Incidence and Determinants of Maternal Sepsis in Ghana in the midst of a pandemic

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Abstract

Background: Despite being preventable, maternal sepsis continues to be a significant cause of death and morbidity, killing one in every four pregnant women globally. In Ghana, maternal sepsis is increasingly becoming a major contributor to maternal mortality. The lack of a consensus definition for maternal sepsis before 2017 created a gap in determining global and country-specific burden of maternal sepsis and its risk factors. This study determined the incidence and risk factors of clinically proven maternal sepsis in Ghana.

Methods: We conducted a prospective cohort study among 1476 randomly selected pregnant women in six health facilities in Ghana, from January to September 2020. Data were collected using primary data collection tools and reviewing the client's charts. We estimated the incidence rate of maternal sepsis per 1,000 pregnant women per person-week. Poisson regression model and the cox-proportional hazard regression model estimators were used to assess risk factors associated with the incidence of maternal sepsis at a 5% significance level.

Results: The overall incidence rate of maternal sepsis was 1.52 [95% CI: 1.20-1.96] per 1000 person-weeks. The majority of the participants entered the study at 10-13 weeks of gestation. The study participants' median body mass index score was 26.4 kgm^{-2} [22.9 - 30.1 kgm^{-2}]. The risk of maternal sepsis was 4 times higher among women who developed urinary tract infection after delivery (aHR: 4.38, 95% CI: 1.58-12.18, $p<0.05$). Among those who developed caesarean section wound infection after delivery, the risk of maternal sepsis was 3 times higher (aHR: 3.77, 95% CI: 0.92-15.54, $p<0.05$). Among pregnant women who showed any symptoms 14 days prior to exit from the study, the risk was significantly higher among pregnant women with a single symptom (aHR: 6.1, 95% CI: 2.42-15.21, $p<0.001$) and those with two or more symptoms (aHR: 17.0, 95% CI: 4.19-69.00, $p<0.001$).

Conclusions: Our findings show a low incidence of maternal sepsis in Ghana compared to most Low and Middle-Income Countries. Nonetheless, Maternal sepsis remains an important contributor to the overall maternal mortality burden. It is essential clinicians pay more attention to ensure early and prompt diagnosis. Factors significantly predicting maternal sepsis in Ghana were additional maternal morbidity, urinary tract infections, dysuria, and multiple symptoms. We recommend that Ghana Health Service should institute a surveillance system for maternal sepsis as a monthly reportable disease.

Background

Maternal sepsis is a life-threatening condition defined as organ dysfunction resulting from infection during pregnancy, childbirth, post-abortion, or postpartum period"(Bonet et al., 2017). It is estimated that sepsis contributes to more than 100,000 of all maternal deaths annually, but primarily responsible for more than 35,000 deaths (WHO, 2017). In Africa, maternal sepsis is estimated to cause about 9.7% of all maternal deaths (Oza et al., 2014; Say et al., 2014). A nationwide secondary data analysis of autopsy and maternal mortality data indicates maternal sepsis is the fourth leading cause of maternal deaths accounting for 9.1% of all maternal deaths (Der et al., 2013). Maternal sepsis is increasingly becoming a major contributor to maternal mortality in Ghana (Asamoah et al., 2011; Der et al., 2013).

Pregnancy, labor, and following childbirth present a period of high risk for infections leading to maternal sepsis. There is generally immune suppression during these periods due to tissue and physiological changes, particularly during labor and immediately after childbirth in the placental bed of the uterus (Acosta & Knight, 2013). Unfortunately, this period creates a conducive environment for microorganisms to thrive. Additionally, some heath practices; including non-ante natal attendance, self-medication may further lower their immunity whiles interventions such as vaginal examinations could also introduce microbes leading to infections. The spectrum of infections during pregnancy and following childbirth ranging from mild infection to severe sepsis and septic shock causes high mortality, longer hospitalizations, and excessive cost to the patients and healthcare system. Gram-negative bacteria are responsible for a great portion of maternal sepsis, and an increased incidence of sepsis caused by multidrug-resistant (MDR) Gram-negative bacteria strains in the last decades (Admas et al., 2020).

Despite being preventable, maternal sepsis continues to be a major cause of death and morbidity for pregnant women, killing one in every four pregnant women (Angus et al., 2001; Dellinger, 2003; WHO, 2018). Improving maternal health is a crucial priority for the WHO, culminating in the adoption of a global strategy and goal of ending preventable maternal mortality. The main strategy is to address all causes of maternal mortality, reproductive and maternal morbidities in all WHO countries.

The lack of a consensus definition for maternal sepsis before 2017 created a more serious problem allowing all forms of categorization of women as having sepsis. This created a gap in the determination of global and country-specific burden of maternal sepsis. Ghana is one of 52 WHO member countries that validated the new definition of maternal sepsis has since employed the new in its diagnosis. There has never been an opportune time to document the burden and identify risk factors along the continuum of care for pregnant women and following delivery according to a global consensus definition, identification, and classification of maternal sepsis than now. Prior to the study there was little knowledge on the incidence of maternal sepsis among women in the different parts of the country. Therefore, this study sought to determine the incidence and identified risk factors of clinically proven maternal sepsis among a cohort of pregnant women in Ghana.

Methods

Study Design

This was a prospective cohort study among 1476 pregnant women in three regions of Ghana from 01 January 2020 and 30 September 2020. Women attending ANC at booking (first registration) regardless of gestational age of the pregnancy, were recruited and followed until the postpartum period. The attending midwife or clinician throughout the study period screened women using the WHO new case definition of maternal sepsis. Data was collected through interviews, physical and biochemical assessments.

Study Setting

The research was carried out in three out of 16 regions in Ghana with a total population of more than 7 million people. The Greater Accra Region, Bono Region, and Upper West Region were chosen. Data was collected at six health care facilities across the three regions.

Ghana's population is estimated to be 30.8 million, with a yearly growth rate of 2.4 percent, according to the Ghana Statistical Service (GSS) (GSS, 2021).

The data collection sites included; Wa Municipal Hospital, Jirapa Municipal, Hospital, Sunyani Municipal Hospital, Bono regional Hospital, Tema Genral Hospital and Greater Accra Regional Hospital (Ridge). The Greater Accra Regional hospital is a 420-bed capacity hospital in the Osu-Klotey sub metro in the Accra metropolitan area that provides inpatient and outpatient services and specialized services. The Brong Ahafo Regional Hospital is a 330-bed capacity health facility that provides OPD and inpatient care services in the Bono region. Sunyani Municipal Hospital is a 95-bed capacity hospital located in the eastern part of the Sunyani Municipality that provides Outpatient and Inpatient services. The Wa Municipal Hospital and Jirapa Hospital each is a 200-bed capacity facility in the Upper West region which provides both OPD and Inpatient services (**Figure 1**).

Inclusion criteria

All pregnant women regardless of age who were registered in antenatal clinics of the selected health facilities, and who did not intend to leave the study site over the study period were included.

Exclusion criteria

Records of women who become pregnant with assistance of advanced reproductive technology, women with pre-existing medical conditions outside of pregnancy (e.g., HIV positive, hepatitis B or hepatitis C, hypertension, renal disease) at study enrolment were excluded.

Definition of maternal sepsis

In 2017, the definition of maternal sepsis was updated. WHO now defines maternal sepsis as “organ dysfunction resulting from infection during pregnancy, childbirth, post-abortion, or postpartum period”, which includes 42 days after the pregnancy has terminated, irrespective of the cause (Bonet et al., 2017).The disease-specific criteria set by WHO (2019) were employed to identify sepsis in pregnancy and following child birth including maternal near-miss cases.

Suspected infection

If the woman has any of the following (to treat the source of infection): laparotomy and lavage, incision and drainage, hysterectomy, vacuum aspiration, percutaneous drainage, wound debridement, culdotomy, dilatation and curettage, removal of infected cannula, any other surgery.

Or

The woman has one or more of the following:

Shock, cardiac arrest, severe hyperfusion, and severe acidosis are all possible outcomes. Continuous vasoactive drug administration, cardiopulmonary resuscitation, acute cyanosis, gasping, severe tachypnea, severe bradypnea, severe hypoxemia, intubation and ventilation unrelated to anesthesia, oliguria, inability to respond to fluids or diuretic, acute severe azotemia, acute renal failure dialysis, inability to form clots, severe acute thrombocytopenia, blood or red cell transfusion, in the presence of preeclampsia, there is jaundice. Long periods of unconsciousness or coma, uncontrollable fit / status epilepticus, stroke paralysis all over, hysterectomy as a result of uterine infection or hemorrhage

OR

Woman was admitted to ICU or high dependency care

OR

Woman was transferred to another facility

OR

Related infection death

Otherwise, the woman with suspected infection has “Infections WITHOUT complications”

Study Eligibility and Sampling Process

We used a multistage sampling approach to select 1476 pregnant women for the study. The first stage involved the selection of three regions from the three epidemiological zones in Ghana. The Upper West region in the Northern Zone, Bono region in the Middle Zone, and Greater Accra region in the Coastal Zone

were randomly selected respectively. The second phase involved the sampling of health facilities, one district hospital was then randomly selected from each of the three regions in addition to the regional hospital. Pregnant women who met the selection criteria were invited to participate in the study after obtaining written informed consent.

Data Collection Process

A scheduled follow-up exercise was carried out in collecting data from the study participants. The follow-up period lasted for 8 months from the start of recruitment. The follow-up period was in three phases using a follow-up log book. Phase One was from booking to labor, the follow-up was bi-weekly, Phase two was daily from delivery till discharge from the health facility or seven days after delivery. The third phase was bi-weekly after discharge or seven days after delivery until 42 days after delivery or death. Data was collected on sociodemographic characteristics, habits, anthropometric measurements, physical activity and blood pressure measurements.

Individual habits: The study participants' smoking and drinking habits were obtained at the point of recruitment using a semi-structured questionnaire. The smoking status, frequency of smoking, and the number of cigarettes smoked were obtained during each visit. The frequency of drinking alcohol and the amount of alcohol (glass) was also obtained.

Pregnancy Physical Activity Questionnaire (PPAQ) was used to determine the physical activity of pregnant women. The PPAQ is a semi-quantitative questionnaire that requires participants to report the time spent participating in 32 activities including household/caregiving (13 activities), occupational (5 activities), sports/exercise (8 activities), transportation (3 activities), and inactivity (3 activities). Anthropometric measurements: Weight, height, and waist circumference were measured at study enrolment (antenatal booking) using a standard instrument (SECA digital weighing scale, SECA body meter, and SECA measuring tape). body weight (current pregnancy) and weight at the delivery were obtained from medical records and BMI was calculated as weight (kilogram) divided respondents' height (square meters). Blood pressure measurements performed according to the recommendations of the American Heart Association valid at the time of data collection were extracted.

Outcome measures

The outcome variable "maternal sepsis" was measured using the 2017 World Health Organization experts' definition (Global Sepsis Alliance, 2020; WHO-HRP, 2019). Thus, maternal sepsis was diagnosed as 'yes' when diagnosed by the clinician and 'no' when clinician did not suspect infection.

The independent variables were extracted from the maternal records on demographic characteristics, clinical and obstetric history

Data Management and Statistical Analysis

Data collected was cleaned and exported to Stata version 16 for analysis. The background characteristics of study participants were described using frequencies and percentages for categorical variables, means and standard deviation for normally distributed continuous variables and median and interquartile range for non-normal continuous variables. The incidence rate of maternal sepsis per 1,000 pregnant women per person-week was also estimated.

Poisson regression model estimator and the cox-proportional hazard regression model estimators were used to assess risk factors associated with the incidence of maternal sepsis at a 5% level of significance. For each of the two estimators, two different regression models were fitted. Model 1 of each of the two estimators was populated with the independent variables that were significantly associated with maternal sepsis from the crude incidence rate ratio estimates. Whilst model 2 of each of the two estimators contained all of the independent variables considered in this study. The Poisson regression model estimated the adjusted incidence rate ratio whilst the cox-proportional hazard model estimated the hazard rate ratio. The log-likelihood ratio test was used to assess the most appropriate models at 5% significance level.

Ethical consideration

Prior to the commencement of the study, ethical approval was obtained from the Ghana Health Service Ethical Review Committee (GHS-ERC011/10/19). Permission letters were obtained from Regional Health Directorates and Participating Health facilities before starting the study. Written informed consent and or parental assent was obtained from participants of the study without any form of coercion.

Results

Characteristics of study participants, Ghana, 2022

A total of 1476 women were used for the study's final analysis. The mean age of the women was 29.0 years with a standard deviation of 6.0 years. Eight of every ten of the women were married (80.8%). About a tenth of the women had no formal education (9.7%), 8.8% had primary education, 30.4% had JHS level education, 24.9% were with SHS education and 26.2% had tertiary level education. About two-thirds of the participants entered the study at 10-13 weeks of gestation, a third at 6-9 weeks gestation, and 2.4% at less than 6 weeks gestation. The study participants' median body mass index score was 26.4 kgm^{-2} with

an inter-quartile range of 22.9 to 30.1 kgm^{-2}. At the end of their pregnancies, the participants' mean number of antenatal care attendance was 5 visits with a quarter attaining less than 4 ANC visits, about two-thirds attaining 4 to 7 ANC visits, and 11.5% attaining 8 or more ANC visits (**Table 1**).

Table 1

Descriptive characteristics of study participants, Ghana, 2022

Variables & categories	Frequency (N=1476)	Percentage (%)
Age at booking (years), (mean ± SD)	29.0 ± 6.0	
<20	74	5.0
20-35	1192	80.8
>35	210	14.2
Marital status		
Not married	266	18.0
Married	1192	80.8
Highest educational level		
No formal education	143	9.7
Primary	130	8.8
JHS	448	30.4
SHS	368	24.9
Tertiary	387	26.2
Religion		
Christians	1174	79.5
Islam	287	19.4
Others	15	1.0
Main occupation		
Unemployed	198	13.4
Formal sector	234	15.9
Informal sector	1044	70.7
BMI category, median (IQR)	26.4 (22.9, 30.1)	
<18.5kgm2	39	2.6
18.5 to 24.9kgm2	530	35.9
25.0 to 29.9kgm2	531	36.0
30.0 to 34.9kgm2	262	17.8
>34.9kgm2	114	7.7
Gravidity, median (IQR)	2.0 (1.0, 4.0)	
1 pregnancy	373	25.3
2-3 pregnancies	678	46.0
>3 pregnancies	424	28.7
Parity, median (IQR)	1.0 (0.0, 2.0)	
No child	522	35.4
1-2 children	706	47.8
>2 Children	248	16.8
Number of ANC visits, mean ± SD	5.1 ± 2.1	
<4 visits	371	25.1
4 to7 visits	935	63.3
8+ visits	170	11.5
Type of health facility		
Regional hospital	735	49.8
District hospital	741	50.2
Region		

Bono	469	31.8
Greater Accra	592	40.1
Upper West	415	28.1
Mode of delivery		
SVD	987	68.0
CS	465	32.0
Birth attendant		
Obstetrician/Physician	439	30.0
Midwife/Nurse	1011	69.2
Others (TBA/family member)	12	0.8

Incidence of maternal sepsis, Ghana, 2022

At the exit of the study, 62 out of the 1,476 total study participants were diagnosed with maternal sepsis representing 3.7%. At the end of the study, the 1,476 study participants contributed 40,934 persons-weeks. A total of 62 new cases of maternal sepsis meant that the incidence rate was 1.52 maternal sepsis cases per person-week per 1,000 women. A 95% confidence interval estimate of maternal sepsis was estimated from 1.20 to 1.96 incidence of maternal sepsis per person-week per 1000 women (**Figure 2**)

Incidence and incidence rate ratio of maternal sepsis by background characteristics of study participants, Ghana, 2022

Compared to pregnant women above 35 years of age, the incidence rate of maternal sepsis was higher among pregnant women below 20 years (IRR: 4.27, 95% CI: 0.71-25.56, $p>0.05$) and significantly higher among pregnant women aged 20-35 years (IRR: 4.31, 95% CI: 1.05-17.71, $p<0.05$). Overall, the age of the pregnant women was not significantly associated with the incidence of maternal sepsis from the crude estimate ($p=0.128$). The incidence of maternal sepsis among Christians was three times higher than Muslims (IRR: 3.29, 95% CI: 1.93-5.62, $p<0.001$).

The incidence of maternal sepsis was 54% lower among pregnant women with 2-3 pregnancies compared to those with single pregnancy (IRR: 0.51, 95% CI: 0.30-0.89, $p<0.01$). Overall, the gravidity of the pregnant women was significantly associated with the incidence of maternal sepsis from the crude estimates ($p=0.003$).

The rate of maternal sepsis was over 5 times higher among women who visited facilities with no specialists available (IRR: 5.28, 95% CI: 2.81-9.91, $p<0.001$). Compared to women from the Bono region, the incidence rate of maternal sepsis was over 8 times significantly higher in the Upper West region (IRR: 8.19, 95% CI: 3.49-19.20, $p<0.001$) (**Table 2**).

Table 2

Incidence and incidence rate ratio of maternal sepsis by background characteristics of study participants, Ghana, 2022

	Total person, time in weeks	Number of incidences	Incidence rate per week per 1000 women	Unadjusted Poisson regression model	
				IRR [95% CI]	P-value
Overall	40832.4	62	1.52 [1.20-1.96]		
Age at booking (years)					0.234
<20	2042.4	3	1.47 [0.47-6.92]	1.00	
20 - 35	33000.3	55	1.67 [1.29-2.18]	1.13 [0.35-3.63]	
>35	5789.7	4	0.69 [0.26-2.45]	0.47 [0.11-2.10]	
Marital status					0.350
Not married	7844.0	9	1.15 [0.61-2.41]	1.00	
Married	32988.4	53	1.61 [1.24-2.12]	1.40 [0.69-2.84]	
Highest education					0.862
None/Primary	7650.4	13	1.70 [1.02-3.07]	1.00	
JHS	12351.4	16	1.30 [0.81-2.20]	0.76 [0.37-1.58]	
SHS	10109.7	17	1.68 [1.07-2.80]	0.99 [0.48-2.04]	
Tertiary	10720.9	16	1.49 [0.94-2.53]	0.88 [0.42-1.83]	
Religion					<0.001***
Christians	32371.0	35	1.08 [0.79-1.53]	1.00	
Islam/others	8461.4	27	3.19 [2.25-4.69]	2.95 [1.79-4.88] ***	
Main occupation					0.439
Unemployed	5483.0	11	2.01 [1.15-3.83]	1.00	
Formal sector	6467.7	7	1.08 [0.53-2.57]	0.54 [0.21-1.39]	
Informal sector	28881.7	44	1.52 [1.15-2.07]	0.76 [0.39-1.47]	
BMI category					0.133
<18.5kgm2	1103.1	4	3.63 [1.46-11.81]	1.00	
18.5 to 24.9kgm^{-2}	14814.7	24	1.62 [1.11-2.47]	0.45 [0.16-1.29]	
25.0 to 29.9kgm^{-2}	14247.6	24	1.68 [1.15-2.57]	0.46 [0.16-1.34]	
>29.9kgm^{-2}	10667.0	10	0.94 [0.52-1.88]	0.26 [0.08-0.82] *	
Gravidity					0.004**
1 pregnancy	10385.4	27	2.60 [1.83-3.84]	1.00	
2-3 pregnancies	18704.0	25	1.34 [0.92-2.02]	0.51 [0.30-0.89] *	
>3 pregnancies	11719.1	10	0.85 [0.47-1.71]	0.33 [0.16-0.68] **	
Parity					0.152
No child	14400.6	29	2.01 [1.43-2.94]	1.00	
1-2 children	19549.0	23	1.18 [0.80-1.82]	0.58 [0.34-1.01]	
>2 children	6882.9	10	1.45 [0.81-2.90]	0.72 [0.35-1.48]	
Number of ANC visits					0.354
<4 visits	10370.7	12	1.16 [0.67-2.16]	1.00	
4 to 7 visits	25799.0	40	1.55 [1.15-2.13]	1.34 [0.70-2.55]	
8+ visits	4662.7	10	2.14 [1.19-4.26]	1.85 [0.80-4.29]	
Type of health facility					0.001**
Regional hospital	20435.4	44	2.15 [1.63-2.91]	1.00	
District hospital	20397.0	18	0.88 [0.57-1.45]	0.41 [0.24-0.71] **	
Availability of specialist in					<0.001***

facility					
Specialist available	22821.3	12	0.53 [0.31-0.99]	1.00	
No specialist available	18011.1	50	2.78 [2.14-3.67]	5.28 [2.81-9.91] ***	
Region					<0.001***
Bono	12840.7	6	0.47 [0.21-1.22]	1.00	
Greater Accra	16232.4	11	0.68 [0.38-1.31]	1.45 [0.54-3.92]	
Upper West	11759.3	45	3.83 [2.92-5.12]	8.19 [3.49-19.20] ***	
Mode of delivery					0.669
SVD	27293.4	43	1.58 [1.18-2.14]	1.00	
CS	12884.4	18	1.40 [0.90-2.29]	0.89 [0.51-1.54]	
Birth attendant					0.794
Obstetrician/Physician	12208.7	18	1.47 [0.95-2.42]	1.00	
Midwife/Nurse	27903.1	43	1.54 [1.16-2.10]	1.05 [0.60-1.81]	
Others (TBA/family member)	337.7	1	2.96 [.-.]	2.01 [0.27-15.04]	

Multivariate regression models of risk factors associated with incidence of sepsis among pregnant women

From the multivariable Cox-proportional regression model 2, the risk of maternal sepsis was 88% lower among women who had more than 3 pregnancies (aHR: 0.12 95% CI: 0.02-0.95, p<0.05).

The risk of maternal sepsis was 4 times higher among women who developed urinary tract infection after delivery compared to those who did not (aHR: 4.38, 95% CI: 1.58-12.18, p<0.05).

Among women who developed caesarean section wound infection after delivery, the risk of maternal sepsis was 3 times higher-(aHR: 3.77, 95% CI: 0.92-15.54, p<0.05)-

Relative to pregnant women who had no symptoms present 14 days before exit from study, the risk of maternal sepsis was significantly higher among pregnant women with a single symptom (aHR: 6.1, 95% CI: 2.42-15.21, p<0.001) and those with 2 or more symptoms (aHR: 17.0, 95% CI: 4.19-69.00, p<0.001) (**Table 3**).

Table 3

Multivariate regression models of risk factors associated with incidence of sepsis among pregnant women

	Cox-proportional hazard model	
	Model 3	Model 4
variables & categories	aHR [95% CI]	aHR [95% CI]
Age at booking	0.98 [0.92, 1.04]	0.97 [0.91, 1.04]
Gravidity		
1 pregnancy	1.00	1.00
2-3 pregnancies	0.92 [0.48, 1.76]	0.75 [0.22, 2.55]
>3 pregnancies	0.52 [0.21, 1.30]	0.12 [0.02, 0.95] *
Parity		
No child		0.18 [0.02, 1.37]
1-2 children		0.20 [0.03, 1.11]
>2 children		1.00
Marital status		
Not married		1.00
Married		0.79 [0.34, 1.86]
Highest education		
Primary		1.00
JHS		1.44 [0.54, 3.84]
SHS		1.05 [0.41, 2.70]
Tertiary		1.36 [0.53, 3.48]
Religion		
Christians	1.00	1.00
Islam/others	1.12 [0.58, 2.18]	1.16 [0.56, 2.37]
BMI category		
<18.5kgm2	1.00	1.00
18.5 to 24.9kgm2	0.91 [0.25, 3.35]	0.87 [0.21, 3.57]
25.0 to 29.9kgm2	1.90 [0.49, 7.44]	2.42 [0.55, 10.54]
30.0 to 34.9kgm2	1.27 [0.29, 5.56]	1.18 [0.24, 5.75]
Main occupation		
Unemployed		1.00
Employed		1.69 [0.70, 4.11]
Number of ANC visits		
<4 visits		1.00
4 to 7 visits		0.88 [0.42, 1.86]
8+ visits		3.49 [1.28, 9.51] *
Type of health facility		
Regional hospital	1.00	1.00
District hospital	0.47 [0.21, 1.02]	0.43 [0.18, 1.01]
Availability of specialist in facility		
Specialist available	1.00	1.00
No specialist available	8.37 [0.78, 89.91]	7.57 [0.65, 87.62]
Region		
Bono	1.00	1.00
Greater Accra	4.63 [0.55, 38.75]	5.65 [0.65, 48.98]

Upper West	2.64 [0.85, 8.25]	3.20 [0.94, 10.86]
Mode of delivery		
SVD		1.00
CS		0.84 [0.40, 1.77]
Birth attendant		
Obstetrician/Physician		1.00
Midwife/Nurse		1.14 [0.55, 2.36]
Others (TBA/family member)		6.35 [0.52, 78.18]
History of symptoms 14 days prior to study		
Abdominal pain excluding contractions	2.58 [1.05, 6.33] *	1.48 [0.49, 4.40]
Abnormal vagina discharge	0.55 [0.24, 1.24]	0.64 [0.26, 1.56]
Sore throat /cough		0.52 [0.14, 1.97]
Chest pain	0.80 [0.30, 2.11]	1.14 [0.35, 3.64]
Dysuria	0.26 [0.09, 0.75] *	0.22 [0.07, 0.71] *
Vomiting/ diarrhoea		0.24 [0.08, 0.77] *
Flu-like symptoms		0.67 [0.20, 2.28]
Mastitis	1.14 [0.39, 3.29]	1.48 [0.50, 4.38]
CS wound infection	2.34 [0.71, 7.72]	3.77 [0.92, 15.54]
Urinary tract infection	4.19 [1.68, 10.47] **	4.38 [1.58, 12.18] **
malaria	1.54 [0.60, 3.93]	1.38 [0.49, 3.88]
Other infection	4.24 [1.13, 15.89] *	10.55 [2.33, 47.81] **
Number of different symptoms 14 days prior to study		
None	1.00	1.00
One	5.93 [2.59, 13.58] ***	6.06 [2.42, 15.21] ***
Two or more	8.54 [2.98, 24.42] ***	17.00 [4.19, 69.00] ***

NOTE:

Model 1: all variables significant from the unadjusted incidence rate ratios

Model 2: All independent variables in the study

CI: confidence interval. aRR: adjusted risk ratio. aHR: adjusted hazard ratio.

P-value definition: p<0.05*, p<0.01**, P<0.001***.

Discussion

Maternal sepsis remains a major public threat to women's survival during pregnancy and through delivery globally despite improvements in diagnosis. This is particularly worse for LMICs including Ghana where there is a triple disease (infectious, non-communicable diseases and RTAs) burden. The lack of a consensus definition for maternal sepsis before 2017 created an even more serious problem allowing all forms of categorization of women as having sepsis. This created a gap in a lack of global and country-specific burden of maternal sepsis. The findings from this study show an overall incidence of 4.2/1000 women per week of suspected or confirmed maternal sepsis in pregnant or recently pregnant women. The findings from this study are similar to earlier studies although without a standardized Case definition on maternal sepsis and puerperal sepsis in sub-Saharan Africa. In Benin, studies by Filippi et al., (1998) found the incidence of maternal sepsis rate to be 0.4/1000 pregnant women similar to a study in Senegal where de Bernis et al., (2000) in a population-based cohort study in two regions found the incidence of maternal sepsis to be 0.2/10000 women. Like-wise similar studies in southern Africa by Vandecruys et al., (2002) found the incidence of maternal sepsis to be 0.7 per 10, 000 women. In a cross-sectional study in six countries in West Africa, incidents of maternal sepsis have also been found to be low, less than 0.1/10000 women (Prual, 2000).

On the contrary, studies conducted in Uganda and Benin reported a relatively higher incidence of maternal sepsis compared to the findings from this study (Kaye et al., 2003; Saizonou et al., 2006). The variation in incidence rates of maternal sepsis reported by various studies from sub-Saharan Africa could be due

to different contexts/settings, variation in the criteria used to define maternal sepsis, or rigor used to carry out the study. This study found that Urinary Tract Infections (UTIs) prior to diagnosis were identified as a significant factor of maternal sepsis among women in Ghana. Interestingly we also realize that women diagnosed with other bacterial infections 14 days prior to the study had a significantly higher risk for maternal sepsis. The risk was five folds compared to women without a history of bacterial infections. Similar observations were made in Tanzania, which reported a significant association between bacterial infections and puerperal sepsis (Kajeguka et al., 2020). This outlines the need to effectively monitor the cardinal signs and symptoms in pregnancy, through childbirth, and during the postpartum period. This can help us diagnose early and employ the appropriate interventions or treatments for the affected women.

The study found that women with prior history of caesarean sections (CS) wound infections were at a higher risk of maternal sepsis. This could increase a woman's risk of maternal sepsis by more than four times. Therefore, health professionals should pay more attention to women who have prior CS wound during antenatal visits. This is consistent with previous studies that found a higher risk of maternal sepsis among women with a history of CS (Kajeguka et al., 2020; Muhumuza et al., 2020). On the other hand, a similar study found a lower odds of maternal sepsis associated with CS among Ethiopian women as compared to spontaneous vaginal delivery(Atlaw & Seyoum, 2019).

Deprived health facilities (rural regions) contributed significantly to women developing maternal sepsis as this can restrict the access and utilization of ANC and other obstetric services. Residence affects maternal health outcomes. Women who reside in urban communities could be associated with access to better learning opportunities, better financial status, better birth spacing, better accessibility to vital health information and services. (Ngonzi et al., 2016).

Findings from the study indicate a lot more is required of our clinicians and midwives to correctly and appropriately, implement the focal antenatal care policy. Mothers with better education particularly hand hygiene will improve maternal health and reduce infections in pregnancy. The findings from this longitudinal study also highlight areas for future research. Similar studies should be conducted to capture the entire period of the continuum of care for pregnant women to generate further population-based data on the burden and management of maternal sepsis. The effect of essential neonatal care on late-onset infections also needs to be examined.

A few limitations were however, identified, the exclusion of HIV-positive women and pregnant women who were likely to attrite from the study could have influenced the incidence of maternal sepsis. For this reason, we may not be adequately representing the disease in these minority population groups. Also, the lack of laboratory capacity across all study centers resulted in no available laboratory data on specific diagnoses and to confirm organ dysfunctions. Thus, we could not confirm clinician suspicion of sepsis. However, the new WHO definition allows for clinically diagnosed maternal sepsis, considering the lack of capacity in LMICs including Ghana.

Conclusions

Our findings show a low incidence of maternal sepsis in Ghana compared to most Low and Middle-Income Countries. Nonetheless, Maternal sepsis remains an important contributor to the overall maternal mortality burden. It is essential clinicians pay more attention to ensure early and prompt diagnosis. Factors significantly predicting maternal sepsis in Ghana were additional maternal morbidity, urinary tract infections, dysuria, and multiple symptoms. We recommend that Ghana Health Service should institute a surveillance system for maternal sepsis as a monthly reportable disease

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Ghana Health Service Ethics Review Committee (GHS-ERC 011/10/19). Permissions were obtained from the three regional health directorates; Greater Accra, Bono and Upper West regions and all District Health Management Teams involved in the study. Written informed consent and ascent where applicable were signed by individual participants before responding to the questionnaire and confidentiality of responses was maintained. All Laboratory analysis of women samples were performed in accordance with relevant guidelines and regulations (CLSI, 2018).

Consent to publish

Not applicable

Availability of data and materials

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

Competing of interest

The authors declare no conflict of interest.

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This article represents the views of the authors only and does not represent the views of the World Health Organization

Authors' contribution

CLN RA, AAL conceived and designed the study and participated in data collection; CLN AM participated in data analysis, and CLN drafted the manuscript. EK, AM, AGM, GM, AAL, KT and RA reviewed the manuscript critically for intellectual content. All authors read and approved the final manuscript.

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Figures

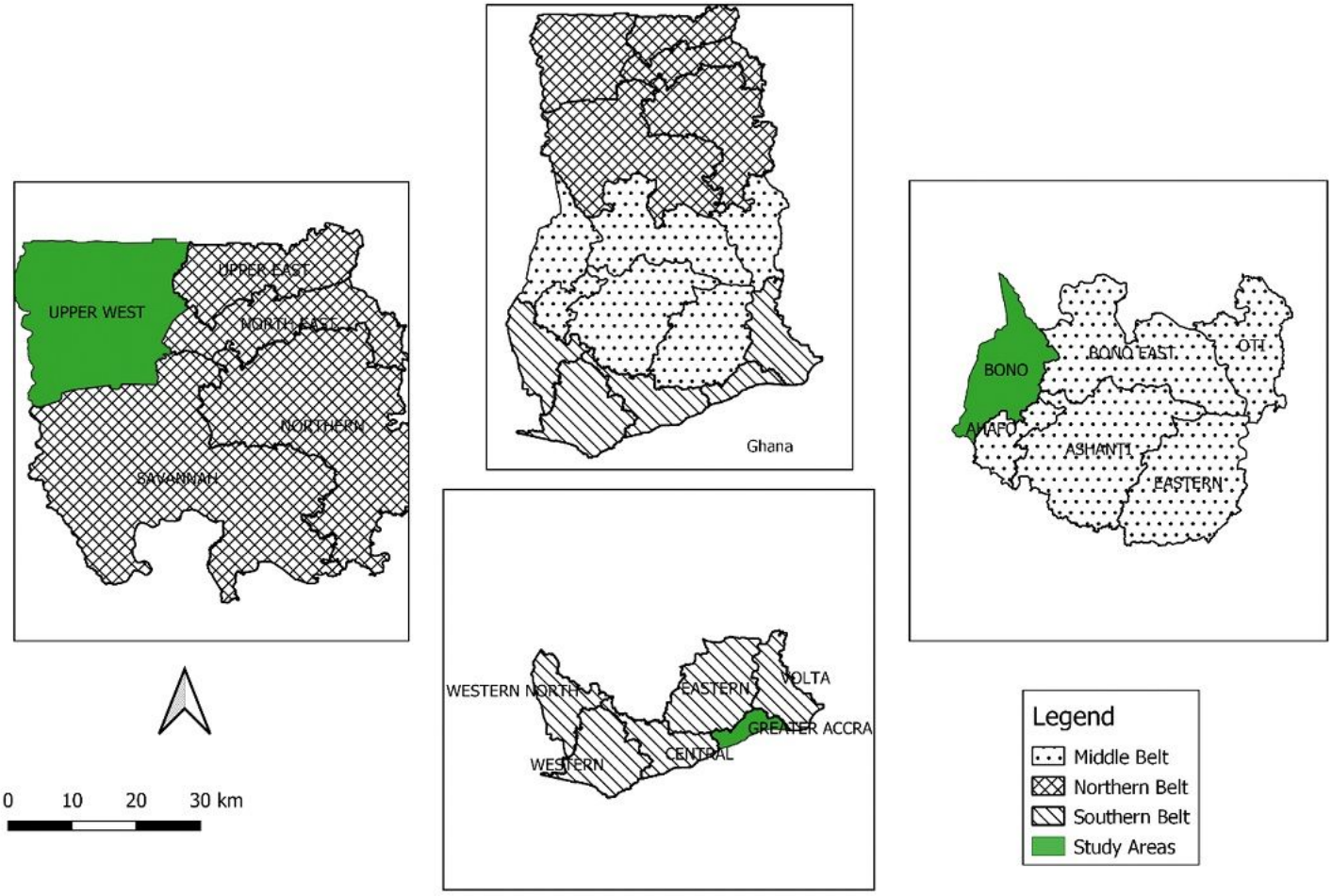

Figure 1: Selected Regions from the three epidemiological zones, Ghana, 2022

Figure 1

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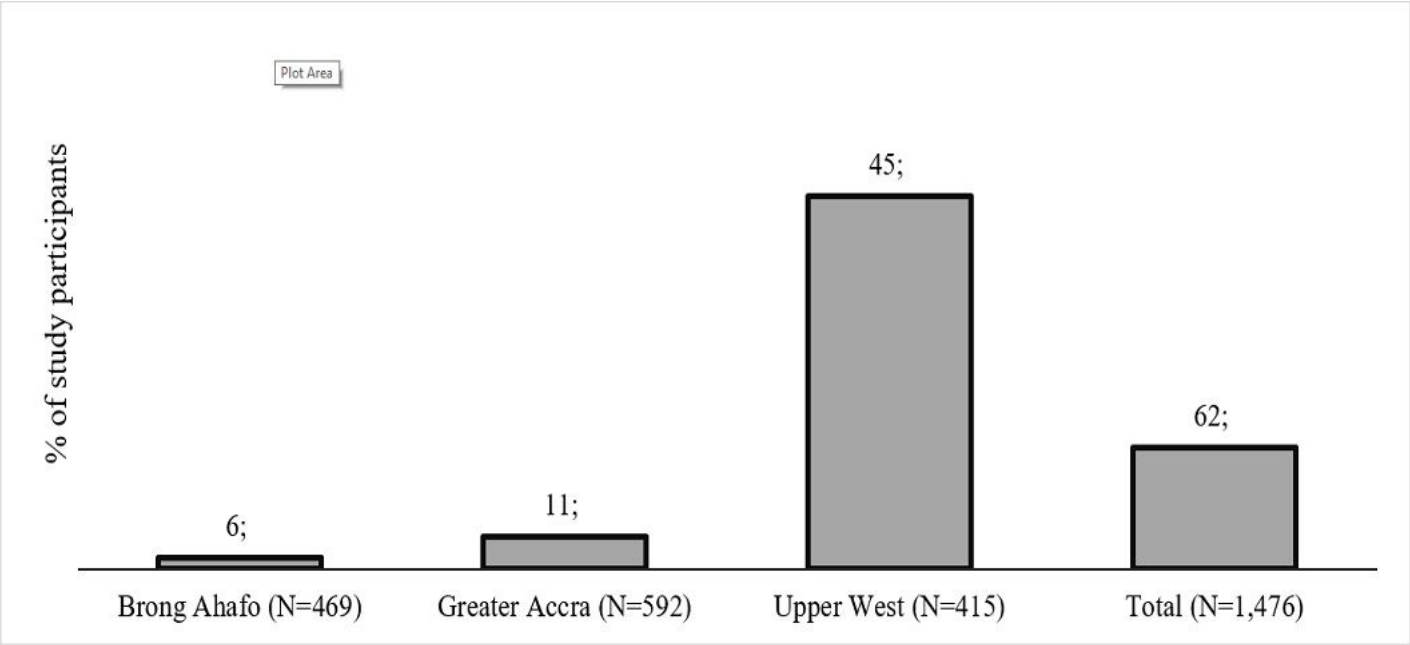

Figure 2: Cumulative Incidence of sepsis among study participants by region, Ghana, 2022

Figure 2

Please See image above for figure legend.