	Midwives (in labour ward) 7 Obstetrician 1 Theatre staff 4 Anaesthetists 2 Neonatologists/Paediatricians 2 Residents 4 Intern medical officer 3 Cleaners at least 10 for (labour ward, theatre,	Midwives (in labour ward) 10 Obstetrician 2 Theatre staff 4 Anaesthetists 2 Neonatologists/Paediatricians 2 Residents 4 Intern medical officer 0 Cleaners at least 10 for (labour ward, theatre, immediate post op and post-natal ward)

Abbreviation/Acronym	GUINEA		NIGERIA	TANZANIA	UGANDA	
	HNID	HRM	LUTH	MNH	KNRH	MSWNH
					immediate post op and post-natal ward)	
Shift composition: Weekend night time	Midwives 2 Professor (on call) 1 Assistant head of clinic 2 Residents 3-4 Interns 2 Anaesthetists 1 Cleaners 3	Midwives 4 Matron 1 Medical doctor 1 Intern 2	2 midwives, 3 senior registrars, 2 registrars and 2 – 4 intern medical officers, health assistant – 1, cleaners – 2	6 Midwives, 1 Obstetrician, 6 Theatre staff, 4 Anaesthetists, 2 Resident doctors, 4 Intern doctors,	Midwives (in labour ward) 6 Obstetrician 1 Theatre staff 3 Anaesthetists 2 Neonatologists/Paediatricians - available for consult Residents 4 Intern medical officer 2 Cleaners at least 10 for (labour ward, theatre, immediate post op and post-natal ward)	Midwives (in labour ward) 8 Obstetrician 1 Theatre staff 3 Anaesthetists 1 Neonatologists/Paediatricians - available for consult Residents 4 Intern medical officer 0 Cleaners at least 10 for (labour ward, theatre, immediate post op and post-natal ward)
LOS after uncomplicated vaginal birth as per usual practice	6 hours	6 hours	Day 2 (24-48 hours)	24 hours	12-24 hours	12-24 hours
LOS (minimum) after caesarean section as per usual practice	78 hours	6 days (some exceptions because of the lack of space)	Day 3 - 5	Minimum 48 hours	72 hours	72 hours
Companions during labour and childbirth allowed?	No (visitors allowed in the postnatal ward)	Yes (Family members, neighbours, healthcare workers)	No (visitors allowed in postnatal ward)	No. Companions are not allowed in the labour ward, but visitors are allowed in postnatal ward.	No (only starting with immediate postnatal period)	Yes, at every stage
Main source of incoming referrals	Receive referrals from a large number of facilities. CMC is the most frequent referring entity.	18 Health centres (5 urban health centers and 13 rural health centers)	One Federal Medical Centre, 26 General Hospitals (secondary health facility), 256 public health centres (primary), 2,886 private hospitals/specialist clinics/laboratories/diagnostic centres, and 160 medical centres, all within Lagos State. Occasional referrals from Lagos State University Teaching Hospital (LASUTH) – the second teaching hospital within Lagos State.	Dar es Salaam Region public hospitals including Amana, Temeke, Mwananyamala Regional Referral Hospitals; Sinza, Mbagala Rangitatu, Vijibweni, Mnazi mmoja hospitals; Coastal Region hospitals including Bagamoyo, Kisarawe, Tumbi-Kibaha, Mkuranga District Hospitals;	Main source of referrals are health centre IVs and IIIs in Kampala and surrounding districts	Kawempe National referral hospital Private facilities around Kampala and surrounding districts

Abbreviation/Acronym	GUINEA		NIGERIA	TANZANIA	UGANDA	
	HNID	HRM	LUTH	MNH	KNRH	MSWNH
Fee for routine ANC	Not offered (ANC for complicated cases is free of charge)	Free of charge	NGN 13,250 registration fee covering all routine ANC	Exempted according to policy for all referred attendees from public hospitals. Self-referrals and others granted user-fee exemptions with Hospital Social Welfare Department. National Health Insurance Fund and other health insurance accepted, private patients billed based on services provided.	No charge but women might be asked to contribute financially or purchase supplies	ANC visit is 14 USDs (50,000UGSHs) in Silver and 17USDs (62,500UGSHs) in Gold. - Package that includes consultation and all investigations throughout antenatal is about 165 USDs (600,000UGSHs) in Gold and about 85 USDs (300,000UGSHs) in Silver]
Fee for vaginal delivery	Free of charge	Free of charge	Public charge: N13,250 for booked patients and N26,500 for unbooked patients (referred in labour) for delivery alone, all parturients are billed additional N19,250 for vaginal delivery pack. Admission fee is charged separately. Beyond 3 days of inpatient stay, N13,250 is charged per week of stay. Private charge: Initial deposit in the private ward is N250,000 – N350,000 and bill is calculated after discharge.	Payment for public referred patients is done in cost sharing basis - 125,000 TZS, for private patients its 250,000 TZS. Women expected to bring a delivery kit. User fee exemptions granted with Hospital Social Welfare Department which assesses the financial status of the woman. National Health Insurance Fund and other health insurance accepted which cover delivery cost.	No charge but women might be asked to contribute financially or purchase supplies. Women expected to come with a delivery kit.	about 220 USDs(800,000 UGSHs) for delivery and hospital stay in Gold and corresponding fee in silver is 140USDs (500,000UGSHs). Referred women from Public facility pay a proportion of fee or whole fee waived
Fee for caesarean section	Free of charge	Free of charge	Public charge: N35,775 for surgery alone, while anaesthesia is billed separately – N53,000 for spinal, N66,250 for general anaesthesia, N86,125 for epidural and N88,775 for combined spinal epidural. The cost of anaesthesia covers the caesarean section pack. The cost of drugs and service charges, and admission fee where applicable are then added to these. Private charge: Initial deposit in the private ward is N350,000 and bill is calculated after discharge.	Payment for public referred patients is done in cost sharing basis by policy - 250,000 TZS, for private patients its 500,000 TZS. User fee exemptions granted with Hospital Social Welfare Department which assess the financial status of the woman to see if she needs to be exempted from fully or partially from the cost sharing amount. National Health Insurance Fund and other health insurance accepted which cover the cost for delivery.	Public: No charge but women might be asked to contribute financially or purchase supplies. Private: (PUT IN LOCAL CURRENCY?) 685USD (2,500,000UGSHs).	total bill 356USDs for silver (1,300,000UGX) after caesarean section and about USDs for 685USD (2,500,000UGSHs). Gold

Abbreviations: Antenatal care (ANC); Length of Stay (LoS); Postnatal care (PNC); High-Dependency Unit (HDU - defined as a clinical area with an enhanced nursing ratio of at least 1 staff per 4 patients where fluid balance, drug administration and continuous vital signs monitoring can be done); Intensive Care Unit (ICU - defined as a clinical area where ventilatory support can be provided)

^In 2016 the maternity department of New Mulago Hospital moved to Kawempe due to renovations in Mulago Hospital

*Medical doctors include cadres such as: anaesthetists, paediatricians, neonatologists, consultants, senior registrars, registrars, medical officers, residents, intern medical officers, fellows, clinical officers, specialist in training

Exchange rates to 1 USD (source: xe.com on April 29, 2021): **Guinean Franc** (GNF) = 9,918.6; **Nigerian Naira** (NGN) = 380.5; **Tanzania Shilling** (TZS) = 2,318.9; **Ugandan Shilling** (UGX) = 3,598.7

S2 Table - Sources of routine data in each referral hospital and indicator definitions

Country	GUINEA		NIGERIA	TANZANIA	UGANDA		Indicator definitions
Hospital name	Hôpital National Ignace Deen (Ignace Deen National Hospital)	Hôpital Regional de Mamou (Mamou Regional Hospital)	Lagos University Teaching Hospital	Muhimbili National Hospital	Kawempe National Referral Hospital	Mulago Specialised Women's and Neonatal Hospital	
Abbreviation/Acronym	HNID	HRM	LUTH	MNH	KNRH	MSWNH	
Indicator / Sources							
Deliveries	SNIS report; Labour ward register	SNIS report; Labour ward register	Labour ward register; Labour ward theatre register	Labour ward MRF	HMIS; Maternity ward register	Delivery book	Total number of deliveries per month (vaginal and abdominal); does not include births before arrival; deliveries of multiple pregnancies are counted as one
Caesarean sections	SNIS report; Theatre register	SNIS report; Theatre register	Labour ward theatre register	Theatre MRF; Labour ward MRF	HMIS; Theatre register	Theatre register	Total number of caesarean sections per month (elective and emergency). Also presented as a percentage out of the total number of deliveries
Labour inductions	SNIS report; Labour ward register	SNIS report; Labour ward register	Labour ward register; Patient records (nurses' notes)	Labour ward book notes; Electronic medical record since September 2020	Maternity ward register	Maternity ward register	Total number of labour inductions per month. Also presented as a percentage out of the total number of deliveries
Total number of sources per facility	3	3	3	4	3	3	

Abbreviations: Health Management Information System (HMIS); Monthly report form (MRF); Système National d'Information Sanitaire (SNIS - National Health Information System)

S3 Table - Themes and quotes relevant to care for women with suspected or confirmed COVID-19 and their newborns

	First wave	Slow period	Second wave
Period-specific themes	<p>Importance of preparedness and learning from first case of COVID-19 positive woman “ we heard that this woman that needed a delivery and the hospital was not ready at that time but we had to improvise. The good thing is that even though there was a need for an urgent delivery, she was not an emergency, it was more an urgent delivery because she had been planned for a planned delivery, what we call an elective C-section. So I had to approach the hospital management who were very supportive. And I remember the Chief medical director said: tell me what you need. I said that I needed a team. At that time I had no team and had to try and assemble a team. I had to start calling people, some of them I knew had volunteered like me and some of them I had to contact. It was very difficult because it kept changing. Some said they gave me their word they would be with me in the theatre only to change their mind five minutes later.” (Respondent D, LUTH)</p> <p>“We had a lot of challenges and obviously were not prepared but we had to move fast, and I think given the situation, we had to do what we could do within the time and with the resources available. So we were not prepared when we had the first case.” (Respondent D, LUTH)</p> <p>Caring for COVID-19 maternity patients “if a COVID patient comes and delivers, of course you can't really tell her in the second stage of labour, you can't deliver her, we would deliver them; we did them, we even did a caesarean. But... I mean the emergency cases were taken care of... and then after that they would be transferred to the isolation hospitals.” (Respondent C, MNH)</p> <p>No mother-baby separation and breastfeeding encouraged “They (babies) stayed with their mum all through even for the one that was not well. The baby was still in its space but there was enough distance, there was cot that was far away, well, almost like 6-10 meter space from where the mother is. She can see her baby and was allowed to breastfeed with all the infection prevention and control practices, washing hands, wearing a face mask and all that, cleaning their breasts and all that. We did those protocols for them.” (Respondent D, LUTH)</p> <p>Not including care to pregnant women in the planning and training for COVID-19 “The people who volunteered for the initial training did not have obstetricians in that group. So there were little or no obstetricians in that group. Internal medicine and ID experts were the ones driving the prevention at that time. That was all part of what I would call the oversight, the deficiencies in the planning that we thought – we just thought everybody who would get COVID would be adults male and female, and probably babies, a child....” (Respondent D, LUTH)</p>	<p>Labour augmentation</p> <p>“If a woman presents with a fever, a cough and she is in labor, you speed up the labor, you first inform, but you speed up the labor so that the woman can be released and then you refer the child and the woman to the CTPI (COVID-19 treatment center)” (Respondent 6, HNID)</p>	<p>Lack of guidelines challenging to care provision</p> <p>“There is enough support, though we still have some dilemmas at the time of management, like when you see a pregnant woman during that time, is it COVID patient, and we don't know at what time you have to deliver the woman and so forth. So, sometimes, in terms of guideline, I think we have not reached to that point yet and there are organisations that carried out to make sure that we have a guideline to tell us what to do, but in terms of other support, we were highly supported, we had the spirit and everything was online.” (Respondent D, MNH)</p>
Themes raised during the whole study period	<p>Lack of rapid testing for COVID-19 “It was also a challenge trying to pick a sample from these because the turn-around time was quite longer. You pick samples but you wouldn't see the results before 48 hours. That was another challenge. Yet labour is not... it can't wait for you, for your results to return.” (Respondent B, KNRH)</p> <p>Confusing symptoms – COVID-19 or obstetric complications Those symptoms are very confusing and maybe misleading because if they send, refer the mother who has PPH, she is bleeding. She starts bleeding and then they want her to come over and see maybe you can get her blood. These are not people who are breathing normally and that was our biggest challenge. Doctors, once they see a person who is not breathing, they would say 'suspected COVID', and maybe they will not touch [the patient] and they request for a COVID test to be done, but COVID kits were not available at all in these facilities. They were only in the COVID treatment units who had them. They were also not accessible by everybody, aaa, so, that is the challenge and because we take long to get a test, nowadays, there is a rapid test; they are also not very available. So, you find that a patient may continue to deteriorate or you isolate her for days and then again the access of the health workers would be limited, especially doctors, until the results come back. Some people were isolated and results came back and they were negative even they had suffered. Others did not live to get the results, and others had died but they were negative and now as.... (Respondent D, MSWNH)</p> <p>“At the clinics we used to wear N95... all the precautions at the clinic and we kind of linked all the complaints to COVID just to see that this patient is only, is purely an obstetric patient without COVID or a gynaecological patient without COVID. Like women who had cardiomyopathy, they were also referred to us because you know how cardiomyopathy in pregnancy can present difficulties like shortness of breath, cough... and everybody said: “no, no, no, no this is a COVID suspect” and then they will be set aside and screened and after screening if they're positive they are taken care of by the isolation wards, in other hospitals, not even at Muhimbili and if negative then we kept taking care of them like any other patient.” (Respondent C, MNH)</p>		