

## TRENDS IN DIRECT CAUSES OF MATERNAL DEATHS AS SEEN AT THE KORLE-BU TEACHING HOSPITAL MORTUARY (1995 –2014): A RETROSPECTIVE AUTOPSY STUDY

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### Abstract

**Objectives:** Our main research aim was to describe the relative proportions and trend of direct causes of maternal death over a period of 20-years in the largest tertiary hospital in Ghana.

**Material and methods:** This was a descriptive retrospective review of cases of maternal death for which autopsy examination was conducted at the KBTH mortuary from 1995 to 2014. Data on direct maternal deaths were collected on the age, local of death (coroner and permission), the anatomical site and diagnosis: 1) obstetric haemorrhage, (including abruptio placentae, placenta praevia, uterine atony, and retained products of conception, etc); 2) abortion, 3) hypertensive disorders in pregnancy (pre-eclampsia, eclampsia), 4) ruptured ectopic gestation, 5) ruptured uterus in labour, 6) amniotic fluid embolism, and 7) genital tract sepsis.

**Results:** There were 1,846 maternal deaths of which 86.4% were classified as direct maternal deaths ( $P < 0.0001$ ). The mean age was  $28.72 \pm 6.47$  years. The majority, 1,346 (84.4%) were coroner cases ( $p < 0.0001$ ). Abortion (27.4%), hypertensive disorders in pregnancy (27.3%), and obstetric haemorrhage (27.0%) were the common causes. There was a general decline in the trend of maternal deaths over the 20-year period, particularly those due to abortion, obstetric haemorrhage, ruptured tubal gestation and ruptured uterus in labour. However, deaths due to hypertensive disorders in pregnancy showed a relative rise over the period.

**Conclusion:** Abortion, hypertensive disorders in pregnancy and obstetric haemorrhage, were the major causes of maternal deaths. There was a general decline in the trend of maternal deaths over the study period.

**Key Words:** Maternal deaths, direct obstetric causes, trend, Ghana, Korle-Bu teaching hospital, Accra.

### Introduction

The main goal of Millennium Development Goal 5 was to reduce maternal mortality ratio by three-quarters between 1990 and 2015.<sup>1,2</sup> For this reasons, WHO and other international and local agencies implemented programmes aimed at achieving this goal.<sup>3,4</sup> It is however clear from the available data that this has not been universally achieved, particularly in sub-Saharan Africa.<sup>1,2,5</sup> The inability to achieve the Millennium Development Goal 5 globally and for the fact that maternal mortality is a preventable death but still a leading cause of death among women aged 15 – 49 years,<sup>6,7,8,9</sup> resulted in the formulation of Sustainable Development Goal (SDG) 3, target 3.1; which aims at reducing global maternal mortality to fewer than 70 per 100,000 live births by 2030.<sup>10</sup> However, achieving this

target requires reviewing the causes and patterns of maternal deaths, effective strategies and interventions built on previous experiences to improving maternal health and enhancing the monitoring and evaluation processes.<sup>11</sup> Understanding the relative proportions and trends of direct causes of maternal deaths is essential for planning health programs, setting priorities, and allocating resources especially in countries with limited resources and dysfunctional health information systems. Unfortunately, accurate data on direct causes of maternal deaths in most developing countries from vital registration systems are limited.

In Ghana, the lack of accurate mortality data is further hindered by the non-existent of robust vital registration systems in most regions of Ghana, or where they exist, the data is incomplete.<sup>12,13</sup> There is thus the need for an alternative source of accurate data on maternal deaths.

Maternal autopsies are thus required for accurate death certification, determination of the underlying causes of death, and establishment of maternal mortality rates.<sup>14</sup> Autopsy as investigative tool, provides valuable information about the pathophysiological changes in various organs which may be important in the delineation of the sequence of events leading to death.

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**Conflict of Interest:** None Declared

The use of autopsy data as a tool to ascertain causes of maternal deaths has been documented in most developed countries and also in some West African countries.<sup>14,15,16,17</sup> Despite the vital role it plays in accurately determining the cause of maternal death, only few hospitals in Ghana performed autopsy. Information provided on autopsy data has been shown by previous studies to increase the accuracy of cause of death reports, even in cases where the cause of death can be wholly based on clinical evaluation.<sup>18,19,20</sup> Our main research aim was to describe the relative proportions and trends of direct obstetric causes of maternal death over a period of 20-years in the largest tertiary hospital in Ghana.

## Material and Methods

In this retrospective study covering the period 1995 - 2014, "maternal death" was defined according to the tenth revision of International Classification of Diseases (ICD-10) by WHO. It is described as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.<sup>43</sup> "Direct maternal deaths" were defined as maternal deaths resulting from complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment, or from a chain of events arising from any of the above. "Indirect maternal deaths" were defined as maternal deaths due to previously existing disease or diseases that develop during pregnancy, and not due to direct obstetric causes but which were aggravated by the physiological effects of Pregnancy.<sup>21</sup> Coroner's deaths were deaths that occurred in the community or within 24-hours of admission to a health facility, where no definitive diagnosis was arrived at before death. Hospital deaths on the other hand were deaths that occurred in a health facility while the patient was on treatment for a given diagnosis.

**Study design:** This was a descriptive retrospective review of cases of maternal death for which autopsy examination was conducted at the KBTH mortuary from 1995 to 2014.

**Study site:** All data were gathered from the autopsy logbooks of the Korle-Bu Teaching Hospital Mortuary, the largest mortuary in the country. This mortuary receives cases from Korle-Bu Teaching hospital, the largest referral hospital in Ghana; as well as cases within the Accra Metropolis, neighbouring towns and Districts, and in special circumstances, cases from other regions across the country.

**Study population:** Women aged 15 – 49 years who had autopsy examination at the KBTH mortuary from 1995 to 2014.

**Data collection and analysis:** Maternal deaths were first classified into direct and indirect causes. Direct maternal deaths were further classified based on the specific

anatomical site and diagnosis as: 1) obstetric haemorrhage, (including abruptio placentae, placenta praevia, uterine atony, and retained products of conception, etc); 2) abortion, 3) hypertensive disorders in pregnancy (pre-eclampsia, eclampsia), 4) ruptured ectopic gestation, 5) ruptured uterus in labour, 6) amniotic fluid embolism, and 7) genital tract sepsis. Underlying causes of maternal deaths were recoded for bivariate analysis. Finally, maternal deaths were classified based on the location of death, into community (coroner) and hospital (permission) deaths. All available autopsy logbooks were reviewed for the period of 1<sup>st</sup> January, 1995 to 31<sup>st</sup> December, 2014, and all cases of pregnancy-related deaths were recorded. Data were collected and cross-checked by two Pathologists, to prevent double entry. For each case of maternal death, data were collected on age, cause of death and category of death (Coroner's or hospital). The age categories used in this study is that recommended by the United Nations (UN).<sup>22</sup> The data obtained was entered into a computerized spreadsheet and analysed using SPSS software (Version 23). Frequency distributions and descriptive statistics were calculated for each variable. Chi-square analysis was performed where applicable, with the P -value set at 0.05. The relative proportions and the spectrum of direct underlying and immediate causes of maternal deaths were determined. Associations between cause of death (underlying and immediate) and age at death were determined. The associations between the category of death by location and the cause of death were also examined. Also the trend in the underlying causes of maternal death over the 20-year period of review was described.

## Results

### *Age distribution of maternal deaths that had autopsy performed*

There were 1,846 maternal deaths during the period of review (1995 to 2014), that had autopsies performed at the Korle-Bu Teaching Hospital (KBTH) mortuary. The majority 1,595 (86.4%) were classified as direct maternal deaths with 13.7% indirect maternal deaths ( $P < 0.0001$ ). The age ranged of the 1,595 who died from direct causes was 15 to 48 years, mean age 28.72  $\pm$  6.47 years and median age 28.00 years. The modal age group was 25 to 29 years (26.4%) (figure 1).

### *Category of maternal deaths by location*

The majority, 1,346 (84.4%) of the maternal deaths were coroner (community) cases, with 249 (15.6%) being hospital or permission cases ( $p < 0.0001$ ).

### *Underlying and immediate causes of maternal deaths*

The top five underlying causes of maternal death were: abortion (27.4%), hypertensive disorders in pregnancy (27.3%), obstetrics haemorrhage (27.0%), ruptured tubal gestation (11.5%) and ruptured uterus in labour (5.1%) (Table 1).

The top five immediate causes of maternal death were: haemorrhagic shock (41.8%), septicaemia (19.4%) disseminated intravascular coagulation (DIC) (7.5%), anaemia (6.8%), and acute heart failure (6.6%) (Table 1).

#### **Association between underlying causes of maternal deaths and other variables**

##### *Relationship between maternal age group and underlying cause of death*

The common (62.3%) underlying cause of maternal death among women aged group < 20 years and those within 20 - 24 years age group (41.6%) was abortion ( $P < 0.0001$ ). For women within the age groups of 25 -29 and 30 - 34, the common causes were hypertensive disorders in pregnancy (29.0%) and obstetric haemorrhage (35.65) ( $P < 0.0001$ ). Again for women aged 35 - 39 and 40 - 44 years, the common cause of were obstetric haemorrhage: 35.6% and 33.3% respectively ( $P < 0.0001$ ). However, hypertension in pregnancy was the commonest (55.6%) cause of death in women aged 45 -49 years ( $P < 0.0001$ ) (Table 2).

##### *Relationship between location of maternal death and underlying cause of death*

Among the coroner cases, the most (30.5%) underlying cause of death was abortion,  $p < 0.0001$ . For permission cases, the most (60.2%) underlying cause of death was hypertensive disorders in pregnancy,  $p = 0.0001$  (Table 3).

#### *Relationship between year of underlying cause and immediate cause of maternal death*

Haemorrhagic shock was the commonest immediate cause of maternal deaths in women dying from obstetric haemorrhage (49.1%) followed by ruptured tubal gestation (26.5%), and ruptured uterus in labour (11.4%). Septicaemia was the major immediate cause in those dying from abortion (80.6%) . For hypertensive disorders in pregnancy as an underlying cause of maternal deaths, the commonest immediate cause of death was intracranial haemorrhage (96.0%) (Table 4).

#### **Trends in underlying causes of maternal death over years of deaths**

##### *Yearly distribution of the relative proportions of maternal death (1995 - 2014)*

The highest proportion of deaths was recorded in 2002 (7.1%), followed by 2005 (6.9%), 2009 (6.8%), 2006 (6.2%), 2007 (6.2%) and 2004 (5.6%) (Table 5). There was a relative percentage rise of death within the first half of the review period of 0.38, compared to a decline of - 0.38 in the second half of the review period (Table 5). In general, maternal deaths declined over the 20-year period (Figure 2a and 2b).

Similarly, abortion, obstetric haemorrhage, and ruptured uterus as causes of maternal death have showed downward trends (figures 3a, 3b,3c and 3e). However, hypertensive disorders in pregnancy showed a relative rise over the period (figures 3a and 3d).

Table 1: Underlying and immediate causes of maternal deaths

<b>Underlying cause of death</b>	<b>Frequency (n =1595)</b>	<b>Percentage (%)</b>
Obstetrics haemorrhage	430	27.0
Abortion	437	27.4
Hypertensive in pregnancy	435	27.3
Ruptured tubal gestation	183	11.5
Ruptured uterus in labour	82	5.0
Amniotic fluid embolism	6	0.4
Genital tract sepsis	22	1.4
<b>Total</b>	<b>1,595</b>	<b>100.0</b>
<b>Immediate cause of death</b>		
Haemorrhagic shock	667	41.8
Septicaemia	310	19.4
Disseminated intravascular coagulation	119	7.5
Anaemia	108	6.8
Intracranial haemorrhage	99	6.2
Acute renal failure	94	5.9
Acute cardiac failure	106	6.6
Cerebral oedema	80	5.0
HELLP syndrome	12	0.8
<b>Total</b>	<b>1,595</b>	<b>100.0</b>

**Table 2:** Relationship between maternal age group and underlying cause of death

UNDERLYING CAUSE OF DEATH									
	Obst. haemorrhage	Abortion	HDs in pregn	Ruptured tubal gestation	Rupture uterus	Amniotic fluids embolism	GTS	Total	P-Values
≤20	17	76	19	9	1	0	0	122	0.0001
	13.9%	62.3%	15.6%	7.4%	.8%	0.0%	0.0%	100.0%	
20 – 24	53	133	73	50	8	0	3	320	
	16.6%	41.6%	22.8%	15.6%	2.5%	0.0%	.9%	100.0%	
25 – 29	104	111	122	61	12	3	8	421	
	24.7%	26.4%	29.0%	14.5%	2.9%	.7%	1.9%	100.0%	
30 – 34	139	70	110	31	30	2	8	390	
	35.6%	17.9%	28.2%	7.9%	7.7%	.5%	2.1%	100.0%	
35 – 39	94	34	88	22	22	1	3	264	
	35.6%	12.9%	33.3%	8.3%	8.3%	.4%	1.1%	100.0%	
40 – 44	23	11	18	9	8	0	0	69	
	33.3%	15.9%	26.1%	13.0%	11.6%	0.0%	0.0%	100.0%	
45 – 49	0	2	5	1	1	0	0	9	
	0.0%	22.2%	55.6%	11.1%	11.1%	0.0%	0.0%	100.0%	
Total	430	437	435	183	82	6	22	1595	
	27.0%	27.4%	27.3%	11.5%	5.1%	.4%	1.4%	100.0%	

Chi-square ( $X^2$ ) = (36, 1595) = 227.364,  $P \leq 0.001$

KEY: OBST= obstetric, HDS =hypertensive disorders, GTS genital tract sepsis

**Table 3:** Relationship between the underlying cause and the category (location) of maternal death

CATEGORY OF DEATH					
		Coroner N( %)	Permission N(/%)	Total N(/%)	P-Values
UNDERLYING CAUSE OF DEATH	Obstetric Haemorrhage	371	59	430	0.0001
		(27.6)	(23.7)	(27.0)	
	Abortion	411	26	437	
		(30.5)	(10.4)	(27.4)	
	Hypertensive disorders in pregnant	285	150	435	
		(21.2)	(60.2)	(27.3)	
	Ruptured tubal gestation	181	2	183	
		(13.4)	(0.8)	(11.5)	
	Rupture uterus	82	0	82	
		(6.1)	(0.0)	(5.1)	
	Amniotic fluids embolism	5	1	6	
		(0.4)	(0.4)	(0.4)	
	Genital tract sepsis	11	11	22	
		(0.8)	(4.4)	(1.4)	
Total		1346	249	1595	
		(100.0)	(100.0)	(100.0)	

Chi-square ( $X^2$ ) = (6, 1595) = 213.925,  $P \leq 0.001$

**Table 4:** Relationship between year of underlying cause and immediate cause of maternal death

UNDERLYING CAUSE OF DEATH										
		PPH	Abortion	PIH	Ruptured tubal gestation	Rupture uterus	Amniotic fluids embolism	GTSs	Total	P-values
IMMEDIATE CAUSE OF DEATH	Haemorrhagic shock	328 (49.2)	68 (10.2)	18 (2.7)	177 (26.5)	76 (11.4)	0 (0.0)	0 (0.0)	667 (100.0)	0.0001
	Septicaemia	16 (5.2)	250 (80.6)	17 (5.5)	3 (0.1)	2 (0.06)	0 (0.0)	22 (7.1)	310 (100.0)	
	Anaemia	33 (30.6)	74 (68.5)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	108 (100.0)	
	DIC	26 (21.8)	17 (14.3)	68 (57.1)	0 (0.0)	2 (1.7)	6 (5.0)	0 (0.0)	119 (100.0)	
	Heart failure	17 (16.0)	8 (7.5)	79 (74.5)	1 (0.9)	1 (0.9)	0 (0.0)	0 (0.0)	106 (100.0)	
	Acute renal failure	9 (9.6)	14 (4.3)	70 (74.5)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	94 (100.0)	
	Intracerebral Haemorrhage	0 (0.0)	4 (4.0)	95 (96.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	99 (100.0)	
	HELLP syndrome	0 (0.0)	0 (0.0)	12 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (100.0)	
	Cerebral oedema	1 (1.3)	2 (2.5)	75 (93.8)	1 (1.3)	1 (1.3)	0 (0.0)	0 (0.0)	80 (100.0)	
Total	430 (100.0)	437 (100.0)	435 (100.0)	183 (100.0)	82 (100.0)	6 (100.0)	22 (100.0)	1595		

Chi-square ( $X^2$ ) = (48, 1595) = 2007.972,  $P \leq 0.001$

**Table 5:** Yearly trend in maternal deaths from autopsy data (1995 to 2014)

Year of death	Frequency (n = 1595)	Percentage (%)	Relative percentage (%) rise
1995	50	3.1	-
1996	50	3.1	0
1997	88	5.5	2.4
1998	67	4.2	-1.3
1999	60	3.8	-0.4
2000	71	4.5	0.7
2001	85	5.3	0.8
2002	113	7.1	1.8
2003	68	4.3	-2.8
2004	90	5.6	1.3
2005	110	6.9	1.3
2006	99	6.2	-0.6
2007	99	6.2	0
2008	89	5.6	1.2
2009	109	6.8	-1.9
2010	78	4.9	0.6
2011	87	5.5	-0.3
2012	83	5.2	1.8
2013	54	3.4	-0.6
2014	45	2.8	-
Total	1595	100.0	

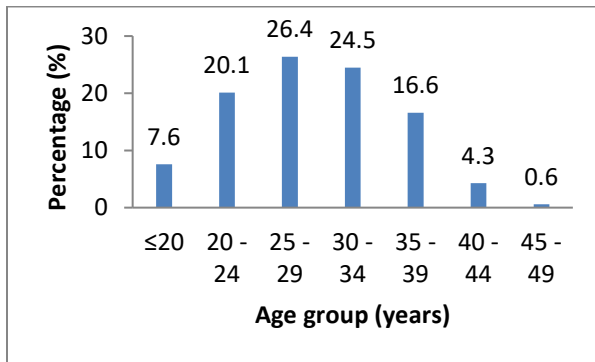


Figure 1: Age distribution of study population



Figure 2a: Trend in all maternal deaths over the study period (1995 – 2014)

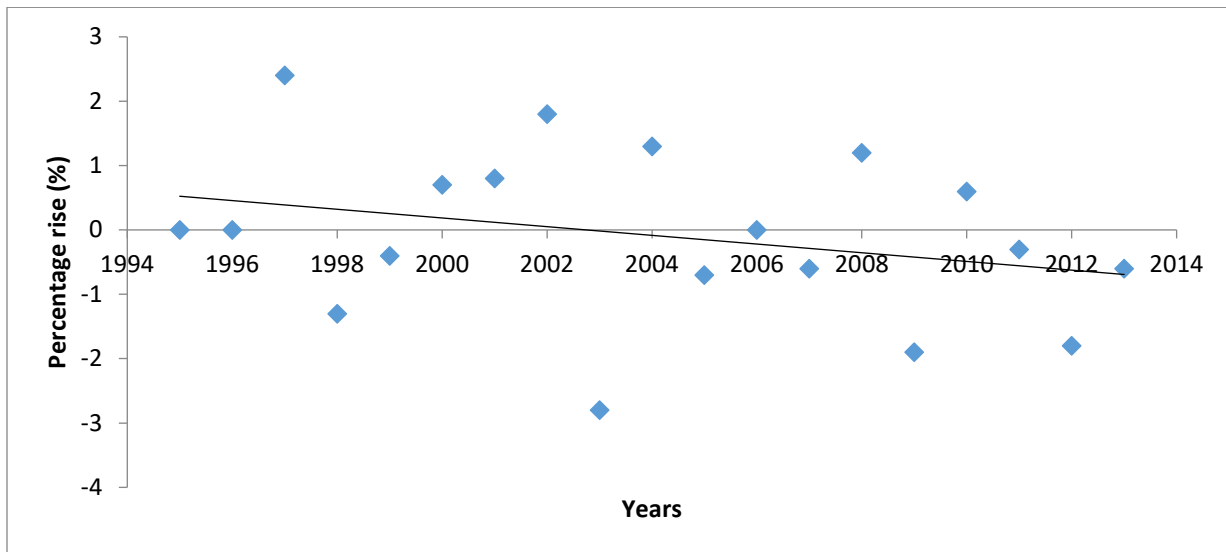


Figure 2b: Trend in all maternal deaths over the study period (1995 – 2014)

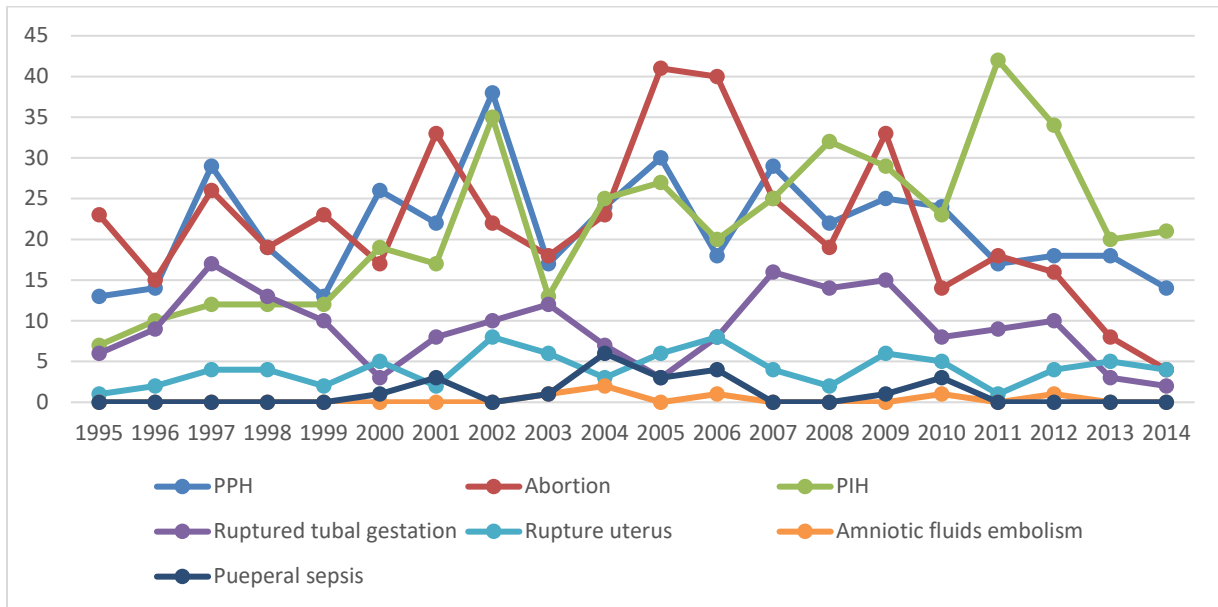


Figure 3a: Trends in underlying causes of maternal death over the study period (1995 to 2014)

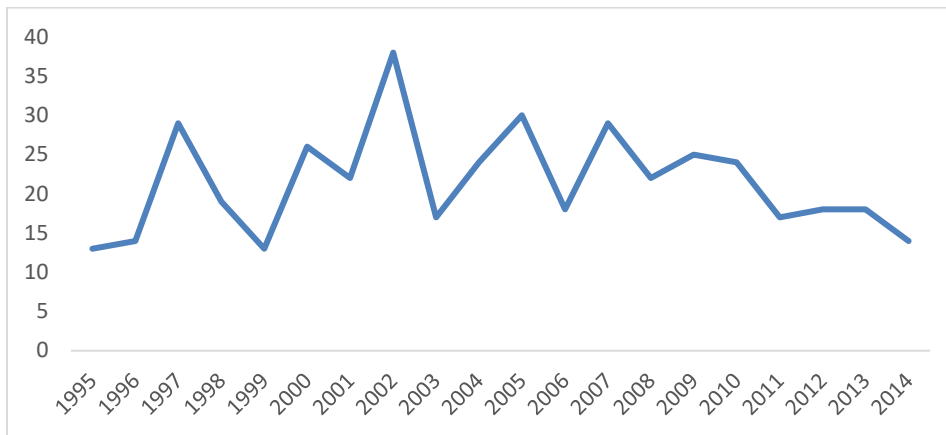


Figure 3b: Trend in obstetric haemorrhage as underlying cause of maternal death over the study period (1995 to 2014)

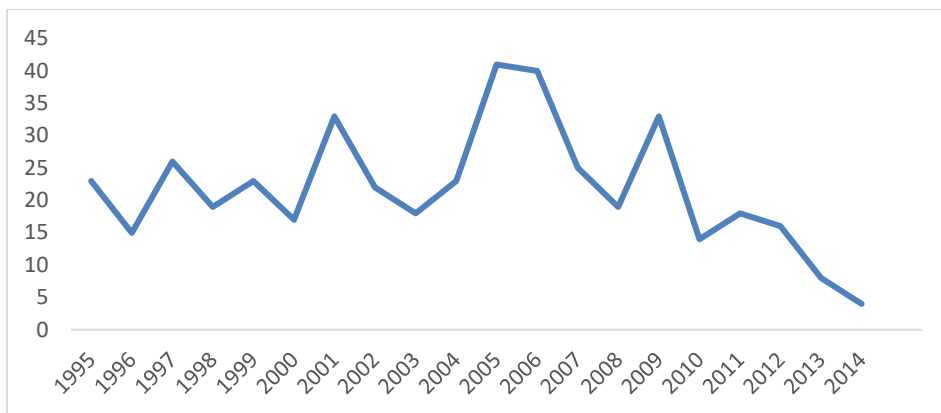
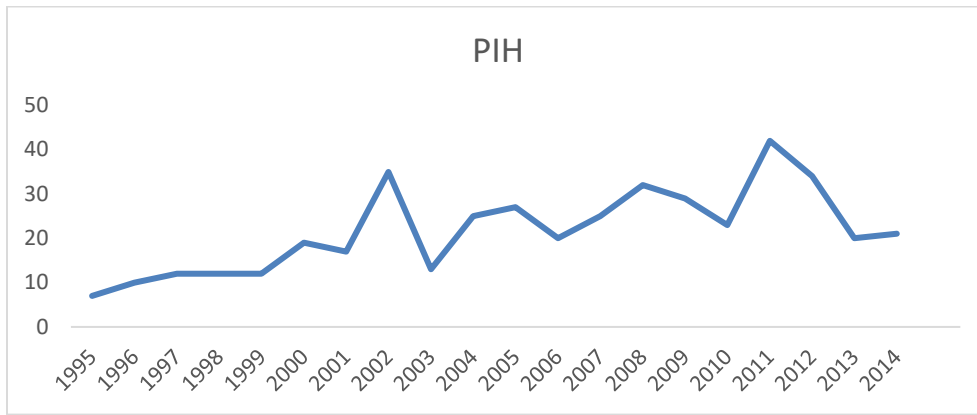
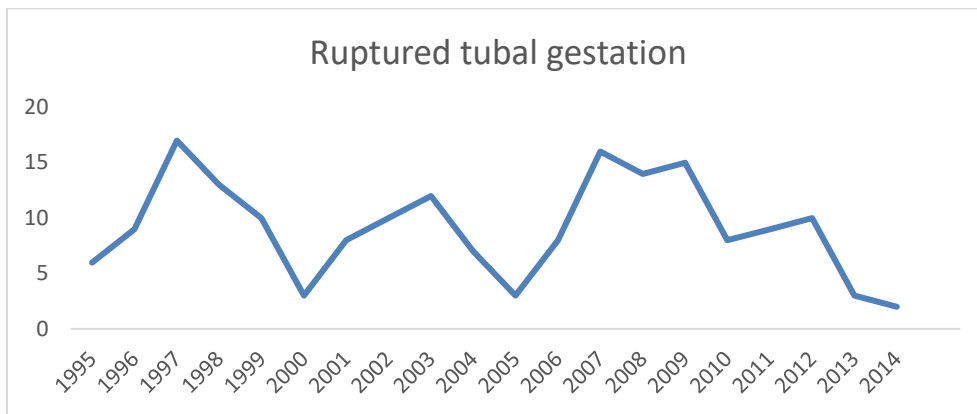


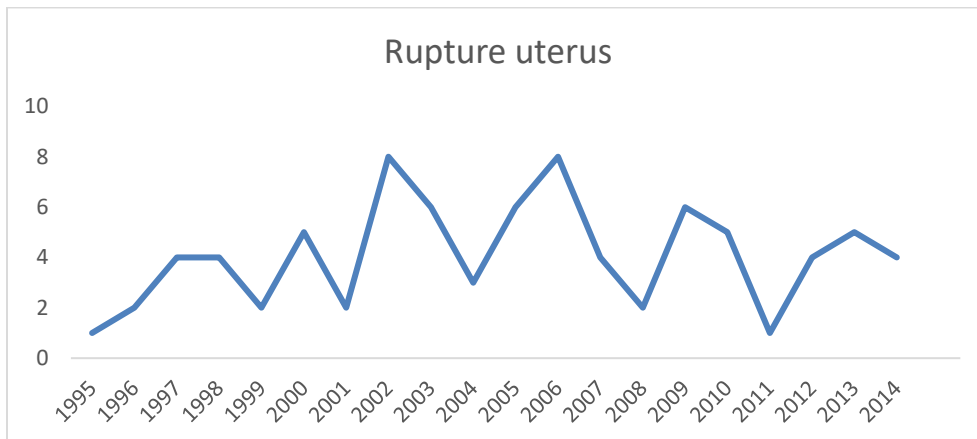
Figure 3c: Trend in abortion as underlying cause of maternal death over the study period (1995 to 2014)



**Figure 3d:** Trend in hypertensive disorders in pregnancy as underlying cause of maternal death over the study period (1995 to 2014)

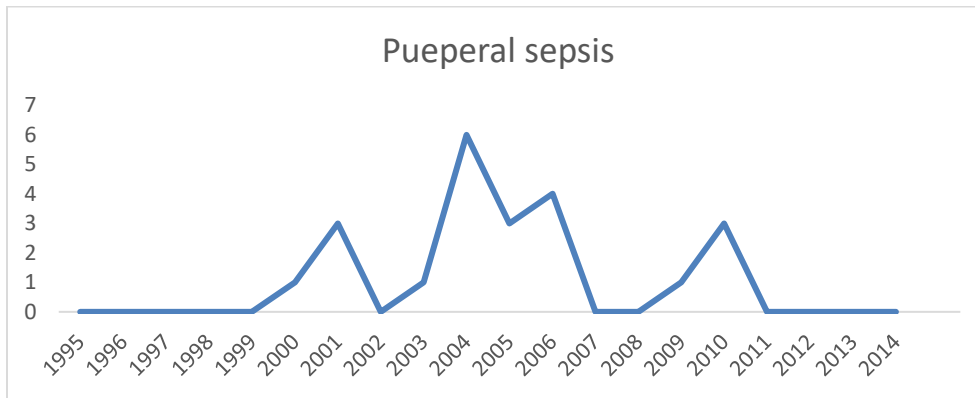


**Figure 3e:** Trend in ruptured tubal gestation as underlying cause of maternal death over the study period (1995 to 2014)



**Figure 3f:** Trend in ruptured uterus in labour as underlying cause of maternal deaths over the study period (1995 to 2014)





**Figure 3g:** Trend in genital tract sepsis as underlying cause of maternal deaths over the study period (1995 to 2014)

## Discussion

Our analysis of the autopsy data on direct causes of maternal death at the KBTH mortuary from 1995 to 2014 provides new evidence on the relative proportions and trends of deaths. The majority of the deaths in this current review were classified as direct maternal deaths (86.4%;  $P < 0.0001$ ), involving very young women (mean age  $28.72 \pm 6.47$  years), and that more than half were younger than 30-years of age. These findings are in line with previous studies in Africa<sup>23,24,25</sup>. For instance, Dinyain *et al.*, (2013) in their study of 48 autopsies certified maternal deaths reported a mean age of  $27.9 \pm 7.5$ <sup>24</sup>. This age group is consistent with the peak age of active female reproductive years. Also, Faduyile *et al.*, (2017), recently in Nigeria reported that maternal deaths were common among women younger than 35-years of age.<sup>25</sup> Direct obstetric causes being the major cause of maternal death in this current study differs from Panchabhai *et al.*, (2009) study in India who found indirect causes as the common causes of maternal death.<sup>19</sup> However, our findings are similar to previous autopsy and clinical studies in Ghana<sup>15,16</sup>, Nigeria<sup>14,17,18,20,23,24,25</sup> and across the globe<sup>26,27</sup> which reported direct obstetrics deaths as the major causes of maternal mortality.

The majority of the maternal deaths in this current study were coroner cases (84.4%,  $P < 0.0001$ ). This supports findings of previous studies conducted across the globe, that most maternal deaths occurred outside a health facility or shortly on arrival in the facility.<sup>16,18,19</sup> For instance, Der *et al.*, (2013) study in Ghana reported that 81.6% of all pregnancy related deaths occurred in the community.<sup>16</sup> This may indicate that a proportionately higher number of young women are dying in the communities from pregnancy related causes.

The top five direct causes of maternal deaths were: abortion (27.4%), hypertensive disorders in pregnancy (27.3%), obstetric haemorrhage (27.0%), ruptured ectopic gestation (11.5%) and ruptured uterus in labour (5.1%). Also, the top five immediate causes of maternal death were: haemorrhagic shock (41.8%), septicaemia (19.4%), DIC (7.5%), anaemia (6.8%) and intracranial haemorrhage (6.6%). This is in agreement with the

findings of previous autopsy and clinical studies in Ghana<sup>15,16,28,29</sup> west Africa<sup>14,17,18</sup> and India<sup>19</sup>.

Among the coroner cases, the common (30.5%) underlying cause of death was abortion, ( $P < 0.0000$ ). For the permission cases, many (60.2%) of the underlying causes of death were due to hypertension in pregnancy ( $P < 0.0000$ ), similar to previous studies in Ghana.<sup>15,16</sup>

Abortion in this study was found to be the leading direct cause of maternal death and more so in the community. Again, abortion was most likely to be complicated by septicaemia as the immediate cause of death ( $P < 0.0001$ ). Autopsy studies in other parts of the world similarly found abortion and its associated complications to be the major predictor of maternal mortality.<sup>15,30,31</sup> The current findings however, disagreed with others who found obstetric haemorrhage as the leading cause of maternal death.<sup>16,32,33</sup> Furthermore, the study also found a positive significant statistical association with younger age at death ( $P < 0.0001$ ), similar to the findings in a previous study in Ghana.<sup>16</sup> Among factors that may have accounted for this association in this age group is the fact that most of the women within this age group are unmarried and therefore, more likely to seek illegal abortion to avoid stigmatization, as noted by previous publications.<sup>16,34,35</sup> Another study by Fubara *et al.*, (2007) in Port-Harcourt, South-South Nigeria on abortion-related deaths showed that septic shock accounted for 50% of abortion-related maternal deaths.<sup>18</sup> Similarly, abortion related complications were identified globally by Say *et al.*, (2014) as contributors of maternal mortality.<sup>26</sup>

Obstetric haemorrhage as a cause of maternal death was the third in descending order of magnitude and was also found to be common among women aged 30-years and above ( $P < 0.0001$ ). The leading immediate cause of death was haemorrhagic shock, and this means that a woman with peripartum haemorrhage in the Ghana is at a higher risk of dying from haemorrhagic shock, as women in other parts of Africa<sup>5</sup>. Obstetric haemorrhage being the third cause of maternal death in this current study is in line with some studies in Africa<sup>15</sup> and India<sup>19</sup>, but differs from others reports in Africa<sup>7,16,17,26,36</sup>, thus a mixed picture than. For instance, Dinyain *et al.*, (2013) in their autopsy study in Nigeria

reported haemorrhage as the leading direct cause of maternal death and this accounted for more than half of their study population.<sup>24</sup>

Hypertensive disorder in pregnancy was identified as the second direct obstetric cause of maternal death in this study. It was also found to be significantly common in women aged 30-years and above ( $P < 0.0001$ ). Furthermore, a good proportion of these deaths occurred in health facilities. These findings support previous autopsy studies in Ghana<sup>15,16</sup> and Nigeria<sup>24,25</sup>. It however differs from findings from other studies in Ghana<sup>21,37</sup> and India<sup>19,20</sup> which reported hypertensive disorders in pregnancy as the leading cause of maternal death. For instance, Lee *et al.*, (2011) reported the top five causes of maternal death as hypertensive states of pregnancy (26.4%), haemorrhage (16.8%), genital tract sepsis (10.6%), early pregnancy deaths (8.4%) and infection (8.7%).<sup>23</sup> The common immediate causes of death in women dying of hypertensive disorders in pregnancy in descending order were: intracranial haemorrhage, heart failure, cerebral oedema, acute renal failure and DIC similar to Der *et al.*, study in Ghana.<sup>16</sup>

#### **Historical trends in maternal mortality**

Maternal mortality in the 1870s in areas now called developed world exceeded 600 per 100,000 live births, a figure comparable with current maternal mortality ratios in many developing countries; Safe Motherhood Inter-Agency Group, 2000.<sup>38</sup> Significant reductions in maternal mortality were accomplished first in northwestern Europe (Sweden, Norway, Denmark, and the Netherlands) in the mid- to late-19th century, and several decades later in Britain and the United States.<sup>39</sup>

In the 21<sup>st</sup> century, the risk of a woman dying during childbirth has declined significantly across the world, yet inequality in health infrastructure and personnel across the globe, countries, and in some regions still remains major predictors of pregnancy outcome. Published data available indicated a significant decline in maternal death in countries such as Finland, Greece, Iceland, and Poland as at the end of 2015.<sup>40</sup> The 100-fold decline of maternal mortality is attributable to the modern scientific understanding of the cause of maternal mortality and the adoption of practices which appear surprisingly simple in hindsight. This is however not true of countries in Asia and Sub-Saharan Africa.<sup>40,41</sup> The five countries with the highest number of maternal deaths in 2015 were: Nigeria (58,000); India (45,000); Democratic Republic of Congo (22,000); Ethiopia (11,000); and Pakistan (9,700).<sup>41</sup>

A significant finding in this current retrospective autopsy study in Accra Ghana, is the decline in total maternal deaths, especially during the second half of the study period (2005 – 2014). Of course, the chances that a woman dies from maternal causes are not only dependent on the risk per pregnancy – which we looked at above – but also the number of pregnancies she has. With the increased family planning rate in Ghana over

the years, this is expected. This supports the general trend in maternal globally.<sup>40,41,42</sup>

Specifically, we found a decline in maternal deaths relating to abortion, obstetric haemorrhage, ruptured ectopic gestation and ruptured uterus in labour over the study period. The decline in obstetric haemorrhage as a direct cause of maternal over the 20-year period supports studies in both developed and developing that reported a declined peripartum death between 1990 and 2015.<sup>5, 42</sup>

However, hypertensive disorders in pregnancy is not only major cause of maternal death as reported by Adu-Bonsaffoh *et al.*, (2013)<sup>37</sup>, but showed a rising trend during the period of this review. This may be attributed to the fact that hypertensive disorders occur in pregnancy, continue throughout labour and the early puerperium. Again the pathogenesis of hypertension in pregnancy is not clear. More recently, the report of the Ghana Maternal Health Survey indicated that the relative proportion of maternal death due to hypertension in pregnancy has doubled over the past decade, showing an increment from 9% in 2007 to 18% in 2017.<sup>43</sup> This recent national report buttresses the finding of rising trends hypertensive maternal deaths determined in this study. Recent global WHO estimates indicates that the maternal mortality ratios in Ghana remains unacceptably high (308 per 100,000 live births) despite implementation of several measures to improve maternal health in the country.<sup>44</sup> There is the need to re-strategize as a country to improve maternal health by instituting evidence-based and locally appropriate measures with specific reference to the major underlying causes of maternal morbidity and mortality

#### **Conclusion**

The major direct obstetric causes of maternal deaths identified by this study were: abortion, hypertensive disorders in pregnancy, obstetrics haemorrhage, ruptured tubal gestation and ruptured uterus in labour. Most of the deaths occurred in the community and commonly involved younger women. There was a general decline in most of the underlying causes of maternal death, except hypertension in pregnancy, which showed a rising trend. This autopsy based maternal mortality study would have been more robust if the enforcement of the Coroner's law was in place so that all cases of maternal deaths are investigated by autopsy. We therefore recommend the Ghana Government to have a second look at this Act and its strict implementation.

#### **Strength of the study**

1. The large sample size in current study conducted in the mortuary of the largest referral hospital in Ghana can be said to have a better representation of the prevalence of the direct causes of maternal deaths.

2. The present study provides detailed pathological analysis of maternal mortality in a tertiary hospital covering a period of 20-years.
3. The study further highlighted the importance of autopsy in the investigation of maternal mortality, especially in countries where the vital registration systems are not robust.

### Limitations of the study

1. The retrospective nature of the study design is a major limitation.
2. All the maternal deaths in the catchment area of the referral hospital were not subjected to autopsy investigation, and this may have introduced a bias in the study findings. Thus, it is possible that exclusion of cases which were not autopsied may have skewed the data.

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