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Effect of the COVID-19 Pandemic on Maternal Mortality: A Retrospective Study in a Tertiary Hospital in Northern Ghana

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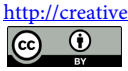

Abstract

Introduction: The COVID-19 pandemic has significantly affected global health systems, particularly maternal healthcare. This study examines the effects of the pandemic on maternal mortality rates at Tamale Teaching Hospital (TTH) in Northern Ghana, a region with high maternal mortality rates. We conducted a retrospective analysis of hospital records from TTH, covering three periods: pre-COVID-19 (March 1, 2019 - February 28, 2020), COVID-19 (March 1, 2020 - February 28, 2021), and post-COVID-19 (March 1, 2021 - February 28, 2022). Maternal mortality ratios were calculated and compared across these periods to evaluate the pandemic's impact on maternal health outcomes. **Results**: The pre-COVID-19 era recorded a Maternal Mortality Ratio (MMR) of 571 per 100,000 live births, while the COVID-19 era recorded an MMR of 591 per 100,000 live births, representing a 3.5% increase. The post-COVID-19 era recorded the highest maternal mortality ratio of 790 per 100,000 live births, which represented a percentage change of 33.67% from the COVID-19 era and a 38.36% increase from the pre-COVID-19 era. Hypertensive disorders in pregnancy were the leading cause of death in all three periods, with more than 70% of all cases of mortalities occurring in the Maternal Intensive Care Unit (MICU). **Interpretation**: The study highlights critical vulnerabilities in maternal health systems exacerbated by the COVID-19 pandemic in Northern Ghana. It underscores the urgent need for targeted interventions to strengthen healthcare infrastructure, enhance maternal health services, and integrate pandemic preparedness into ongoing maternal health policies. **Conclusion**: Addressing the adverse impact of the COVID-19 pandemic on maternal mortality requires a multifaceted approach. Immediate actions include bolstering healthcare resources, expanding telemedicine initiatives, and ensuring eq-

uitable access to maternal health services.

Subject Areas

Gynecology & Obstetrics

Keywords

Post-Partum Hemorrhage, COVID-19: Coronavirus Disease 2019, SARS-COV, AMPATH: Academic Model Providing Access to Healthcare, MICU: Maternal Intensive Care Unit

1. Introduction

Maternal mortality is defined as "The death of a woman while pregnant or within 42 days of termination of the pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes". [1] Globally, success had been chalked in efforts aimed at reducing maternal mortality. Over eighteen years, from 1990 to 2008, a 34% decline in maternal mortality was reported globally. [2] The World Health Organization also estimated a 38% reduction in global maternal deaths over seventeen years from 2000 to 2017. [3] However, as these successes were seen globally, sub-Saharan Africa saw a marginal increase in maternal mortality during the period under study. [2]

The World Health Organization declared the novel coronavirus disease caused by the SARS-CoV-2 virus a global pandemic on 11th March 2020. As of 17th September 2021, there have been 226,844,344 confirmed cases of COVID-19, including 4,666,334 deaths, reported to the WHO. [4] The coronavirus infection causes a cluster of severe respiratory illnesses with clinical features such as cough, fever, headache, myalgia, dyspnoea, haemoptysis, and anosmia. Also, complications due to the illness include, but are not limited to Acute respiratory distress syndrome, Acute cardiac injury, anaemia, and lymphopenia. [5]

At the beginning of the current COVID-19 pandemic, early modeling studies in the United States, for example, predicted at least an 18.7% increase in maternal mortality as compared to the year 2018 as a direct result of the global pandemic. [6] Lower and middle-income countries (LMICs) were estimated to witness an increase in maternal and perinatal mortality from the indirect effects of COVID-19. [7] Before COVID-19, African mothers were three times more likely to die from pregnancy and its related complications as compared to white mothers. [8] Studies further predicted that this racial disparity could be worsened by the novel coronavirus pandemic mainly due to determinants such as lower health insurance coverage, reduced access to maternal health services, and increased prevalence of chronic diseases such as Hypertension and Diabetes. [8]

Some initial studies suggested that pregnant women were not at increased risk of complications from COVID-19 infection as compared to the non-pregnant

populace [9]. Some recent studies, however, suggested otherwise, indicating that pregnant women may suffer from severe complications from the coronavirus disease. [10] [11] "When you are thinking about a pandemic, you have to differentiate between what comes from being infected and what comes from being affected" (Clare Wenham, Assistant Professor of Global Health Policy, London School of Economics and Political Science). The indirect effects of the COVID-19 pandemic have been seen in almost every facet of the healthcare system, including maternal and child health. Indirect effects such as reduced institutional deliveries, reduced antenatal visits, and delays in seeking healthcare because of fear of contracting the disease cumulatively increased pregnancy complications. [12] In maternal health, there had been a reported increase in maternal mortality when the pre-pandemic era was compared with the pandemic era. [13]

Despite significant global progress in reducing maternal mortality—with a 34% decline from 1990 to 2008 and a 38% reduction from 2000 to 2017—sub-Saharan Africa continues to grapple with persistently high maternal death rates. [14] This alarming trend underscores deep-rooted systemic deficiencies and inequities in healthcare access and quality across the region. [15]

The advent of the COVID-19 pandemic, declared by the World Health Organization (WHO) on March 11, 2020, had further exacerbated the challenges in maternal health. [16] As of September 2021, the pandemic had resulted in over 226 million confirmed cases and nearly 4.7 million deaths globally, placing unprecedented strain on healthcare systems worldwide. [4] Early modeling studies in high-income countries like the United States projected an increase in maternal mortality by at least 18.7% due to the pandemic's direct and indirect effects. [17] The situation is even direr in low- and middle-income countries (LMICs), where the pandemic had severely disrupted maternal and perinatal healthcare services. [7]

In Africa, the pre-existing disparities in maternal health outcomes have been stark. African mothers were already three times more likely to die from pregnancy-related complications compared to their white counterparts, a disparity driven by factors such as inadequate health insurance coverage, limited access to quality maternal healthcare, and higher prevalence of chronic conditions like hypertension and diabetes. [18] The COVID-19 pandemic has intensified these disparities, threatening to reverse decades of progress in maternal health. [13]

While initial reports suggested that pregnant women might not be at increased risk of severe COVID-19 complications, subsequent studies have contradicted this view, indicating that pregnant women may indeed face heightened risks. [19] [20] Additionally, the indirect effects of the pandemic—such as reduced institutional deliveries, decreased antenatal visits, and delays in seeking healthcare due to fear of infection—have collectively led to a surge in pregnancy-related complications and maternal deaths. [21] [22]

This study aims to critically examine the impact of the COVID-19 pandemic on maternal mortality at the Tamale Teaching Hospital in Northern Ghana. By analyzing maternal mortality ratios across the pre-COVID-19, COVID-19, and

post-COVID-19 eras. This research seeks to provide a comprehensive understanding of the pandemic's multifaceted effects on maternal health. The findings will contribute to the global discourse on maternal health, offering insights and strategies to mitigate the adverse impacts of such crises on vulnerable populations in similar settings.

1.1. Global Trends in Maternal Mortality before the Pandemic

Before the COVID-19 pandemic, global efforts had led to substantial reductions in maternal mortality rates. According to the World Health Organization (WHO), the global maternal mortality ratio decreased by 38% between 2000 and 2017. [23] Despite this progress, maternal mortality remained unacceptably high in regions like sub-Saharan Africa, where approximately 196,000 maternal deaths occur annually. [23] Factors contributing to these disparities included limited access to quality maternal healthcare services, skilled birth attendants, and emergency obstetric care.

1.2. Impact of COVID-19 Pandemic on Maternal Mortality: Global and African Perspectives

The COVID-19 pandemic disrupted health systems worldwide, posing significant challenges to maternal health services and outcomes. Studies have highlighted disruptions in antenatal care, skilled birth attendance, and access to emergency obstetric services during the pandemic. [24] In Africa, the pandemic exacerbated existing maternal health disparities, particularly affecting vulnerable populations in low-resource settings. [25] The pandemic's impact on maternal mortality was multifaceted. Fear of contracting COVID-19, lockdowns, travel restrictions, overwhelmed healthcare systems, and diverted resources contributed to delays in seeking maternal care and reduced access to essential services. [26] This raised concerns about potential increases in maternal mortality rates, especially in regions with already strained healthcare infrastructures.

1.3. Maternal Mortality Trends in Ghana before and during the COVID-19 Pandemic

Ghana had made significant strides in reducing maternal mortality but continues to face challenges in ensuring equitable access to maternal healthcare services. Before the pandemic, Ghana's maternal mortality ratio stood at 308 deaths per 100,000 live births. [27] However, the COVID-19 pandemic disrupted maternal health services, threatening progress made in reducing maternal deaths.

1.4. Maternal Mortality in the Framework of the Sustainable Development Goals

Within the framework of the Sustainable Development Goals (SDGs), nations are collectively committed to significantly reducing maternal mortality by 2030. One of the key targets of SDG 3 is to bring the global maternal mortality ratio (MMR) down to fewer than 70 deaths per 100,000 live births, with no country exceeding

twice the global average MMR. [28]

In 2020, the global MMR was 223 per 100,000 live births. To lower this to below 70 by 2030, an annual reduction rate of 11.6% is necessary a pace that is rarely achieved on a national scale. However, current scientific and medical knowledge provides the tools needed to prevent most maternal deaths. With only a decade left to achieve the SDGs, there is an urgent need to intensify efforts and mobilize and renew commitments at global, regional, national, and community levels to eliminate preventable maternal mortality. [28]

Improving maternal health remains a top priority for WHO. The organization contributes to reducing maternal mortality by advancing research, providing evidence-based clinical and programmatic guidance, setting global standards, and offering technical support to member states in developing and implementing effective policies and programs. [28]

As detailed in "Strategies toward Ending Preventable Maternal Mortality (EPMM)" and "Ending Preventable Maternal Mortality: A Renewed Focus for Improving Maternal and New-born Health and Well-Being," [28] WHO collaborates with partners to assist countries in:

- Reducing inequalities in access to and quality of reproductive, maternal, and new-born healthcare services;
- Ensuring universal health coverage for comprehensive reproductive, maternal, and new-born healthcare;
- Addressing all causes of maternal mortality, reproductive and maternal health issues, and related disabilities;
- Enhancing health systems to collect high-quality data to address the needs and priorities of women and girls; and
- Ensuring accountability to improve care quality and equity. [28]

1.5. Local Perspectives: Maternal Mortality in the Northern Region (Tamale) of Ghana

The Northern region of Ghana, with Tamale as its capital, experiences poorer maternal health indicators compared to the national average. The Tamale Teaching Hospital (TTH) serves as a major referral centre in the region, facing unique challenges in maternal healthcare provision. A qualitative study by Ameyaw *et al.* [29] highlighted the impact of COVID-19 on maternal health services in Tamale, emphasizing disruptions in antenatal care attendance and skilled birth attendance. The Tamale Teaching Hospital plays a critical role in addressing maternal health needs in the Northern region. However, the pandemic strained resources and healthcare capacity, leading to concerns about maternal mortality rates. Efforts to strengthen maternity services and enhance community outreach are essential to address these challenges. [29]

1.6. Policy and Health System Responses in Ghana

In response to the pandemic, Ghana implemented various policy measures to safeguard maternal health services. The Ministry of Health issued guidelines for the

continuity of essential maternal health services while ensuring infection prevention measures. [29] Community-based interventions, including mobile clinics and telemedicine services, were deployed to reach pregnant women in remote areas, including those in the Northern region.

1.7. Impact of COVID-19 on Maternal Health Services in Tamale, Ghana

The COVID-19 pandemic significantly affected maternal health services in Tamale, Ghana. Ameyaw *et al.* [30] conducted a qualitative study to explore these impacts, highlighting disruptions in antenatal care, reduced skilled birth attendance, and challenges in accessing emergency obstetric services. Pregnant women faced increased barriers to care due to fear of COVID-19 infection, transport restrictions, and strained healthcare resources.

The Tamale Teaching Hospital, as a major referral centre in the Northern region, experienced increased pressure during the pandemic. The limited availability of critical care resources, including ventilators and intensive care units, posed challenges in managing obstetric emergencies and severe COVID-19 cases simultaneously. [30]

1.8. Challenges and Strategies for Addressing Maternal Mortality Post-Pandemic

The post-pandemic recovery efforts must prioritize maternal health services to prevent further increases in mortality rates. Long-term investments in healthcare infrastructure, workforce capacity-building, and community engagement are essential to strengthen maternal health systems. [25] Targeted interventions, such as improving access to skilled birth attendants, expanding emergency obstetric services, and promoting maternal health education, are critical for reducing maternal mortality in Ghana and similar settings.

1.9. Potential Impact of Other Health Crises on Maternal Mortality Rates during the COVID-19 Pandemic in Northern Region of Ghana

While the COVID-19 pandemic posed a significant threat to maternal health systems, it is important to consider the compounding effects of other endemic health crises, such as malaria and tuberculosis (TB), that are prevalent in Northern Ghana. These conditions may have exacerbated maternal mortality during the pandemic through both direct and indirect mechanisms.

Malaria remains a leading cause of maternal morbidity and mortality in sub-Saharan Africa. Pregnant women are particularly vulnerable due to reduced immunity and interruptions in preventive services, such as intermittent preventive treatment in pregnancy (IPTp) and distribution of insecticide-treated bed nets, which likely increased maternal susceptibility to malaria during COVID-19. Reports indicate that routine malaria services were disrupted during the pandemic, especially in rural areas where access to healthcare was already limited [31] Tu-

berculosis, which often affects women of reproductive age, presents another layer of risk. Pregnant women co-infected with TB may experience complications such as low birth weight, preterm delivery, and increased maternal mortality. COVID-19 overwhelmed health systems, diverting resources and attention away from TB control programs. In Ghana, TB case detection significantly declined during 2020-2021, potentially leading to undiagnosed and untreated cases among pregnant women [32].

Moreover, the overlap of symptoms between COVID-19, malaria, and TB may have led to misdiagnosis or delayed treatment. Health worker shortages, fear of attending health facilities, and restricted mobility during lockdowns likely compounded these challenges. Thus, the elevated maternal mortality rates during the pandemic cannot be attributed solely to COVID-19 but must be viewed through a syndemic lens**,** considering the interaction of multiple infectious diseases with socio-economic vulnerabilities [33].

2. Methodology

2.1. Study Design and Study Site

The study was conducted in the Obstetrics and Gynaecology Department (ONG) of Tamale Teaching Hospital (TTH), which is situated in Tamale, Ghana's northern regional capital. Tamale is Ghana's third-largest city. According to the Tamale Metropolitan Assembly's official website, it had an estimated 950,124 residents. It is the city in West Africa with the quickest growth. It is situated 370 miles (600 km) to the north of Accra.)

Tamale serves as the focal point for all administrative and commercial activities in the Northern area and doubles as the region's political, financial, and economic center thanks to its strategic location. TTH is a tertiary facility in Northern Ghana that serves a 4 million catchment area. The facility receives patients from the Northern, North East, Upper East, and Upper West, Savannah regions of Ghana and sometimes from Burkina Faso, La Cote D'Ivoire, and Togo. The hospital also serves as the teaching hospital for training medical students of the University for Development Studies School of Medicine and other allied health professionals. A quantitative retrospective study was conducted at the obstetrics and gynaecology department of the Tamale Teaching Hospital (TTH) using secondary data of cases of maternal mortality from 1st March 2019 to 28th February 2022.

2.2. Study Design

A quantitative retrospective study was conducted at the obstetrics and gynaecology department of the Tamale Teaching Hospital (TTH) using secondary data of cases of maternal mortality from 1st March 2019 to 28th February 2022.

2.3. Study Population and Sampling

2.3.1. Study Population

The study includes all cases of maternal mortality in the Obstetrics department of

TTH from March 2019 to February 2022.

2.3.2. Inclusion Criteria

All cases of maternal mortality at the TTH whose records are available from March 2019 to February 2022.

2.3.3. Exclusion Criteria

Cases of maternal mortality from March 2019 to February 2022, whose records cannot be retrieved or with significantly missing data.

2.4. Data Size Determination

This study comprises the medical records of all maternal mortality cases in the Obstetrics department of TTH from 1st March 2019 to 28th February 2022.

All available data on maternal mortality cases within the specified timeframe were included in this study.

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2.5. Data Analysis

All extracted data were entered into Microsoft Excel and appropriately cleaned for double entry and typographical errors. Data collected quantitatively were keyed into the Statistical Package for the Social Sciences (SPSS) to be analyzed statistically. The results of the analyzed data were then presented in the form of tables, graphs, and charts prepared by SPSS software and shaped in Microsoft Excel. Timelines for the analysis are stated below:

- **Pre COVID-19 era:** defined as the period from 1st March 2019 to 28th February 2020
- **COVID-19 era:** defined as the period from 1st March, 2020 to 28th February 2021
- **Post COVID-19 era:** defined as the period from 1st March, 2021 to 28th February 2022

2.6. Ethical Considerations

We penned a formal letter to the University for Development Studies, seeking the necessary clearance to advance with our research project. After careful consideration, we were delighted to receive official permission, granting us the green light to commence our study.

3. Results

3.1. Socio-Demographic Characteristics of the Study Population

This section examines the socio-demographic nature characteristic of the study subjects across three distinct periods: pre-COVID-19, during COVID-19, and

post-COVID-19. The findings are crucial for understanding the shifts and trends in maternal health. The socio-demographic characteristics include the age of patients at the time of admission, the ward on admission, the parity of the subjects at the time of death as well as the referral status of the subjects, whether they were referred or not.

3.1.1. Socio-Demographic Characteristics of Maternal Mortality Cases Pre-COVID-19 Era

The 20-29 age group emerged as the most affected demographic with a staggering 29 of the total 50 cases of maternal deaths, representing 58%. 48 cases were admitted at the maternal intensive care unit (MICU representing 96% with significant observation of a prevalence of two previous pregnancies (parity), making a significant 32% of the subjects. 49 cases were referred from peripheral facilities, representing 98%. Table 1 shows further details of other parameters under the study.

Table 1. Socio-demographic characteristics of maternal mortality cases pre-COVID-19 era socio-demographic characteristics.

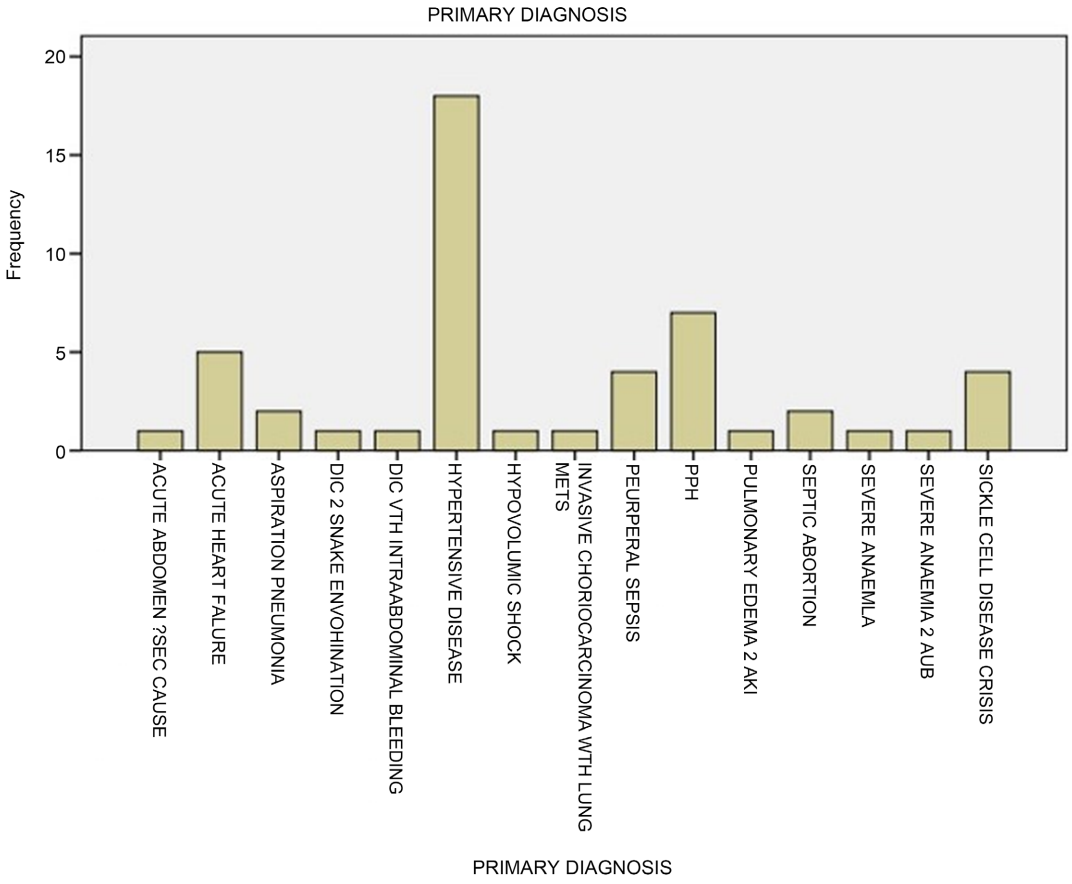
		Frequency	Percentage
AGE OF PATIENTS	10 - 19	4	8
	20 - 29	29	58
	30 - 39	15	30
	40 - 49	1	2
	50 - 59	1	2
Ward on Admission	Case Maternity Ward	1	2
	Emergency ward	1	2
	MICU	48	96
PARITY	P0	11	22
	P1	14	28
	P2	16	32
	P3	4	8
	P4	2	4
	P5	1	2
	P6	1	2
	P8	1	2
REFERRAL STATUS	REFERRAL	49	98
	WALK IN	1	2
	Total	**50**	**100**

Source: Health records unit of the ONG department, TTH.

3.1.2. Primary Diagnosis of Subjects in the Pre-COVID-19 Era

From the study, hypertensive diseases in pregnancy were the leading diagnosis of the study subjects with 18 representing 36%. Post-partum haemorrhage (PPH) and acute heart failure took 2nd and 3rd positions with totals of 7 and 5 respec-

tively representing 14% and 10% of the total cases in the pre-COVID-19 era. Figure 1 shares more details on the other primary diagnoses of the study subjects.



Source: Health records unit of the ONG department, TTH.

Figure 1. A bar chart showing the fiequency of diagnosis pre-COVID-19 era.

3.1.3. Socio-Demographic Characteristics of Maternal Mortality Cases in the COVID-19 Era

The 30 - 39 age group emerged as the most affected demographic with 23 of the total 48 cases of maternal deaths, representing 47.9%. 40 cases were admitted at the maternal intensive care unit (MICU representing 83.3%. A parity of zero had the highest prevalence in this group, making a 22.9% of the subjects. 41 cases were referred from peripheral facilities, representing 85.4%. Table 2 below shows further details of other parameters under the study.

Table 2. Socio-demographic characteristics of maternal mortality cases in the COVID-19 era.

		Frequency	Percentage
Age of Patients	10 - 19	6	12.5
	20 - 29	15	31.3
	30 - 39	23	47.9
	40 - 49	4	8.3

Continued

Ward on Admission	Case man't ward	5	10.4
	Emergency	1	2.1
	Labour	1	2.1
	MICU	40	83.3
	Theatre	1	2.1
Parity	P0	11	22.9
	P1	7	14.6
	P2	8	16.7
	P3	8	16.7
	P4	3	6.3
	P5	6	12.5
	P6	4	8.3
	P7	1	2.1
Referral Status	REFERRAL	41	85.4
	WALK IN	7	14.6
	Total	**48**	**100**

Source: Health records unit of the ONG department, TTH.

3.1.4. Primary Diagnosis of Subjects in the COVID-19 Era

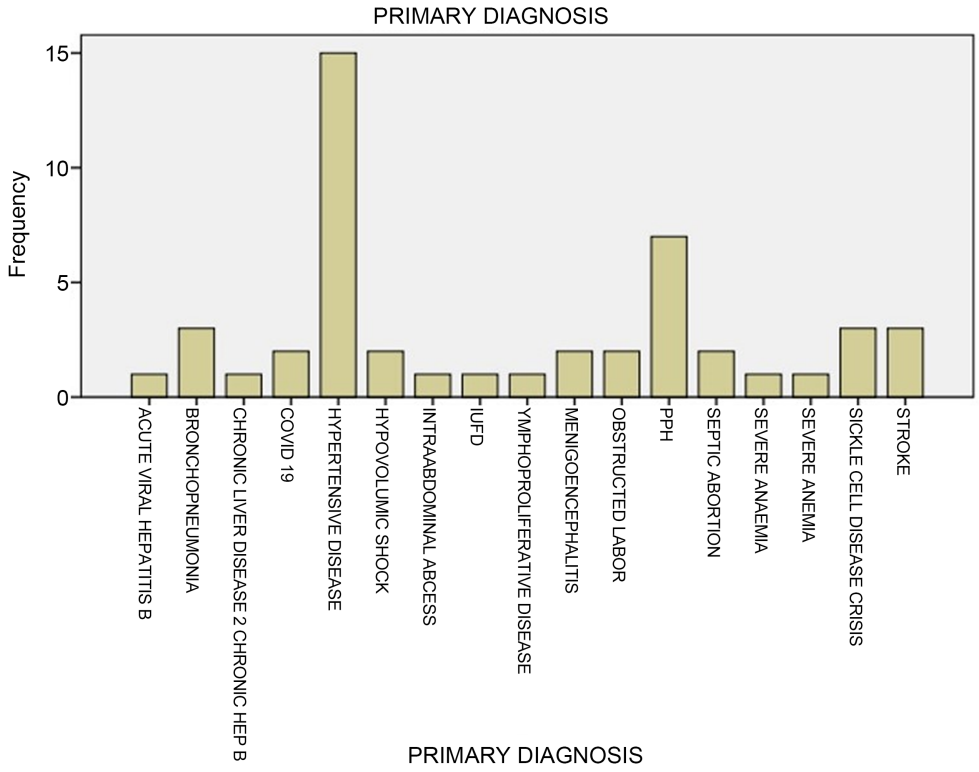
From the study, hypertensive diseases in pregnancy were the leading diagnosis of the study subjects, with a total of 15 cases representing 31.3% of the total cases in the COVID-19 era**.** Post-partum haemorrhage followed closely with a total of 7 cases, representing 14.6%. Sickle cell disease crisis, stroke, and bronchopneumonia all had 3 cases each, representing 6.3% of the total cases in the COVID-19 era.

A special note however in this era was the case of two maternal mortalities resulting from the diagnosis of COVID-19 as the primary cause of death in a 37-year-old with a parity of 5 and a 39-year-old with a parity of 2, who were both managed on in their respective case management ward in isolation, by a dedicated COVID-19 medical taskforce. These two cases represent 4.1% of the cases of maternal mortality in this era. There were no associated comorbidities in both cases, and both were referred from peripheral facilities within the catchment area.

Figure 2 shares more details on the other primary diagnoses of the study subjects.

3.1.5. Socio-Demographic Characteristics of Maternal Mortality Cases in the Post-COVID-19 Era

During this period, the age group with the highest mortality rate was the 20 - 29 bracket, accounting for 33 out of a total of 61 maternal deaths, which is 54.1%. Additionally, 40 cases were admitted to the Maternal Intensive Care Unit (MICU), representing 82% of the total admissions. Among the subjects, those with a parity of one (P1) were the most prevalent, making up 29.5% of the cases. Furthermore, 39 cases were referred from peripheral facilities, representing 63.9% of the total. Table 3 below provides additional details on other parameters studied.



Source: Health records unit of the ONG department, TTH.

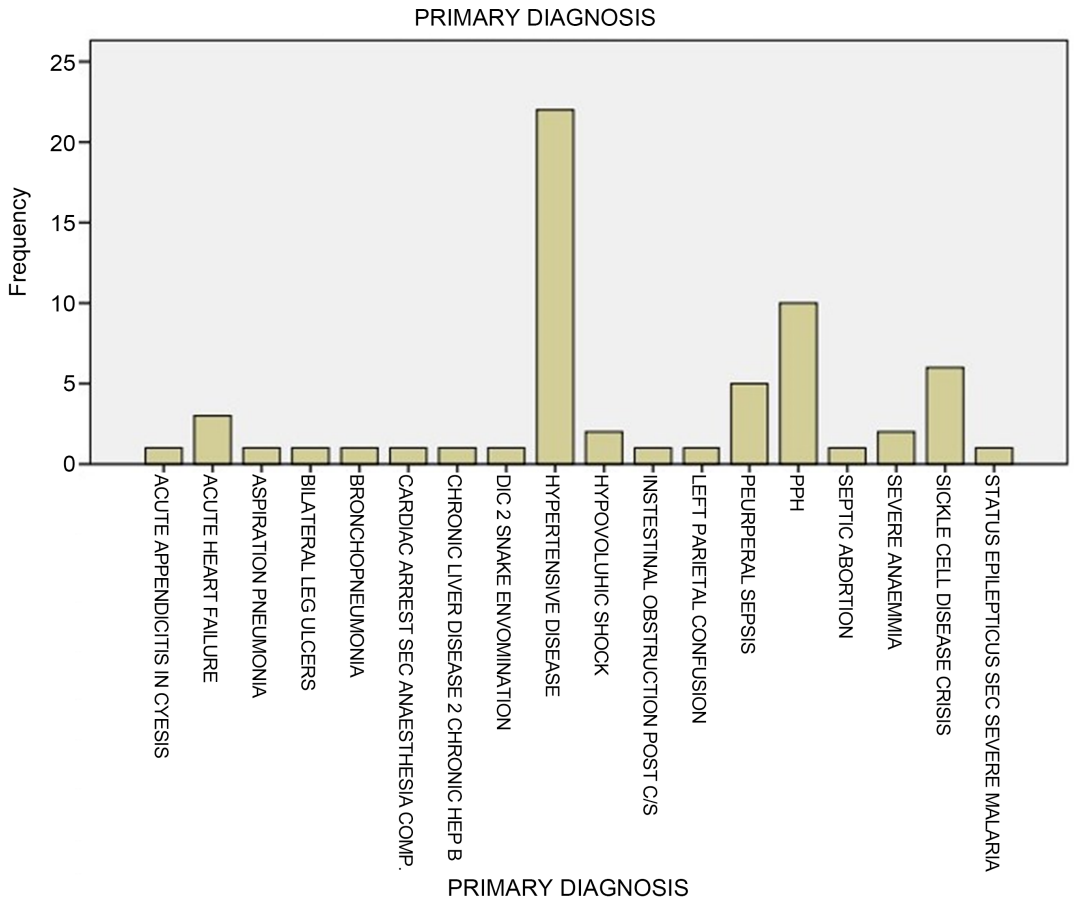
Figure 2. A bar chart showing the firequency of diagnosis in the COVID-19 era.

Table 3. Socio-demographic characteristics of maternal mortality cases in the post-COVID-19 era.

		Frequency	Percentage
Age of Patients	10 - 19	3	4.9
	20 - 29	33	54.1
	30 - 39	21	34.4
	40 - 49	4	6.6
Ward on Admission	Case man't Ward	2	3.3
	Emergency	3	4.9
	Labour	5	8.2
	Micu	50	82.0
	Theater recovery	1	1.6
Parity	P0	13	21.3
	P1	18	29.5
	P2	13	21.3
	P3	5	8.2
	P4	6	9.8
	P5	2	3.3
	P6	4	6.6
Referral Status	REFERRAL	39	63.9
	WALK IN	22	36.1
	Total	**61**	**100**

3.1.6. Primary Diagnosis of Subjects in the Post-COVID-19 Era

From the study, hypertensive diseases in pregnancy were the leading diagnosis of the study subjects with 22 cases representing 36.1%, with postpartum haemorrhage being second with 10 cases representing 16.7%. Sickle cell disease crisis had the third most prevalent diagnosis of 6 cases making 9.8% of the total of 61 cases in the post-COVID-19 era. Figure 3 shares more details on the other primary diagnoses of the study subjects.



Source: Health records unit of the ONG department, TTH.

Figure 3. A bar chart showing the frequency of diagnosis post-COVID-19 era.

3.2. Monthly Distribution of Maternal Cases Within the Specified Timeframes under Study in TTH

Under this section, results of the monthly distribution of maternal death cases under the various timeframes are presented, indicating which months had the highest number of maternal deaths.

3.2.1. Pre-COVID-19 Era (March 1, 2019 - February 28, 2020)

In the pre-COVID-19 era, a total of 50 cases of maternal mortality cases were recorded. The months of February and November recorded the highest mortality cases of 7 deaths each, representing 14% with March following closely with 12%.

Table 4 contains more details on the monthly distribution of maternal deaths in the pre-COVID-19 era arranged in descending order of frequency.

Table 4. Shows the monthly distribution of maternal deaths in the pre-COVID-19 era.

	Month of death	Frequency	Percent
Pre COVID-19 Era	FEBRUARY	7	14
	NOVEMBER	7	14
	MARCH	6	12
	APRIL	5	10
	AUGUST	4	8
	JANUARY	4	8
	SEPTEMBER	4	8
	JULY	3	6
	MAY	3	6
	OCTOBER	3	6
	DECEMBER	2	4
	JUNE	2	4
	Total	**50**	**100**

Source: Health records unit of the ONG department, TTH.

3.2.2. COVID-19 Era (March 1, 2020 - February 28, 2021)

In the COVID era, the month of February recorded the highest mortality cases with 8 cases representing 16.7%. March and October recorded the highest number of cases, with 6 cases each, making up 12.5% of the total. The COVID-19 era witnessed a total of 48 cases of maternal mortality. Table 5 contains more details of the monthly distribution of maternal deaths in the pre COVID-19 era arranged in descending order of frequency.

Table 5. Shows the monthly distribution of maternal deaths in the COVID-19 era.

	Month of death	Frequency	Percent
COVID-19 Era	February	8	16.7
	March	6	12.5
	October	6	12.5
	August	5	10.4
	January	5	10.4
	December	4	8.3
	May	4	8.3
	April	3	6.3
	September	3	6.3
	July	2	4.2
	June	1	2.1
	November	1	2.1
	Total	**48**	**100**

Source: Health records unit of the ONG department, TTH.

3.2.3. Post-COVID-19 Era (March 1, 2021 - February 28, 2022)

The post-COVID-19 era recorded the highest number of maternal mortality cases, with a total of 61. March and May both recorded the highest number of 7 each, making an 11.5% percent of the total. June and July followed with an equal 6 cases each representing 9.8%. Table 6 had further details of the monthly distribution in the post-COVID-19 era arranged in descending order of frequency.

Table 6. Shows the monthly distribution of maternal deaths in the post-COVID-19 era.

	Month of death	Frequency	Percent
Post COVID-19 Era	March	7	11.5
	May	7	11.5
	July	6	9.8
	June	6	9.8
	August	5	8.2
	December	5	8.2
	February	5	8.2
	January	5	8.2
	November	5	8.2
	April	4	6.6
	September	4	6.6
	October	2	3.3
	Total	**61**	**100**

Source: Health records unit of the ONG department, TTH.

3.2.4. Distribution of Live Births within the Specified Timeframes under Study in TTH

The distribution of live births (Table 7) in TTH was rather a tricky business since this study had its timelines different from the traditional yearly calendar. To get accurate results, the monthly distribution of live births was taken to correlate with the timelines under this study, *i.e.* 1st March to 28th February of the following year. The pre-COVID-19 era had the highest number of live births with a total of 8752, with the COVID-19 era coming in second with a total of 8116. The post-COVID-19 period had the least number of live births of 7721. Calculating the total number of live births was significant in determining the maternal mortality ratio, which is one of the objectives of this study.

3.2.5. Calculation of Maternal Mortality Ratios

According to the WHO, the formula for calculation of Maternal Mortality Ratio (MMR) is given as: **MMR = (Number of Maternal Deaths /Number of Live Births)*100,000**.

Post COVID-19 era had the highest maternal mortality ratio of 790 per 100,000 live births, with the COVID-19 era coming in second with an MMR of 591 per 100,000 live births. The pre-COVID-19 era came in third with an MMR of 571 per 100,000 live births. (Table 8)

Table 7. Shows the monthly distribution of live births in TTH.

Month	Pre COVID-19 era	COVID-19 era	Post COVID-19 era	
March	792	817	637	
April	830	845	717	
May	871	777	880	
June	726	627	717	
July	635	639	381	
August	840	587	413	
September	744	580	577	**Monthly Number of Live Births**
October	710	816	844	
November	824	723	771	
December	700	624	678	
January	500	510	572	
February	580	571	534	
Total	**8752**	**8116**	**7721**	

Source: Health records unit of the ONG department, TTH.

Table 8. Shows the maternal mortality ratios in the various timeframes under study.

Maternal Mortality Ratio (MMR)				
	Period	Maternal Deaths	Live Births	Maternal Mortality Ratio (MMR)
MMR = (Number Of Maternal Deaths /Number Of Live Births)*100,000	Pre-COVID-19 Era	50	8752	571
	COVID 19 Era	48	8116	591
	Post COVID 19 Era	61	7721	790

Source: Health records unit of the ONG department, TTH.

3.2.6. How Maternal Mortality Ratios for Both Pre COVID-19 and Post COVID-19 Compare with the COVID-19 Era

1) To analyze the relationship among the maternal mortality ratios across the different time frames and to determine the impact of COVID-19, we calculated the percentage changes (Figure 4):

✓ From Pre-COVID-19 Era to COVID-19 Era.

✓ From COVID-19 Era to Post-COVID-19 Era.

✓ From Pre-COVID-19 Era to Post-COVID-19 Era.

2) Percentage Changes Calculation

➢ **From Pre-COVID-19 Era to COVID-19 Era**

Percentage Change = ((MMR COVID-19 Era − MMR Pre-COVID-19 Era)/MMR Pre-COVID-19 Era)*100.

Percentage Change = (591 − 571)/571*100.

Percentage Change = 3.5%.

➢ **From COVID-19 Era to Post-COVID-19 Era**

Percentage Change = ((MMR Post-COVID-19 Era − MMR COVID-19

Era)/MMR COVID-19 Era)*100.

Percentage Change = (790 − 591)/591*100.

Percentage Change = 33.67%.

➢ **From Pre COVID-19 Era to Post COVID-19 Era**

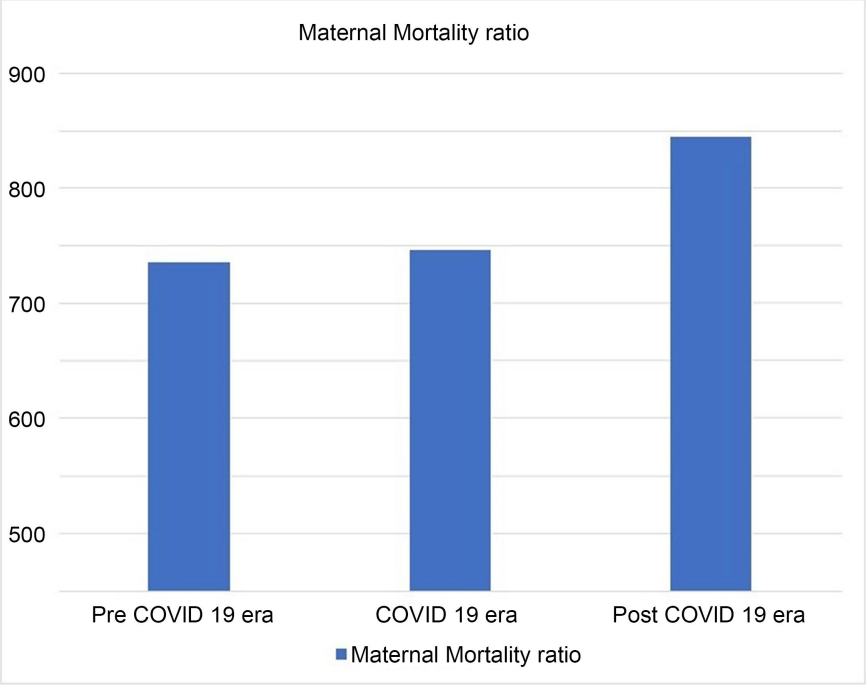
Percentage Change = ((MMR Post-COVID-19 Era − MMR Pre-COVID-19 Era)/MMR Pre-COVID-19 Era)*100.

Percentage Change = (790 − 571)/571*100.

Percentage Change = 38.36%.

3) Results

- From Pre-COVID-19 Era to COVID-19 Era saw a 3.50% increase in maternal mortality ratio.
- From COVID-19 Era to Post-COVID-19 Era saw a 33.67% increase in the maternal mortality ratio.
- From Pre-COVID-19 Era to Post-COVID-19 Era witnessed a 38.36% increase in the maternal mortality ratio.



Source: Health records unit of the ONG department, TTH.

Figure 4. A bar chart showing the relationship in the MMR in the different timeframes.

4. Discussion

4.1. Socio-Demographic Characteristics of the Study Population

The socio-demographic profile of maternal mortality cases at TTH in Northern Ghana provides vital insights into the patterns and determinants of maternal deaths across distinct periods: pre-COVID-19, COVID-19, and post-COVID-19 eras. Understanding these characteristics is essential for designing targeted inter-

ventions to improve maternal health outcomes amidst global health crises.

In the pre-COVID-19 era, the demographic landscape of maternal mortality cases revealed significant patterns. The age group most affected was 20 - 29 years, representing 58% of cases, highlighting the vulnerability of young mothers to maternal health complications (see **Table 1**). This trend aligns with global findings where younger maternal age is associated with a higher risk of complications due to physiological immaturity [34]. The majority of cases (96%) were admitted to the Maternal Intensive Care Unit (MICU), indicating the severity of conditions requiring intensive care management. Furthermore, 98% of cases were referrals from peripheral facilities, suggesting challenges in accessing timely and adequate prenatal and obstetric care services in the region [9]-[16].

During the COVID-19 era, shifts in demographic patterns were observed, with the 30 - 39 age group becoming more susceptible, constituting 47.9% of maternal mortality cases. This demographic shift coincided with global reports indicating altered healthcare-seeking behaviours and disruptions in maternal health services due to the pandemic [36]. Despite the high proportion of MICU admissions (83.3%) and referrals (85.4%), an increase in nulliparous cases (22.9%) suggests potential delays in accessing essential maternal health services, which are exacerbated by pandemic-related restrictions and strains on the healthcare system [35].

In the post-COVID-19 era, the 20 - 29 age group remained predominantly affected (54.1%), but there was a notable decrease in referral rates (63.9%) compared to the COVID-19 era. This may indicate improvements in local healthcare infrastructure or adaptations in service delivery post-pandemic [36]. The varying parity distributions, with primiparous women (P1) comprising the highest proportion (29.5%), reflect diverse maternal health profiles and care needs during the recovery phase from the pandemic [34].

4.2. Primary Diagnosis of Subjects

The leading causes of maternal mortality consistently included hypertensive disorders in pregnancy across all study periods, reaffirming its critical role as a primary contributor to maternal deaths in Northern Ghana.

In the pre-COVID-19 era, hypertensive diseases accounted for 36% of cases, highlighting the persistent challenge of managing pre-eclampsia and eclampsia in resource-constrained settings (see **Figure 1**). This is consistent with global studies that have identified hypertensive disorders as a major cause of maternal mortality, particularly in low- and middle-income countries (LMICs) [14] [37]. Post-partum haemorrhage (PPH) and acute heart failure followed with significant proportions (14% and 10%, respectively), underscoring the multifaceted nature of maternal health emergencies faced in the region [34].

During the COVID-19 era, hypertensive disorders remained predominant (31.3%), but there was an increase in cases attributed to other acute conditions such as sickle cell crises, stroke, and bronchopneumonia (each accounting for 6.3% of cases) (see **Figure 2**). 4.1% represented the percentage of cases that at-

tributed to COVID-19. This is of significant note because during the peak of the pandemic, only two cases of COVID-19 of a total of 48 led to maternal deaths, which means the pandemic rather manifested its indirect effects on maternal mortality. These include potential shifts in healthcare priorities and resource allocation during the pandemic, impacting maternal health outcomes [36].

In the post-COVID-19 era, hypertensive diseases continued to pose the greatest risk (36.1%), with variations in the incidence of other acute conditions like PPH (16.7%) and sickle cell crises (9.8%) (See **Figure 3**). These findings highlight ongoing challenges in maternal health management post-pandemic, necessitating targeted interventions to strengthen emergency obstetric care and mitigate preventable maternal deaths [34].

In the post-COVID-19 phase, efforts to re-establish routine ANC services have been uneven, and the continuity of hypertensive disorders of pregnancy (HDP) prevention programs has not fully rebounded in all facilities. At Tamale Teaching Hospital, a premier tertiary facility in Northern Ghana, a new unit within the Obstetrics and Gynecology department for maternal-fetal medicine started in August 2023. This development aims to enhance attention and surveillance, implementing timely intervention protocols for hypertensive disorders and other high-risk conditions during pregnancy. The goal is to reduce maternal mortality rates and improve outcomes for hypertensive disorders of pregnancy (HDPs) despite the likelihood of these issues persisting even as COVID-19 subsides.

4.3. Monthly Distribution of Maternal Mortality Cases

The analysis of monthly distribution patterns revealed distinct temporal trends in maternal mortality cases influenced by seasonal variations and healthcare service utilization patterns across different study periods. In the pre-COVID-19 era, peaks in maternal mortality were observed in February and November, coinciding with the dry season characterized by increased healthcare demands and potential health system stressors (see **Table 6**). This pattern aligns with findings from other studies in sub-Saharan Africa, where seasonal variations significantly impact maternal health outcomes [16] [38].

During the COVID-19 era, despite the pandemic's disruptive impact on healthcare services, February and March recorded the highest mortality rates, highlighting critical periods of strain on healthcare resources and maternal health outcomes (see **Table 7**). This trend is consistent with global reports that documented increased maternal mortality rates during the early months of the COVID-19 pandemic due to healthcare disruptions [35] [36].

In the post-COVID-19 era, peaks in maternal mortality cases were observed in March and May, underscoring persistent challenges in maternal health management and healthcare service delivery during the recovery phase from the pandemic (see **Table 8**). These findings emphasize the need for sustained efforts to strengthen health system resilience and adaptive capacities to safeguard maternal health in future health crises [34].

4.4. Distribution of Live Births

The distribution of live births mirrored fluctuations in maternal mortality rates across the study periods, reflecting broader impacts of healthcare system dynamics and public health responses. In the pre-COVID-19 era, the highest number of live births was recorded, indicating robust healthcare service utilization and maternal health outcomes during this period (see **Table 8**). This aligns with global trends where stable healthcare systems support higher birth rates and better maternal outcomes [16].

During the COVID-19 era, a decline in live births corresponded with disruptions in healthcare access and service utilization amidst pandemic-related restrictions and health system strains (see **Table 7**). Similar trends were reported globally, where reduced healthcare access during the pandemic led to declines in institutional deliveries and increased home births, often without skilled care [35] [36].

In the post-COVID-19 era, while an improvement in live birth numbers was observed compared to the COVID-19 era, the total remained lower than pre-pandemic levels. This highlight ongoing challenges in maternal health recovery and healthcare service delivery, similar to global observations where healthcare systems are gradually rebuilding post-pandemic [34].

4.5. Maternal Mortality Ratios

The Maternal Mortality Ratio (MMR), as shown in **Table 8** is an essential indicator for evaluating the severity and trends of maternal mortality over time. Our study uncovered significant variations in the MMR across the pre-COVID-19, COVID-19, and post-COVID-19 periods, highlighting the pandemic's impact on maternal health outcomes.

4.5.1. Pre-COVID-19 Era

In the pre-COVID-19 era, the MMR at the Tamale Teaching Hospital in Northern Ghana was calculated to be 571 per 100,000 live births. This figure, although high, aligns with the broader regional trends observed in sub-Saharan Africa, where MMRs remain significantly elevated due to various factors, including limited access to quality healthcare, high prevalence of obstetric complications, and socioeconomic challenges [37].

4.5.2. COVID-19 Era

During the COVID-19 era, the MMR increased to 591 per 100,000 live births, representing a 3.5% increase from the pre-COVID-19 period. This rise is indicative of the pandemic's adverse effects on maternal health services, including disruptions in routine antenatal care, delays in seeking care due to lockdowns, and the reallocation of healthcare resources to manage COVID-19 cases [35] [36]. Globally, similar trends were observed, with countries reporting increased maternal mortality rates due to pandemic-induced healthcare system strains [13]-[34].

4.5.3. Post-COVID-19 Era

The post-COVID-19 era saw a further increase in MMR to 790 per 100,000 live births, marking a significant 33.6% rise from the COVID-19 era and a 38.3% increase from the pre-COVID-19 period. This substantial escalation underscores the prolonged and compounded impact of the pandemic on maternal health services. Factors contributing to this rise include lingering disruptions in healthcare delivery, reduced healthcare-seeking behaviors, and ongoing healthcare system recovery challenges [4]-[36].

Post-COVID-19 recovery efforts have not fully restored service delivery to pre-pandemic levels. Delays in the replenishment of medical supplies, including emergency obstetric care drugs, and ongoing funding constraints, especially in rural and underserved areas, have impaired the quality and timeliness of maternal care. Health systems that were already under strain before the pandemic have been further weakened, making it difficult to catch up with deferred care and missed antenatal visits [38] [39].

4.5.4. Global Comparisons

Comparing these findings with global studies provides a broader context for understanding the implications of these MMR trends. Brown and Shen [35] reported a 20% increase in maternal mortality rates in sub-Saharan Africa during the COVID-19 pandemic, largely due to similar disruptions in healthcare access and service delivery. In Southeast Asia, Smith *et al.* [34] documented a comparable rise in maternal mortality, attributing it to delays in accessing emergency obstetric care and reduced availability of skilled birth attendants during the pandemic.

During the peak of the COVID-19 pandemic, there was global awareness and mobilization of emergency responses, including temporary adaptations to sustain essential health services. While access to routine maternal care declined, many hospitals adopted stopgap measures, such as triage systems, remote consultations, and designated maternity zones, that offered some protection to maternal health services [40].

In contrast, the post-pandemic period was marked by strained health systems, with many facilities struggling to recover from prolonged resource depletion, infrastructure wear, and healthcare worker burnout and attrition. These lingering effects reduced the capacity of hospitals to deliver quality maternal care, despite the formal end of the pandemic [41]. The decline in public health focus on maternal health during the recovery period may have led to delayed replenishment of critical supplies, inadequate staffing, and reduced supervision, all of which are critical for timely obstetric interventions [40] [41].

Moreover, factors unrelated to COVID-19 may have amplified maternal mortality during the post-pandemic period. These include:

- Economic instability, inflation, and reduced household income, which limited women's ability to seek care.
- Increased teenage pregnancies and unsafe abortions due to pandemic-related school closures and limited access to family planning.

- Weak health information systems, making it difficult to promptly identify and respond to maternal near-misses or deaths.

The post-COVID-19 period thus represents a phase of systemic vulnerability, where the long-term consequences of health system disruption intersected with pre-existing inequities and new socio-economic challenges, contributing to a higher MMR than during the acute COVID-19 phase itself [39]-[41].

4.5.5. Comparison of Maternal Mortality Trends in the Northern Region of Ghana: Pre-, during-, and Post- COVID-19

Period	Maternal Mortality Ratio (MMR)	Key Contributing Factors
Pre-COVID-19 Era	Relatively lower MMR (571)	-Persistent health system challenges -Socio-economic inequality Limited access in rural areas
COVID-19 Era	Slight decrease or plateau (591)	Reduced facility deliveries due to lockdowns Emergency response protocols maintained minimal essential care
Post COVID-19 Era	Significantly higher (790)	Staff burnout and shortages Depleted health system resources Rising costs of care Increased adolescent pregnancy Weak post-pandemic recovery and funding gaps

COVID-19-era MMR appeared slightly lower in some settings due to underreporting and reduced service utilization (fewer facility-based births).

The post-COVID-19 spike likely reflects the accumulated effects of system fatigue, socio-economic deterioration, and delayed complications surfacing after missed care opportunities.

Furthermore, a comprehensive review by Chmielewska *et al.* [13] highlighted a global increase in maternal mortality and morbidity during the pandemic, with low- and middle-income countries (LMICs) being disproportionately affected. This review emphasized the need for resilient healthcare systems capable of sustaining essential maternal health services amidst global health crises.

5. Conclusions

This study had examined the impact of the COVID-19 pandemic on maternal mortality in the Tamale Teaching Hospital (TTH), Northern Ghana. The findings reveal significant disruptions in maternal health during the pandemic and post-pandemic periods, contributing to an increase in maternal mortality ratio compared to the pre-pandemic era.

The analysis underscores the vulnerability of maternal health systems to external shocks such as pandemics and highlights the urgent need for resilient health infrastructure and adaptive policy frameworks to safeguard maternal health during health emergencies.

6. Recommendations

Based on the study's findings, the following recommendations are proposed to mitigate the impact of future health crises on maternal health in Northern Ghana:

- Invest in healthcare infrastructure to improve facilities and resources at TTH and ensure uninterrupted maternal health services during crises.
- Integrate Pandemic Preparedness into Maternal Health Policies at TTH.
- Strengthen Telemedicine and Digital Health Solutions to facilitate remote consultations and healthcare delivery for pregnant women, especially in rural areas.
- Promote community awareness and engagement through health education campaigns to dispel misinformation and encourage early healthcare-seeking behaviors among pregnant women and their families.

Recommendations for Future Research

Further research is needed to explore the long-term impacts of the COVID-19 pandemic on maternal health and to develop strategies for improving maternal health resilience. Studies should focus on understanding the socio-economic determinants of maternal mortality, evaluating the effectiveness of policy interventions, and exploring innovative approaches to maternal health service delivery in crisis settings.

Conflicts of Interest

The authors declare no conflicts of interest.

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