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Maternal mortality at the Korle Bu Teaching Hospital, Accra, Ghana: A five-year review

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Abstract

Maternal death is a major global health issue with the highest impact in low-income countries. Despite some modest decline in the maternal mortality rates in Ghana since the 1990's, this has been below expectation.   The aim of this study was to describe the trends and contributory factors to maternal mortality at the Korle Bu Teaching Hospital (KBTH), Accra, Ghana. We performed a retrospective chart review of all maternal deaths at KBTH from 2015 to 2019. Data were analyzed using SPSS version 23. A p-value of <0.05 was considered statistically significant. Over the period, there were 45,676 live births, 276 maternal deaths and a maternal mortality ratio of 604/100,000 live births (95% CI: 590/100,000 - 739/100,000). The leading causes of maternal death were hypertensive disorders (37.3%), hemorrhage (20.6%), Sickle cell disease (8.3%), sepsis (8.3%), and pulmonary embolism (8.0%). Significant factors associated with maternal mortalities at the KBTH were: women with no formal education [AOR 3.23 (CI: 1.73-7.61)], women who had less than four antenatal visits [AOR 1.93(CI: 1.23-3.03)], and emergency cesarean section [AOR 3.87(CI: 2.51-5.98)]. Hypertensive disorders remain the commonest cause of the high maternal mortality at KBTH. Formal education and improvement in antenatal visits may help prevent these deaths. *(Afr J Reprod Health 2021; 25[1]: 56-66).*

Keywords: Maternal mortality, maternal mortality ratio, hypertensive disease, eclampsia, case fatality, Ghana

Résumé

La mortalité maternelle est un problème de santé mondial majeur ayant le plus grand impact dans les pays à faible revenu.Malgré une légère baisse du taux de mortalité maternelle au Ghana depuis les années 1990, cela a été au-dessous des attentes. Le but de cette étude était de décrire les tendances et les facteurs qui contribuent à la mortalité maternelle à l'Hôpital Universitaire de Korle Bu (KBTH), Accra Ghana. Nous avons effectué un examen rétrospectif des dossiers concernant les décès maternels à KBTH de 2015 à 2019. Les données ont analysé à l'aide de SPSS version 23. Une valeur p de <0,05 était considérée comme statistiquement significatif. Sur la période, il y a eu 45 676 naissances, 276 décès maternels et un taux de mortalité maternelle de 604/100 000 naissances (IC à 95% : 590/100 000 – 739/100 000). Les causes principales des décès maternels étaient les troubles hypertensifs (37,3%), les hémorragies (20,6%), la drépanocytose (8,3%) la septicémie (8,3%) et l'embolie pulmonaire (8,0%). Les facteurs importants associés aux mortalités maternelles à KBTH étaient : les femmes sans éducation formelle [AOR 3,23 (IC : 1,73-7,61)], les femmes qui ont eu moins de quatre visites prénatales [AOR 1.93 (IC : 1,23-3,03)] et l'urgence césarienne [AOR 3,87(IC : 2,51-5,98)]. Les troubles hypertensifs restent la cause le plus fréquente de la mortalité maternelle à KBTH. Une éducation formelle et une amélioration des visites prénatales peuvent aider à éviter ces décès. *(Afr J Reprod Health 2021; 25[1]:56-66).*

Mots-clés: Mortalité maternelle, taux ce mortalité maternelle, maladie hypertensive, éclampsie, cas décès, Ghana

Introduction

Maternal death is one of the most painful, unforgettable tragedies that can befall a family or community anywhere[1]. Globally, a woman dies every minute as a result of complication of pregnancy and childbirth[2,3]. Most of these deaths are preventable, yet this tragedy remains so common in low and middle income countries[3]. Maternal death, by ICD-10 classification, is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes[4]. The causes of these deaths have traditionally been classified into direct and indirect ones. The direct causes are those resulting from obstetric

complications of the pregnant state (pregnancy, labor, and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above. Indirect obstetric deaths are those resulting from previous existing disease, or diseases that developed during pregnancy and which was not due to direct obstetric causes but was aggravated by physiological effects of pregnancy[4]. Behind any of these causes are several avoidable or contributory factors. Globally the leading direct causes of death are obstetric hemorrhage, hypertensive disease in pregnancy, sepsis, thromboembolic disease, complications of abortions, obstructed labor and ruptured uterus. The indirect causes are anemia, sickle cell disease, HIV/AIDs, malaria, cardiovascular diseases, pneumonia and other systemic illnesses.

A measure of maternal death is the maternal mortality ratio (MMR) defined as the number of maternal deaths in a specified period of time per 100,000 live births. This ratio is used as an index of the quality of health care delivery in a country, and maternal health in particular. Ghana's maternal mortality ratio (MMR) has been on the decline over the past three decades. The MMR in Ghana as at 1990 was 760 per 100,000 live births and it declined to 380 in 2013[5]. At the end of 2015 it further decreased to 319. The most current MMR for Ghana, as at 2017 by the Ghana Maternal Health survey is 310 deaths per 100,000 live births[6].

The institutional maternal mortality rates from the teaching hospitals do not follow the national average. Over 20 years ago, Lassey *et al*, in their 11- year review (1984 – 1994) of maternal deaths at Korle Bu Teaching Hospital (KBTH), reported MMR of 734.4 per 100,000 live births with hemorrhage as the leading cause of death[7]. A three-year review of maternal deaths at Komfo Anokye Teaching hospital, (2008 – 2010) in Ghana also showed a MMR of 1004 per 100,000 live births with hypertensive disease as leading cause of death[8].

Since the last review of maternal deaths at KBTH, significant changes have taken place at the hospital such as provision of on-sight blood bank at the department, supportive supervision of some referring hospitals, establishment of obstetric triage system, comprehensive multidisciplinary obstetric sickle cell clinic, all geared toward reduction of maternal mortality and morbidity. Recent reports from the KBTH suggest that hypertensive diseases in pregnancy have overtaken hemorrhage as the leading cause of maternal death in the hospital[9] and a multi-disciplinary care for pregnant women with SCD significantly reduced maternal death[10]. This five-year review seeks to document the new and emerging trends in maternal death at the KBTH and to identify contributory factors to these deaths.

Methods

Study design and setting

This was a retrospective charts review of all maternal deaths that took place from January 2015 to December, 2019 at the Korle-Bu Teaching Hospital (KBTH). The study was approved by the Ethical and Protocol Review Committee of the College of Health Sciences, University of Ghana (approval number *CHS-Et/M3-8.16/2019/2020*) The KBTH is Ghana's premier teaching hospital, and the largest referral hospital located in the capital city of Accra. The department of Obstetrics and Gynecology performs about 10,000 deliveries annually.

The maternity unit of KBTH conducts maternal morbidity and mortality audit of all major pregnancy related complications and deaths. During this audit, cause of death, events leading to death as well as identifiable avoidable factors in the events leading to death are reviewed. In this study, maternal death was defined by the ICD10 classification[4]. We included all maternal deaths that occurred in the hospital during the study period. We excluded deaths that did not meet this criterion such as death from gestational trophoblastic disease, and pregnancy in a setting of malignancy, as well as maternal deaths that occurred outside the hospital.

Study procedure

Data source for this retrospective review included monthly mortality audit reports, morbidity mortality data from the biostatistics unit, death certificate books, mortality folders and the monthly returns at the nurse's secretariat and annual

Table 1: Socio-demographic and obstetric characteristics of women with maternal mortalities at the Korle Bu Teaching Hospital between 2015 and 2019

Variable	Frequency	%	Variable	Frequency	%
			Mode of Delivery	**N=194**	
			Spontaneous vaginal delivery	54	27.8
Age	N=276		Assisted vaginal delivery	1	0.5
15-19	14	5.1	Emergency CS	73	37.6
20-24	32	11.6	Elective CS	10	5.2
25-29	71	25.7	Undelivered	51	26.3
30-34	84	30.4	Others	5	2.6
35-39	58	21	**Delivery Outcome for those who delivered**	**N=138**	
40-44	13	4.7	Live birth	84	60.9
45-49	4	1.4	MSB	18	13
Educational Status	N=183		FSB	33	23.9
Primary	26	14.2	ENND	3	2.2
JHS	60	32.8	**Triage Color Code on Arrival**	**N= 192**	
SHS	46	25.1	Red	109	56.77
Tertiary	26	14.2	Orange	39	20.31
None	25	13.7	Yellow	35	18.23
Marital Status	**N=192**		Green	9	4.688
Single	43	22.4	Blue		0
Cohabiting	17	8.9	**Mode of Transportation To KBTH**	**N=180**	
Married	130	67.7	Ambulance	88	48.9
Separated/Divorced	2	1	Taxi	60	33.3
Widow	0	0	Walk in	20	11.1
Religion	**N=193**		Private car	9	5.0
Christian	176	91.2	Others	3	1.7
Muslim	16	8.3			
Traditionalist	0	0	**Duration of Stay In Hours At KBTH**	**N=270**	
Buddhist	0	0	<1 hr	1	0.4
Others	1	0.5	1hr to 4hrs	23	8.5
Occupation	**N=276**		>4hrs to 24hrs	83	30.8
Student	7	2.5	>24hrs to 72 hrs.	58	21.5
Formal work	137	49.6	>72hrs to 168hrs	56	20.7
Non formal work	120	43.5	>168hrs	49	18.1
Unemployed	12	4.3	**Gestational Age at Death**	**N=272**	100
			Antepartum	166	61.0
Parity	**N=271**		Postpartum	106	39.0
0	76	28			100
1	57	21	**Classification of Cause of Death**	**N=276**	
2	59	21.8	Direct	211	76.4
3	39	14.4	Indirect	64	23.2
4	24	8.9	Unclassified Cause	1	0.4
5 or more	16	5.9			
ANC Attendance	**N=185**		**Place of Death**	N=276	
Yes	162	87.6	Emergency rooms	24	8.7
No	23	12.4	Labor wards	39	14.1
Total Number of ANC Visits	**N=150**		Theatres	17	6.2
<4	68	45.3	Recovery Rooms	65	23.6
4 or more	82	54.7	Prenatal and postnatal wards	88	31.9
			Gynecology wards	2	0.7
			ICU	33	12
			Others	4	1.4
			Not Stated	4	1.4
					100

Table 2: All causes of death and top 5 direct and indirect causes of maternal mortality at Korle Bu Teaching Hospital 2015-2019

Cause of death	Frequency (%)	Causes of death (Top 5)	Frequency (%)	Total Cases (Case Fatality Rate)
		Direct Causes		
Hypertensive Disorders	103 (37.3)	Hypertensive Disorders	103(49.5%)	3754(2.74)
Hemorrhage*	57 (20.6)	Hemorrhage	57 (27.4%)	2064(2.76)
Sepsis	23 (8.3)	Sepsis	23 (11.1%)	42(54.76)
Sickle Cell Disease	23(8.3)	Pulmonary Embolism	22 (10.6%)	36(61.11)
Pulmonary Embolism	22 (8.0)	Abortion	3 (1.4%)	323(0.93)
Retroviral Infection	8 (2.9)			
Heart Failure	7 (2.5)	**Indirect Causes**		
Pneumonia	7 (2.5)	Sickle Cell Disease	23 (46.9%)	492(4.67)
Diabetic Complications	4 (1.4)	Retroviral Infection	8 (16.3%)	161(4.97)
Abortion complications	3(1.1)	Heart Failure	7 (14.3%)	51(13.73)
Liver Failure	3(1.1)	Pneumonia	7(14.3%)	61(11.48)
Ruptured Ectopic	2 (0.7)	Diabetic Complications	4 (8.2%)	292(1.37)
Cerebral Abscess	2 (0.7)			
Intracranial Space Occupying Lesion	2 (0.7)			
Steven Johnsons Syndrome	2 (0.7)			
Amniotic Fluid Embolism	1 (0.4)			
Disseminated Tuberculosis	1(0.4)			
Disseminated Hodgkin Lymphoma	1(0.4)			
Multiple Organ Dysfunction	1(0.4)			
Purulent Bacterial Meningitis	1(0.4)			
Recurrent Hypoglycemia Secondary To Insulinoma	1(0.4)			
Pancytopenia Secondary To Lymphoma	1(0.4)			
Gastroenteritis + Intrauterine Fetal Death	1(0.4)			
TOTAL	276 (100)			

- Of the 57 cases of Hemorrhage: Postpartum hemorrhage=31(57.4%), Antepartum hemorrhage=23(42.6%) and Hemoperitoneum=7(12.3%)

delivery records from the biostatistics unit. The causes of death were assigned based on the postmortem result or on the most obvious clinical cause of death following the mortality audit, in situations where postmortem was not performed. Where multiple causes of death were documented, we used adjudication to settle on a single most plausible cause. The data collected included; age, year/ month of death, educational status, occupation, marital status, religion, parity, antenatal attendance, mode of transportation, condition on arrival at KBTH, mode of delivery, delivery outcome, cause of death, gestational age at death, timing of death in relation to pregnancy (i.e. antepartum, intrapartum, postpartum), and duration of hospital stay at the KBTH before death and place of death such as emergency room, theatre, labor ward, recovery ward, main ward or ICU). Data collected were stored in Kobo Toolbox.

Data analysis

Data were downloaded into an excel spread sheet and exported to Statistical Package for Social Sciences (SPSS) -23 (IBM Corp, Armonk, NY) for analysis. The data were summarized as frequencies, means with their standard deviation and median with range and presented as tables and charts.

Summary statistics were compared with Chi square and student t-tests where appropriate. Multiple logistic regression models were used to test the association between contributory factors and

maternal death and the association expressed as odds ratio (OR) and adjusted odds ratio (AOR) with their 95% confidence interval (95% CI). In all statistical analysis, a p-value of <0.05 was considered statistically significant.

Results

Over the five-year period January 2015 – December 2019, there were 47,309 total births and 45,676 live births. There were 276 maternal deaths giving maternal mortality ratio of 604 per 100,000 live births (95% CI 590/100,000 - 739/100,000). About three-quarters (76.4% (211/276) were due to direct obstetric causes. Postmortem reports were available for 53.6% (148/276) of the cases. The majority of deaths occurred in the age group 30-34 years; 30.4% (84/276) with mean of 30.5±6.4 years. The other sociodemographic characteristics of the women who died are shown in Table 1.

Nulliparous women formed the majority, 28% (76/271), and grand multi-para (>para5) contributed only 5.9% (16/271) of maternal deaths. An overwhelming majority of the maternal deaths 93% (258/276) were cases referred to the KBTH in an emergency with 56% (109/192) arriving as life-threatening emergency and triaged 'RED' on arrival. Most of the maternal deaths were delivered by emergency cesarean section; 37.6% (73/194) and death occurred within 24 hours of arrival in 39.6% (107/270).

Hypertensive disease in pregnancy, was the commonest cause of death accounting for nearly two-fifths 37.3% (103/276) of all deaths. Hypertensive disease consistently remained the highest cause of death over the five years. Eclampsia was the leading immediate cause of death amongst the hypertensive diseases 33.0% (34/103). The other direct causes of death were: hemorrhage 20.6% (57/276), sepsis 8.3% (23/276), pulmonary embolism 8.0% (22/276) and abortion 1.1% (3/276). Sickle cell disease (SCD) in pregnancy was the leading indirect cause of maternal death and overall, the third leading cause of all maternal deaths accounting for 8.3% (23/276). The leading specific immediate cause of death related to SCD was acute chest syndrome 60.9%

(14/23). The other four highest indirect causes of death were: retroviral infection 2.9% (8/276), heart failure 2.5% (7/276), pneumonia 2.5% (7/276) and diabetic complications 1.4% (4/276). Pulmonary embolism 61.11% (22/36) and sepsis 54.76% (23/42) were the two conditions with the highest case fatality rate, while abortion 0.93% (3/323) had the lowest case fatality rate (Table 2).

Among the 51 women who died undelivered, the 5 leading causes of death were: hypertensive disorders 33.3% (17/51), Sickle Cell Disease 13.7% (7/51), Pulmonary embolism 11.8% (6/51), obstetric hemorrhage 9.8% (5/51) and then Retroviral infection 5.8% (3/51).

Of these women who died undelivered, their deaths occurred over the following number of hours on admission: 23.5% (12/51) between 72 hours and 168 hours, 21.6% (11/51) more than 168 hours, 21.6% (11/51) between 24 and 72 hours, 15.7%(8/51) between 1 and 4 hours, 11.8% (6/51) between 4 and 24 hours, 2% (1/51) in less than an hour. Almost 4 percent (2/51) of the women who died undelivered did not have records about the time spent in hospital before their death.

Thirty –seven percent (19/51) of the women who died undelivered died in less than 24 hours. The causes of death among these women were: hypertensive disorders-47.3% (9/19), Pulmonary embolism 15.7% (3/19), Obstetric haemorrhage-10.5% (2/19). Ruptured ectopic, sepsis, Sickle cell Disease, Cerebral abscess and an unknown cause of death each accounted for 5.3% (1/19).

The highest MMR was recorded in 2016 with 697/100,000 live births, whereas the year with the lowest MMR was 2015 with 482/100,000 live births. There was, however, a downward trend from 2016 to 2018 with a small spike in 2019. Year on year, the months with the highest average maternal mortality rates were January and August while those with the lowest maternal mortality rates were June and October (Figure 1).

In a multiple logistic regression model educational level, number of antenatal visits, mode of delivery and fetal outcome were significantly associated with maternal death (Table 4). Maternal death was increased threefold in women with no formal education compared to those with tertiary
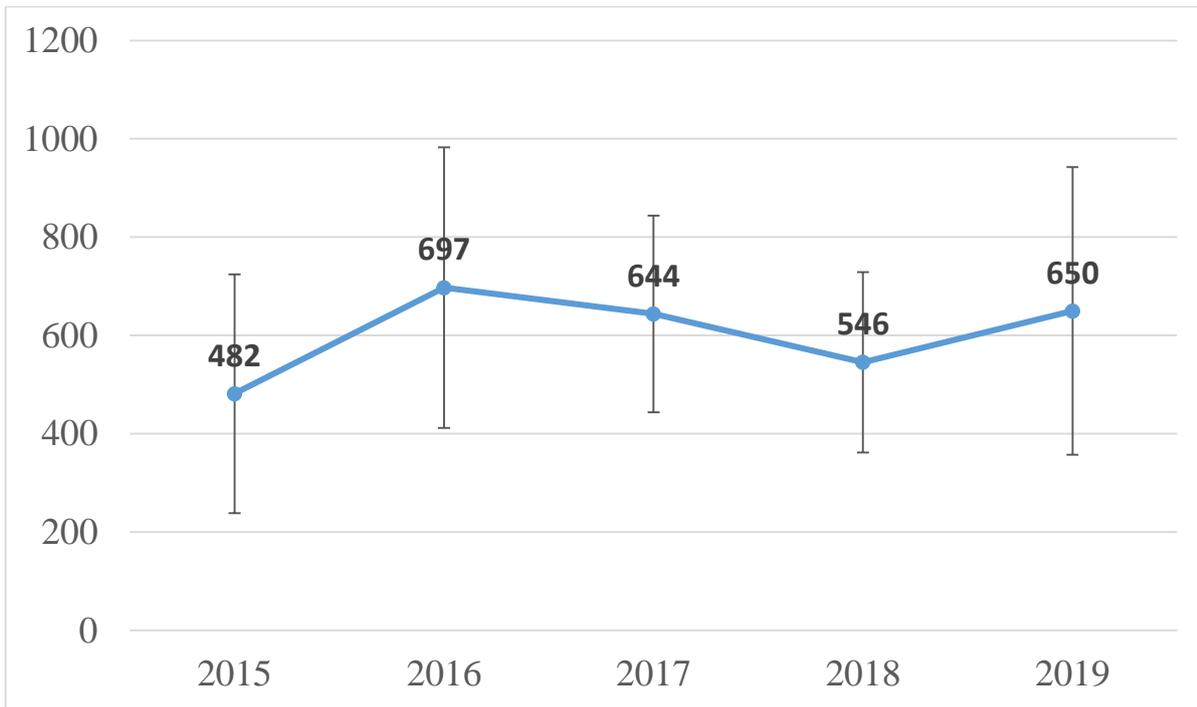
Total live births for the years 2015 to 2019 were respectively 9,281, 9362, 9599,9146 and 8288

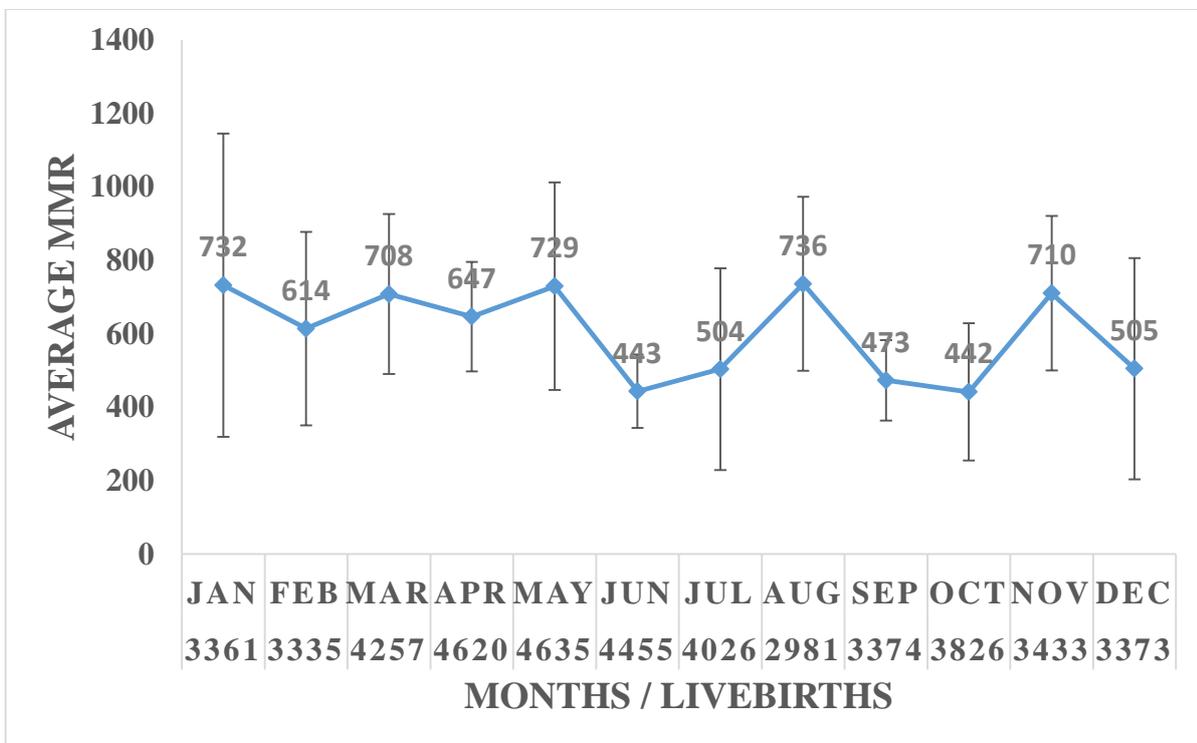**Figure 1a:** Trends in maternal mortalities from 2015 to 2019 at the Korle Bu Teaching Hospital

Figure 1b: Average monthly mortality ratios from 2015 to 2019

Table 3: Bivariate analysis of contributory factors for maternal mortality at the Korle Bu Teaching Hospital from 2015 to 2019

Variable	Maternal deaths	Alive	Total deliveries	Chi-squared	p-value
Age group	N=276	N=37354[a]	N=37630	4.606	0.203
<20	14 (5.1)	1827 (4.9)	1841 (4.9)		
20-24	32 (11.6)	5113 (13.7)	5145 (13.7)		
25-29	69 (25.0)	10932 (29.3)	11001 (29.2)		
30+	161 (58.9)	19482 (52.2)	19643 (52.2)		
Educational level	N=183	N=35147[b]	N=35330	19.728	**0.001**
None	25 (13.7)	2559 (7.3)	2584 (7.3)		
Primary	26 (14.2)	3418 (9.7)	3444 (9.7)		
JHS	60 (32.8)	12803 (36.4)	12863 (9.7)		
SHS	46 (25.1)	8598 (24.5)	8644 (24.5)		
Tertiary	26 (14.2)	7769 (22.1)	7795 (22.1)		
Occupation	N=276	N=35147[c]	N=35330	24.607	**<0.001**
Student	7 (2.5)	1107 (3.0)	1114 (3.0)		
Formal work	137 (49.6)	13420 (36.6)	13557 (36.7)		
Non-formal work	120 (43.5)	20657 (56.4)	20777 (56.3)		
Unemployed	12 (4.3)	1433 (3.9)	1445 (3.9)		
Parity	N=271	N=36982[d]	N=37253	15.554	**0.001**
P0	76 (28.0)	12000 (32.4)	12076 (32.4)		
P1	57 (21.0)	9965 (26.9)	10002 (26.9)		
P2-P4	122 (45.0)	13846 (37.4)	13968 (37.5)		
P5+	16 (5.9)	1171 (3.2)	1187 (3.2)		
Number of ANC visits	N=150	N=26725[e]	N=26875	103.219	**<0.001**
<4	68 (45.3)	4082 (15.3)	4150 (15.4)		
4 or more	82 (54.7)	22643 (84.7)	22725 (84.6)		
Mode of delivery	N=143	N=37454[f]	N=37597	51.859	**<0.001**
SVD	54 (37.8)	21133 (56.4)	21187 (56.4)		
Assisted delivery	1 (0.7)	431 (1.2)	432 (1.1)		
Emergency CS	78 (54.5)	10369 (27.7)	10447 (27.8)		
Elective CS	10 (7.0)	5521 (14.7)	5531 (14.7)		
Outcome of delivery	N=135	N=37175[g]	N=37310	337.453	**<0.001**
Live	82 (60.7)	35103 (94.4)	35185 (94.3)		
MSB	17 (12.6)	1069 (2.9)	1086 (2.9)		
FSB	33 (24.4)	925 (2.5)	958 (2.6)		
ENND	3 (2.2)	78 (0.2)	81 (0.2)		

education [AOR 3.23, (95% CI: 1.37 – 7.61)], two-fold in those with less than four antenatal visits [AOR 1.93, (95% CI: 1.23-3.03)], and four-fold in those delivered by cesarean section [AOR 3.87, (95% CI: 2.51 – 5.98)]. Fresh stillbirth and macerated stillbirths and early neonatal deaths were associated with sixteen- , ten- and twenty-two-fold odds of maternal mortality [AOR 16.12, (95% CI: 9.60-27.05)], [AOR 9.52, (95% CI: 5.18-17.47)] and [AOR 21.67, (95% CI 6.35-73.94)] respectively.

The total number of live births was 45,676. The columns with the live births have missing data

and hence (**a,b,c,d,e,f,g**) do not add up to the total number of live births.

Discussion

The average maternal mortality ratio over the five-year period was 604/100,000 live births, with a range between 482 and 697 per 100,000 live births. The leading cause of death was hypertensive disease in pregnancy accounting for nearly two-fifths of all deaths with eclampsia as the immediate cause of death. Lack of formal education, less than four antenatal visits, emergency cesarean delivery

Table 4: Multiple logistic regression on contributory factors for maternal mortality at the Korle Bu Teaching Hospital from 2015 to 2019

Variable	COR	P-value	AOR	P-value
Age group				
20-24	1		1	
<20	1.22 (0.65-2.30)	0.529	1.69 (0.62-4.63)	0.304
25-29	1.01 (0.66-1.54)	0.969	1.01 (0.49-2.08)	0.984
30+	1.32 (0.90-1.93)	0.152	1.16 (0.57-2.36)	0.384
Educational level				
Tertiary	1		1	
None	2.92 (1.68-5.06)	**<0.001**	3.23 (1.37-7.61)	**0.007**
Primary	2.27 (1.32-3.92)	**<0.001**	1.70 (0.69-4.21)	0.252
JHS	1.40 (0.88-2.22)	0.152	1.06 (0.49-2.31)	0.883
SHS	1.60 (0.99-2.59)	0.056	1.53 (0.73-3.20)	0.261
Occupation				
Formal work	1		1	
Student	0.62 (0.29-1.32)	0.218	1.78 (0.56-5.63)	0.324
Non formal work	0.57 (0.44-0.73)	**<0.001**	1.04 (0.62-1.76)	0.884
Unemployed	0.82 (0.45-1.48)	0.512	1.03 (0.34-3.11)	0.958
Parity				
P2-P4	1		1	
P0	0.72 (0.54-0.96)	**0.024**	0.90 (0.50-1.64)	0.740
P1	0.65 (0.47-0.89)	**0.007**	0.89 (0.51-1.56)	0.691
P5+	1.55 (0.92-2.62)	0.101	1.21 (0.49-2.99)	0.687
Number of ANC visits				
4+	1		1	
<4	4.60 (3.33-6.36)	**<0.001**	1.93 (1.23-3.03)	**0.004**
Mode of delivery				
SVD	1		1	
Assisted delivery	0.91 (0.13-6.58)	0.924	-	0.994
Emergency CS	2.94 (2.08-4.17)	**<0.001**	3.87 (2.51-5.98)	**<0.001**
Elective CS	0.71 (0.36-1.39)	0.318	1.12 (0.46-2.70)	0.816
Outcome of delivery				
Live	1		1	
MSB	6.81 (4.02-11.52)	**<0.001**	9.52 (5.18-17.47)	**<0.001**
FSB	15.27 (10.14-22.99)	**<0.001**	16.12 (9.60-27.05)	**<0.001**
ENND	16.47 (5.09-53.23)	**<0.001**	21.67 (6.35-73.94)	**<0.001**

and stillbirths were associated with increased odds of maternal death. The lowest maternal mortality ratio of 482/100,000 live births in 2015 could be a result of the gains made due to the Millennium Development Goals (MDG 5). Unsustainable decline since 2016 makes a case for the Sustainable Development Goals.

This review shows hypertensive disease in pregnancy as the leading cause of maternal death in the hospital, similar to reports from other tertiary hospitals in Ghana[3, 9] and in Nigeria[11]. This implies that any strategy developed to reduce maternal deaths in KBTH must also target hypertensive disease. Critical evaluation of the current management protocols for hypertensive complications in pregnancy at both referring and tertiary hospitals is urgently needed to identify gaps in their operations for redress. There may be the need to train and retrain doctors, midwives and other care givers on the national treatment guidelines and protocols for the management of hypertensive disease in pregnancy, especially on the use of magnesium sulfate to prevent eclampsia. Supportive supervision of referral centers has to be intensified so that preeclampsia is recognized, treated and referred early.

The second most common direct cause of maternal death is obstetric hemorrhage which accounted for one fifth of all deaths and a considerable reduction in maternal death from hemorrhage compared to previous reports from the same hospital and elsewhere[1,9,12,13]. In the past five

years various interventions have been put in place to solve the previous problem of non-availability of blood and blood products in the department. These include establishment of satellite blood bank for grouping and cross-matching, weekly blood donation campaigns, onsite bleeding of donors, and a revolving funding for purchase of blood products from the central blood bank. These interventions have improved the availability of blood and reduced the request to delivery time for blood. Most of the hemorrhage-related deaths were referred cases that arrived in hemorrhagic and sometimes irreversible shock and died within 24 hours. In addition to blood transfusion, these patients often require intensive care which is sometimes not available. A rather worrying cause of death is hemoperitoneum from obstetric surgery which also contributed 2.5% to maternal deaths. This situation is totally avoidable. Meticulous surgical techniques for routine and lifesaving obstetric procedures and optimal post-operative monitoring are necessary to prevent such deaths.

Sepsis and pulmonary embolism made significant contribution to maternal death and also had very high case fatality rates of 54.76% and 61.11% respectively. Pulmonary embolism as a major contributor to maternal death is not commonly reported in Africa. This is the first time that pulmonary embolism has been reported in the top five in any teaching hospital in Ghana. This calls for a critical appraisal of our thromboprophylaxis protocols and to evaluate its effectiveness. In an autopsy study of pregnancy related causes of death in Ghana between 2004 and 2008, Der *et al* reported that 1.3% of the 634 pregnancy related deaths were due to pulmonary embolism[12]. Pulmonary embolism was not part of the top five causes of death in that report, over a decade ago.

Among women who were undelivered, pulmonary embolism was a major contributor of death. More than three-quarters of the deaths in our cohort was due to direct causes, similar to reports from elsewhere[1,7,8,13-17]. Sickle cell disease remained the leading indirect cause of death over the five years, contributing 8.3% of all maternal deaths. The commonest specific immediate cause of death among these women was acute chest syndrome, just as previously reported[18]. The department established a multidisciplinary team-based approach to care for these patients in 2015/2016 leading to remarkable reduction in maternal deaths from this condition[10]. A lot more still needs to be done for the sustainability of this reduction. Nearly 40% of our cohort died within 24 hours of admission. This proportion is similar to that in the subgroup that was undelivered.

In this report, we identified lack of formal education, poor antenatal visit, emergency cesarean delivery, and poor perinatal outcomes as factors associated with maternal death which have also been reported in other studies[8,9,13,17,19]. Sageer *et al*, in a report from Nigeria, showed that the main contributory factors of maternal deaths were: inadequate manpower, delay in seeking help, lack of essential equipment/medication/blood, lack of ambulance/ transportation, delay in referrals especially of high risk pregnant women, lack of money and lack of awareness of danger signs by care givers[13] which were slightly different from our report.

The study had some limitations. There were missing folders or case notes with incomplete information from the available folders or inadequate documentation of events. However, due to the monthly audit of these cases which is recorded in the departmental mortality audit file, the needed information was retrieved. The ongoing migration to an electronic data capture system will help greatly to overcome this challenge in the future. In addition, autopsy was not performed in all cases, so the specific causes of death were determined by clinical audit in those cases. The strength of this study lies in the demonstration of monthly trends in maternal mortality. This study has also gone beyond just looking at the causes of maternal mortality and included case fatality rates of these causes.

Conclusion

Maternal mortality at the KBTH is still high despite the decreasing trend over the years. The major causes of death are hypertensive disease in pregnancy, hemorrhage, sickle cell disease in pregnancy, sepsis and pulmonary embolism, with hypertensive disease in pregnancy accounting for almost two-fifths of all maternal deaths. Lack of formal education, lack of antenatal care, emergency cesarean delivery and poor perinatal outcomes were

significant predictors of maternal mortality. Improved female education, regular antenatal care and better management of complications of hypertensive disease in pregnancy may reduce maternal death.

Contribution of Authors

TKB conceived the idea and designed the study, analyzed the data, participated in writing the manuscript, reviewed and approved the final version
MYN conceived the idea and designed the study participated in writing the manuscript, reviewed and approved the final version
KAO helped with the literature search, performed the data search and collection, analyzed data, participated in writing the manuscript, reviewed and approved the final version
PS performed the data search and collection, participated in writing the manuscript, reviewed and approved the final version
BO performed literature review, the data search and collection, participated in writing the manuscript and reviewed and approved the final version
SAO performed data analysis, participated in writing the manuscript, reviewed and approved the final version.

Conflict of Interest

None.

Acknowledgements

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