MATERNAL MORTALITY IN THE GREATER HARARE MATERNITY UNIT, ZIMBABWE (2013-18)

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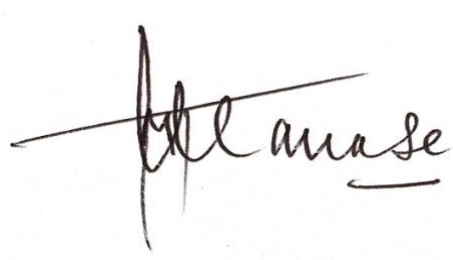
A dissertation submitted to the Faculty of Health Sciences, University of Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Public Health in the field of Maternal and Child Health

Johannesburg, September 2021

DECLARATION

I, Marshall Tineyi Manase, declare that this Dissertation Report is my own, unaided work. It is being submitted for the Degree of Master of Public Health in the field of Maternal and Child Health at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



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30th day of September 2021 in Harare

DEDICATION

This work is dedicated to Yvonne, Kudzi and Anesu, and to the Wits School of Public Health in recognition of their pursuit for truth and perfection.

ABSTRACT

Background: Reducing maternal mortality is a global health priority. The World Health Organization's Sustainable Development Goals (SDGs) have set all countries a target of reducing the maternal mortality ratio (MMR) to below 70 per 100 000 live births by 2030. This study aimed to calculate the MMR for the Greater Harare Maternity Unit (GHMU), identify hospital-specific trends in the MMR over time, determine immediate and underlying causes for maternal deaths, and assess the occurrence and value of post-mortems.

Methods: A retrospective record review of all maternal deaths in the GHMU from January 2013 to December 2018 was undertaken. It involved two central hospitals and referral units in the district. Maternal characteristics associated with death and causes of maternal death were evaluated.

Results: A total of 377 deaths were recorded. The GHMU MMR (95% confidence intervals) was 137 (107, 173) per 100 000 live births in 2013, peaked at 168 (133, 211) in 2017 before decreasing to 103 (77, 136) in 2018. Hypertensive disorders were the most common cause of death (21.0%), followed by obstetric haemorrhage (19.6%), pregnancy with abortive outcomes (18.8%) and non-obstetric complications (18.6%). The MMR for Sally Mugabe Central Hospital (SMCH) declined from 334 (280, 396) in the first triennium (2013-2015) to 295 (247, 349) in the second triennium (2016-2018). The MMR at Parirenyatwa Central Hospital increased from 150 (108, 202) to 290 (221, 373) during the first triennium and from 123 (106, 142) to 138 (119, 158) over the entire six-year period. Differences in maternal death patterns at the two hospitals were significantly associated with religious affiliation, level of education, parity and the number of antenatal visits. The majority of the GHMU deaths (85%) had post-mortems conducted. About three-quarter (77%) of the post-mortems done at SMCH had a diagnosis identical to the clinical diagnosis, whilst a further 18% had a similar cause of death.

Conclusion: The MMR in the GHMU, and the iMMR at both SMCH and PCH, are high and not dissimilar to those in other low-resourced settings. The primary causes of

maternal mortality are also similar to these settings. The clinically assigned cause of death did not differ much from the post-mortem established cause of death in most instances. Sizeable changes are needed to attain the 2030 SDG MMR target.

Keywords: maternal mortality, Greater Harare Maternity Unit, Zimbabwe

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ABBREVIATIONS

ANC	antenatal clinic
CI	confidence interval
GHMU	Greater Harare Maternity Unit
HIV	human immunodeficiency virus
ICD	International Classification of Diseases
iMMR	institutional maternal mortality ratio
IQR	interquartile range
MMR	maternal mortality ratio
PCH	Parirenyatwa Central Hospital
SDGs	Sustainable Development Goals
SMCH	Sally Mugabe Central Hospital
WHO	World Health Organization
ZMPMMS	Zimbabwe Maternal and Perinatal Morbidity and Mortality Survey

1. BACKGROUND

1.1 Definitions

A maternal death is 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.[1]

The maternal mortality ratio (MMR) is defined as the proportion of maternal deaths during a given time period per 100 000 live births during the same time-period.[2] The maternal mortality ratio is used as measure of the quality of the health care delivery system of a particular country.[3]

The institutional maternal mortality ratio is defined as the proportion of maternal deaths among 100 000 deliveries in health facilities or institutions.[4]

1.2 Causes of maternal deaths

WHO classifies the causes of maternal death into nine different groups (Table 1.1).[5]

Table 1.1 WHO classification of causes of maternal death

1. Pregnancies with abortive outcomes
2. Hypertensive disorders
3. Obstetric hemorrhage
4. Pregnancy - related infection
5. Other obstetric complications
6. Unanticipated complications of management
7. Non-obstetric complications
8. Unknown or undetermined
9. Coincidental causes

Source: WHO 2012[5]

From 2003 to 2009, 73% of maternal deaths worldwide were attributed to direct causes whilst 27% were related to indirect causes.[6] The four leading causes of maternal death worldwide were haemorrhage (27.1%), hypertension (14.0%), sepsis (10.7%) and complications of abortion (7.9%).[6] The indirect causes of maternal death included death from previously existing diseases and illnesses that began in the course of the pregnancy.[7] Included in this group are conditions such as malaria, HIV, diabetes, tuberculosis and cardiovascular diseases.[7] Pre-existing medical conditions that are worsened by pregnancy, including HIV infection, contributed to more than 70% to the indirect causes of maternal death.[6] In 2017, there were 295 000 maternal deaths, approximately 810 women dying daily. 94% of these deaths were in low and lower-middle income countries.[8]

1.3 Data challenges

The biggest challenge in obtaining accurate data globally is that large numbers of women die in countries where vital registration is inadequate and also that a sizeable number of the women who need care do not avail themselves to the services that are there.[5] With these limitations and recognising it may not always be feasible to obtain accurate data, it has been suggested that it should not be a pre-requisite that all maternal mortality be reported, but rather that a representative sample be examined to identify emerging trends.[9] Therein lies another problem, how easy will it be to get a representative sample?

Recognising the need for accurate data, whereby each maternal death is counted, UNICEF and WHO, as of February 2018, committed themselves to working with countries to strengthen their civil registration and vital statistics,[10]

1.4 Importance of maternal mortality review

Most maternal deaths worldwide occur because women fail to get the health care that they require.[11] This may be the result of a failure to get to the health care service or because of the inadequacies of the service to attend to women's needs.[11]

Maternal death review forms a major component of efforts to improve the quality of maternal health services by homing in on the causes of death and highlighting deficiencies where interventions might have resulted in a different outcome,[12] with a promise of improved future case management. It can also identify the magnitude, trends, patterns and differences in maternal mortality.[9] This knowledge can then be used to prioritise, plan, implement, allocate resources more effectively, monitor and evaluate policy and activities aimed at reducing maternal mortality.[9, 13]

1.5 Institutional maternal mortality ratio

Institutional maternal mortality ratios (iMMR) in teaching and tertiary hospitals tend to be higher than the MMR reported in national statistics.[3] This is in part due to the fact that as referral centres, they tend to get more severely ill women being referred to them.[3]

1.6 Maternal mortality review in sub-Saharan Africa

Accurate data is of paramount importance in achieving health targets.[14] In most parts of sub-Saharan Africa, maternal death reporting is done without a framework. Reporting is incomplete and there is little political, institutional or legal support for the process.[12] South Africa was the first sub-Saharan African country to make maternal death reporting a routine part of the health system. It introduced the confidential enquiry of maternal death system in 1997.[12] Maternal deaths are reported, analysed,

reviewed and recommendations made to improve quality of care.[12] For this to work, political buy-in was required and legislation put into place.[12]

Four other countries in the region have national confidential enquiries into maternal deaths: Lesotho, Botswana, Malawi and Namibia.[15] Zimbabwe, Swaziland and Eritrea have maternal death committees in place that produce reports.[15]

1.7 Maternal mortality in Zimbabwe

The WHO estimated that in 1995 the MMR in Zimbabwe was 450 per 100 000 live births, and 579 and 690 in 2000 and 2005, respectively.[16] In 2007, the Zimbabwe Maternal and Perinatal Morbidity and Mortality Survey (ZMPMMS) was carried out. It was the first time Zimbabwe provided a MMR (of 725) with a narrower confidence interval (648-810).[17]

Table 1.2 lists the causes of maternal death in Zimbabwe described in a small study conducted before the 2007 ZMPMMS survey.[17] The exercise was done to assess the degree of completeness of the notification system. It concluded that, firstly, the total number of deaths identified was an underscore of the real number of maternal deaths. Secondly, there was a difference in the notification diagnosis and the reviewers' diagnosis. In the table below, notification diagnosis refers to the diagnosis that was written on the death certificate, comparing it with assessor's diagnosis after reviewing the file. This data was collected before the ICD 10 maternal mortality classification was in use.

Table 1.2: Causes of maternal deaths in Zimbabwe in 2006 (n=364).

Cause	Notification diagnosis no.	%	Assessor's diagnosis no.	%	Difference no.
HIV and AIDS related	87	29.7	94	26.9	+7
Pregnancy induced hypertension/ eclampsia	50	17.1	55	15.7	+5
Postpartum haemorrhage	43	14.7	65	18.6	+22
Puerperal sepsis	41	14	43	12.3	+2
Malaria	23	7.9	26	7.4	+3
Cardiac disease	16	5.5	16	4.6	0
Antepartum haemorrhage	9	3.1	15	4.3	+6
Abortion related	5	1.7	9	2.6	+4
Ruptured uterus	5	1.7	2	0.6	-3
Diabetes mellitus	5	1.7	4	1.1	-1
Obstructed labour	3	1.0	4	1.1	+1
Anaesthetic complications	2	0.7	2	0.6	0
Suicide	2	0.7	2	0.6	0
Caesarean section related	1	0.3	1	0.3	0
Unknown	72	19.8	14	3.8	-58
Total	364	100	364	100	

A limitation highlighted was the underreporting of maternal deaths from the community and district through to the tertiary level. Data loss was noted in the process of transfer of maternal death reports from the peripheral hospitals to the Ministry of Health offices.[17]

2. JUSTIFICATION FOR THE STUDY

The Greater Harare Maternity Unit (GHMU) is made up of two central hospitals, Sally Mugabe Central Hospital (formerly Harare Central Hospital) and Parirenyatwa Central Hospital, together with the clinics that refer patients to them. The MMR for the GHMU has not been documented precisely for the past two decades. The last review done

was by Majoko et al. in 1997.[18] This review estimated an MMR of 122 per 100 000 live births for the GHMU.[19] When women living outside the Harare municipality were excluded, the MMR for the GHMU was 53 per 100 000 live births.[19] The current study aimed to establish an annual MMR for a six-year period in the GHMU as well as provide information on the leading causes of maternal mortality within the GHMU.

Another reason for undertaking the study was that as Zimbabwe attempts to achieve the Sustainable Development Goals (SDGs), it is important to take stock of where it is compared to where it needs to be in 2030. This study provides data that may assist in the development of a road map for Harare and Zimbabwe, especially since the Ministry of Health is keen to reduce maternal mortality.

3. AIM OF THE STUDY

The study aimed to establish the incidence, causes of, and factors associated with maternal mortality in the Greater Harare Maternity Unit from 2013 to 2018.

4. STUDY OBJECTIVES

4.1 Primary objective

4.1.1 To calculate the annual maternal mortality ratio for the period 2013-2018 in the Greater Harare Maternity Unit (for government and city council maternity care services).

4.2 Secondary objectives

4.2.1 To describe the leading causes of maternal death in the Greater Harare Maternity Unit for the years 2013-2018.

4.2.2 To describe the demographic and the obstetric characteristics of maternal deaths in the Greater Harare Maternity Unit for 2013-2018.

4.2.3 To determine the proportion of maternal deaths that had autopsies done and to compare the cause of death established thereby to that stated on the maternal death notification form.

5. STUDY METHODS

5.1 Study setting

The GHMU includes the maternity wings of the two central hospitals in the city - Sally Mugabe Central Hospital (SMCH) and Parirenyatwa Central Hospital (PCH) - and the twelve Harare city council clinics that offer maternity services.

The city council clinics are manned by midwives and provide complete care for uncomplicated pregnancies. High-risk women are referred from the city council clinics to the central hospitals during the antenatal, intrapartum and postpartum periods. Four Harare city council clinics refer to the maternity wing of PCH (Mbuya Nehanda Maternity Hospital) whilst eight refer to the maternity wing of SMCH.

The two central hospital are affiliated to the College of Health Sciences which is under the University of Zimbabwe. Both hospitals are serviced by consultants from the university's Department of Obstetrics and Gynaecology as well consultants from the government. The hospitals also serve as referral centres for the surrounding districts and provinces. Neither hospital has a stand-alone intensive care unit nor laboratory service. They rely on the main hospitals which provide centralised care.

PCH is located a few kilometres from the central business district. It was designed to cater for the low-density areas in the pre-independence period. It has a smaller catchment area. It has a bed capacity of 223 patients, including a neonatal and kangaroo mother care unit. It has a staff complement of 158 midwives including matrons and sisters in charge.

SMCH was built to cater for the high-density areas. It has a wider catchment area and traditionally has always delivered more patients than PCH. It has 282 beds covering both maternity and the neonatal unit and has a staff complement of 282.

5.2 Study period

The study included all maternal deaths from 1 January 2013 to 31 December 2018.

5.3 Births during study period

According to the City of Harare Department of Health annual reports,[20-25] the following were the live births for the City for the period 2013-18:

	2013	2014	2015	2016	2017	2018
Total live births	51 194	49 661	49 105	49 636	45 163	48 354

5.4 Maternal death capture system

Both central hospitals employ a reproductive health nurse and an assistant. The responsibilities of the reproductive health nurses include identification of maternal deaths as they occur within the hospital. The reproductive health nurse and her assistant do daily ward rounds in the maternity hospitals, the gynaecological wards, the medical wards and the surgical wards with the purpose of identifying maternal deaths. They record all the information pertaining to each maternal death including demographic and obstetric characteristics and cause of death. Similar to all other patient case files, the case files for each maternal death are kept in the records department of the two hospitals. In addition to keeping the paper-based case files, the records departments also scan the clinical notes to retain an electronic record of the case file.

Each hospital holds regular maternal and perinatal mortality meetings as well as monthly GHMU maternal mortality meetings. Death data in the city clinics are provided by the city health team.

5.5 Study design

The study involved a retrospective record review of patient records, with analytical components. The records of city clinic death patients were not retrieved or reviewed and only summaries were used.

5.6 Outcome measures

The key outcome measures of the study were:

- Number of maternal deaths
- Causes of maternal death established clinically
- Causes of maternal death established via autopsy
- Demographic characteristics of maternal deaths.
- Obstetric characteristics of maternal deaths.
- Maternal mortality ratio

5.7 Inclusion criteria

The study included women who were booked and unbooked, domiciled in Harare, and who received their antenatal care in the GHMU (as opposed to those referred from outside Harare). The study included all pregnant women whether alive or dead at the end of 42 days after delivery, miscarriage, ectopic pregnancy or gestational trophoblastic disease.

5.8 Causes of death

The causes of death in this study were based on the WHO Classification of Maternal Deaths in Pregnancy, Childbirth, and the Puerperium: ICD-Maternal Mortality (ICD-MM). This is based upon the ICD-10 and its coding rules.[26] The International Classification of Diseases (ICD) is the international standard for reporting diseases and health conditions and the basis for identifying health trends globally. It is the diagnostic classification standard for all clinical and research purposes. It is used to plan how services are delivered and in how resources are apportioned.

The WHO classification for the cause of maternal death has been simplified to make worldwide comparison possible. It defines the cause of maternal death by group, category and underlying causes.[26] The attraction about ICD-MM is that it can be used in all settings, such as when the cause of a woman dying is decided by a facility-based death review or via verbal autopsy.[26]

The four groups of maternal deaths are indirect, direct, unanticipated complications of management and unknown.[26] Each group has several categories and each category has a number of underlying causes. Thus, the ICD-MM facilitates data collection is uniform and allows for standard data analysis and interpretation on maternal deaths.[26]

A cause of death could be considered direct or indirect. For example, direct causes include placenta praevia or pre-eclampsia and indirect causes include infections such as pneumonia or HIV, and cardiac disease.

5.9 Sampling

There was no sampling or sample size calculation performed. The study included all maternal deaths that occurred over the study period. The study period was selected

based on it being the most current at the time and its ability to provide a sizeable number of patient records. The expected number of deaths over the six-year period was about 400 for the GHMU, based on a pre-study review of the hospital death register for the study period.

5.10 Data collection

The case file for each maternal death was retrieved form the records department by the reproductive health nurse. The researcher reviewed each patient record and extracted data onto a researcher-developed data collection form (Appendix A). Clinic deaths statistics were obtained from the city health statistical department.

5.11 Statistical analysis plan

Data was entered into a Microsoft Excel spreadsheet (Microsoft, Seattle, USA) and thereafter transferred into Stata 15 (StataCorp, Texas, USA) for cleaning and analysis. Basic descriptive statistics were generated, such as the percentage of deaths from various causes.

Patient descriptive characteristics such as age, parity, booking status and religious affiliation were reported using proportions while continuous data were summarised using means and standard deviations for normally distributed data and medians and interquartile ranges for non-parametric data. A point estimate of the MMR and its associated 95% confidence interval was calculated. A chi-square test was used to test for association between categorical variables of interest (e.g. whether the death was avoidable, or an autopsy performed, and other clinical or demographic characteristics). The rank sum test was used to compare non-parametric continuous data. A p-value <0.05 was considered statistically significant.

To describe the maternal mortality ratios for 2013-2018, maternal mortality data from SMCH and PCH are presented as ratios using the population of live births in the GHMU during the same period, taken from the delivery registers, as the denominator. To identify and compare the causes for maternal mortality between the two hospitals, data are presented as proportions for each category.

5.12 Ethical considerations

Approval to conduct the study was obtained from the joint Parirenyatwa and College of Health Sciences Ethics Review Committee (Appendix B), the Harare Hospital Ethics Committee (Appendix D) and the Medical Research Council of Zimbabwe. As this was a Masters research report, ethical approval was also be obtained from the Committee for Research in Human Subjects (Medical) at the University of the Witwatersrand (M200154) (Appendix C).

6. RESULTS

6.1 Site of origin

A total of 680 deaths were recorded in the unit death register for the period 2013 to 2018. Some 377 deaths (55.4%) were of women residing or referred from within the GHMU catchment area whilst 303 deaths (44.6%) were of women referred from centres outside the GHMU. There were 15 City council deaths captured in the period under review. All subsequent data (unless indicated otherwise) refer to deaths occurring in women based in the GMHU catchment area only (i.e. 377 women). Most deaths (269/377, 71%) occurred at SMCH, with 108 (29%) happening at PCH (Table 6.1).

Table 6.1 Site of origin and hospital location of all hospital recorded deaths from 2013-2018.

Year / Hospital	2013		2014		2015		2016		2017		2018		Subtotal		Total
	SM	PC	SM	PC	SM	PC	SM	PC	SM	PC	SM	PC	SM	PC	
All GHMU Deaths	48	16	54	13	34	17	42	28	53	23	38	11	269	108	377
Referred deaths	26	24	26	9	33	20	41	27	34	29	17	17	177	126	303
Institutional deaths	74	40	80	22	67	37	83	55	87	52	55	28	446	234	680
City Council death	7		0		3		2		1		2		15		15

Abbreviations: GHMU=Greater Harare Maternity Unit; PH=Parirenyatwa Central Hospital; SM=Sally Mugabe Central Hospital

6.2 Demographic characteristics

Demographic details of the deceased women is shown in table 6.2. The majority (86%) of women were aged between 20 and 39 years. Almost half of deaths (45%) were in the 20-29 year age group, closely followed by the 30-39 year age group (40%) (Figures 6.1 and 6.2).The mean age (± standard deviation [SD]) of the women was 29.0 (±6.7) years (range 14-45) for SMCH and 27.8 (± 6.0) years (range 16-44) for PCH.

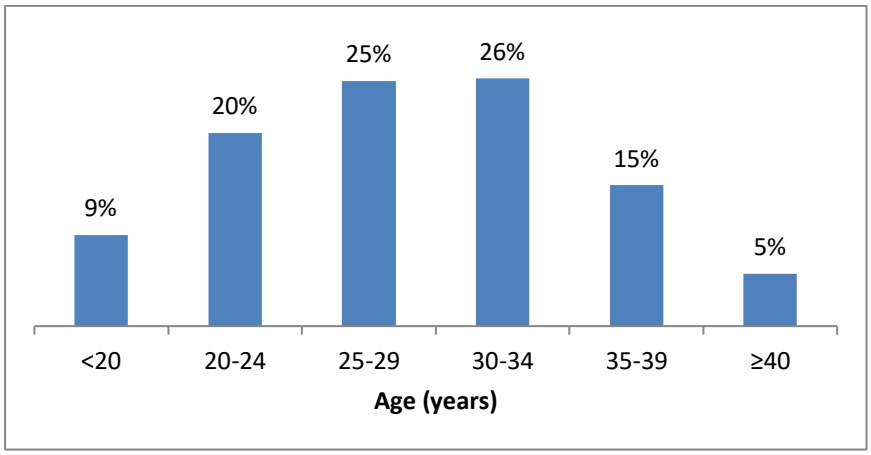

Figure 6.1: Distribution of women by age group, both hospitals combined (n=377)

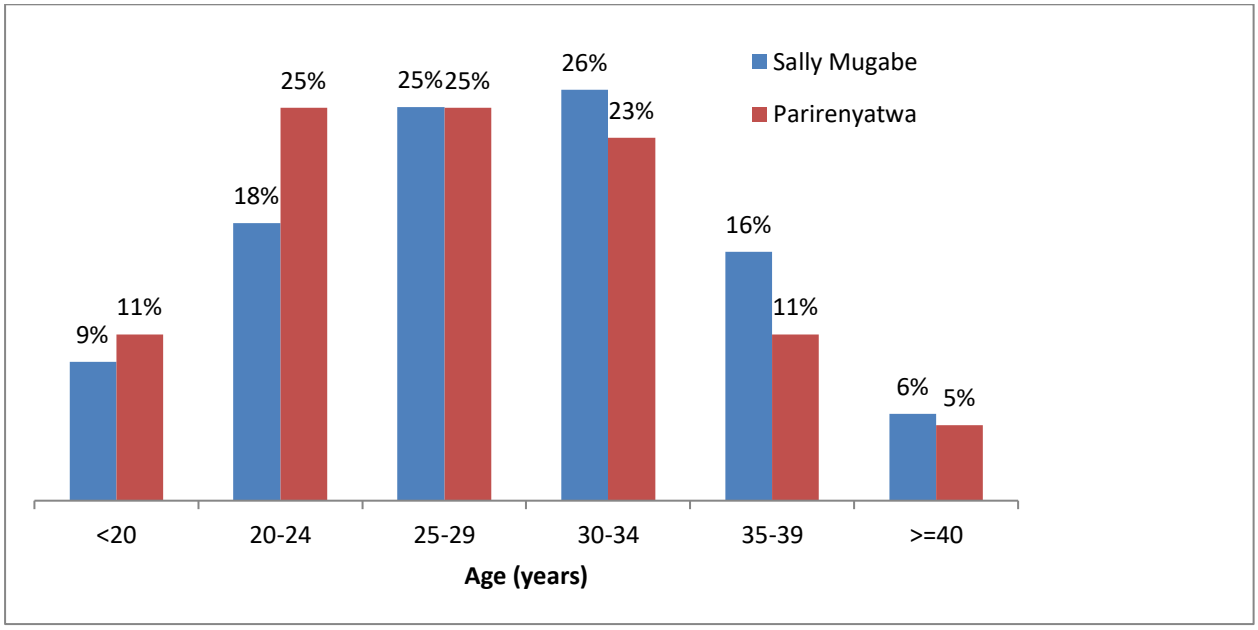

Fig 6.2 Distribution of women stratified by age and hospital (n=377)

Most women (80%) were married. Religious affiliation varied, with apostolic faith being commonest (48%). About 60% of women had completed secondary education. Educational status was unknown for a third of women (Table 6.2). Comparing deaths at the two hospitals, a higher proportion of deaths at SMH were in women of the apostolic faith and who were better educated.

Table 6.2 Demographic characteristics of women at GHMU, stratified by hospital, 2013-2018 (n=337).

Characteristic	Combined GHMU frequency no. (%)	Hospital		p-value
		SMCH, no. (%)	PCH no. (%)	
Age (years)				0.47
< 20	35 (9.4)	24 (8.9)	11 (10.7)	
20-29	168 (45.2)	116 (43.1)	52 (50.5)	
30-39	149 (40.1)	114(42.4)	34 (34.0)	
40-49	20 (5.4)	15 (5.6)	5 (4.9)	
Marital status				0.31
Married	302 (80.0)	216 (80.3)	86 (79.6)	
Single	41 (10.9)	30 (11.2)	11 (10.2)	
Co-habiting	3 (0.8)	1 (0.4)	2 (1.9)	
Divorced	3 (0.8)	1 (0.4)	2 (1.9)	
Widowed	4 (1.1)	4 (1.5)	0	
Unknown	24 (6.4)	17 (6.3)	7 (6.5)	
Religion				<0.001
Catholic/Anglican/Methodist	51 (13.5)	24 (8.9)	27 (25.0)	
Pentecostal	78 (20.7)	47 (17.5)	31 (28.7)	
Apostolic faith	179 (47.5)	156 (58.0)	23 (21.3)	
Muslim	2 (0.5)	2 (0.7)	0	
Unknown	67 (17.8)	40 (14.9)	27 (25.0)	
Highest level of education				<0.001
Primary	19 (5.0)	14 (5.2)	5 (4.6)	
Secondary	232 (61.5)	192(71.4)	40 (37.0)	
College	6 (1.6)	4 (1.5)	2 (1.9)	
University	3 (0.8)	3 (1.1)	0	
Unknown	117 (31.0)	56 (20.8)	61 (56.5)	

6.3 Antenatal details

The median (IQR) parity was 2 (1-3). The median (IQR) gestational age at booking was 24 (20-29) and the median (IQR) gestational age at death was 32 (24-38). Two-thirds of deaths were in women who were directly admitted to the hospitals, whilst a third came in as a referral from the clinics. The median (IQR) number of antenatal clinic visits was 1 (0-3). A third of the women who died (33.7%) did not attend antenatal care. The antenatal characteristics of women are presented in Table 6.3.

Table 6.3 Summary of antenatal characteristics of women

Parity, median (IQR)	2 (1-3)
Gestation at booking (weeks), median (IQR)	24 (20-29)
Gestation at death (weeks), Median (IQR)	32 (24-38)
Place where referred from, no. (%) Within hospital Clinic	 240 (63.7) 137 (36.3)
No. of ANC visits, median (IQR)	1 (0-3)
HIV status, no. (%) Positive Negative Unknown	 90 (23.9) 141 (37.4) 146 (38.7)
Pre-existing medical condition Yes No Unknown	 29 (7.7) 264 (70.0) 84 (22.3)

Table 6.4 presents the antenatal characteristics, stratified by hospital. Statistically significant differences were identified between the two hospitals for parity, gestation age at death and the median number of antenatal visits. Three quarters of the women who died at SMCH were parity 0-3 compared to PCH where only half of those who died had a similar parity. The median gestational age at death was 33 weeks (IQR 26-38) at SMCH compared to 29 (IQR 20-37) at PCH. Women at PCH had significantly more antenatal visits compared to women at SMCH (3 (IQR 2-4) vs. 1 (IQR 0-1), $p<0.001$).

Table 6.4 Antenatal characteristics, stratified by hospital

Characteristic	Combined GHMU	Hospital		p-value
		SMCH	PCH	
Parity, no. (%)				<0.001
0	72 (19.1)	62 (23.1)	10 (9.3)	
1	97 (25.7)	67 (24.9)	30 (27.8)	
2	88 (23.3)	71 (26.4)	17 (15.7)	
3	65 (17.2)	40 (14.9)	25 (23.2)	
4+	35 (9.3)	23 (8.6)	12 (11.1)	
Unknown	20 (5.3)	6 (2.2)	14 (13.0)	
Gestation at booking (weeks), median (IQR)	24 (20-29)	24 (20-29)	24 (19-28.5)	0.73
Gestation at death (weeks), median (IQR)	32 (24-38)	33 (26-38)	29 (20-37)	<0.001
Place where referred from, no. (%)				0.005
Booked with hospital	240 (63.7)	183 (68.0)	57 (52.8)	
Booked with city clinics	137 (36.3)	86 (32.0)	51 (47.2)	
No. of ANC visits, median (IQR)	1 (0-3)	0 (0-2)	3 (2-4)	<0.001
HIV status, no. (%)				0.93
Positive	90 (23.9)	63 (23.4)	27 (25.0)	
Negative	141 (37.4)	102 (37.9)	39 (36.1)	
Unknown	146 (38.7)	104 (38.7)	42 (38.9)	
Pre-existing medical condition, no. (%)				0.48
Hypertension	14 (3.7)	9 (3.4)	5 (4.6)	
Diabetes	3 (0.8)	3 (1.1)	0	
Rheumatic heart disease	2 (0.5)	2 (0.7)	0	
Cardiac disease	2 (0.5)	0	2 (1.9)	
Asthma	3 (0.8)	2 (0.7)	1 (0.9)	
None	264 (70.0)	189 (70.3)	25 (23.1)	
Other	5 (1.3)	4 (1.5)	1 (0.9)	
	84 (22.3)	60 (22.3)	24 (22.2)	

6.4 Mode of delivery

About a third of the deceased women had normal vaginal deliveries whilst a quarter had caesarean deliveries (Table 6.5). A fifth were miscarriages or undelivered. There was no statistically significant difference between the two hospitals.

Table 6.5 Mode of delivery, stratified by hospital

Characteristic	GHMU (n=377)	Hospital		p-value
		SMCH (n=269)	PCH (n=108)	
Mode of delivery				0.473
Normal vaginal	137 (36.3)	102 (37.9)	35 (32.4)	
Assisted vaginal	4 (1.1)	3 (1.1)	1 (0.9)	
Caesarean	81 (21.5)	53 (19.7)	28 (25.9)	
Miscarriage	69 (18.3)	53 (19.7)	16 (14.8)	
Undelivered	74 (19.6)	51 (19.0)	23 (21.3)	
Unknown	12 (3.2)	7 (2.6)	5 (4.6)	

6.5 Timing of death

Most maternal deaths (71%) occurred in the post-partum period (Table 6.6). Over a third of post-partum deaths (37%) occurred within the first 24 hours after delivery (figure 6.3). There was no statistically significant difference between the two hospitals (Table 6.6).

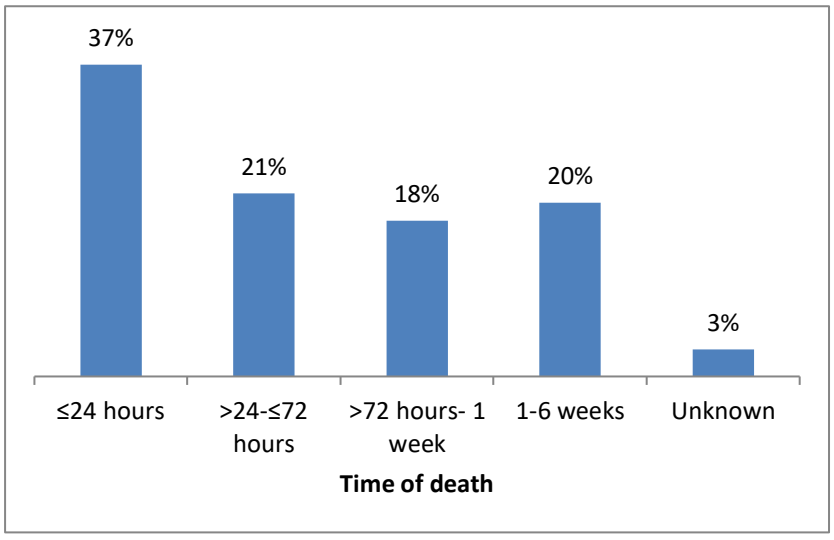

Figure 6.3 Time from admission to death (all deaths).

Table 6.6 Timing of death, stratified by hospital

Timing of death	GHMU, no. (%)	Hospital	
		SMCH	PCH
Antepartum	79 (21.0)	56 (20.8)	23 (21.3)
Intrapartum	9 (2.4)	9 (3.4)	0
Postpartum	266 (70.6)	181 (67.3)	85 (78.7)
Not stated	23 (6.1)	23 (8.6)	0

There was no significant difference in the length of hospital stay before death between the two hospitals (median (IQR) - SMCH 48 (10-152) vs PCH 40 (10-115) hours).

6.6 Birth outcomes

Only a third of the deceased women in the GHMU had a live birth, whilst 28% had a stillbirth (Table 6.7). About 18% were either undelivered or had a miscarriage. There was no statistically significant difference between the two hospitals.

Table 6.7 Perinatal outcome, stratified by hospital

Perinatal outcome	GHMU, no. (%)	Hospital	
		SMCH	PCH
Live birth	124 (32.9)	88 (32.7)	36 (33.3)
Stillbirth	106 (28.1)	78 (29.0)	28 (25.9)
Undelivered	69 (18.3)	46 (17.1)	23 (21.3)
Miscarriage	69 (18.3)	52 (19.3)	17 (15.7)
Unknown	9 (2.4)	5 (1.9)	4 (3.7)
Total	377	269	108

6.7 Maternal mortality ratio

6.7.1 MMR for GHMU

In calculating the MMR for the GHMU, maternal deaths occurring at GHMU council clinics, but not recorded under either SMCH or PCH, were included. The MMR over the study period is shown in tables below. Table 6.8 and Figure 6.4 show the GHMU

MMR per year over the study period. Live birth data was obtained from the City of Harare Department of Health annual health reports.[20-25] The GHMU deaths includes deaths at the two hospital and at associated clinics. The MMR was 137 (95% CI 107, 173) per 100 000 live births in 2013, declined in 2015, only to increase in 2016 and peaked at 168 (95% CI 133, 211) in 2017 before lowering to 103 (95% CI 77, 136) in 2018.

Table 6.8 Greater Harare Maternity Unit annual maternal mortality ratio, 2013-2018.

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Overall**
Live births, no.	51 194	49 661	49 105	49 636	45 163	48 354	293 113
Deaths, no.	70 (63+7)	65 (67+0)	50 (47+3)	71 (69+2)	76 (75+1)	50 (48+2)	394
MMR/100 000 live births (95% CI)	136.7 (107,173)	130.9 (101,167)	101.8 (76,134)	143 (112,180)	168.3 (133,211)	105.5 (103,108)	134.4 (133,136)

Considering the triennial trend, there was an increase in the MMR from 123 per 100 000 live births for the period 2013-2015 to 138 per 100 000 live births for the period 2016-2018 (Table 6.9).

Table 6.9 GHMU maternal mortality triennial trend (2013-15 vs 2016-18)

Year	**2013-2015**	**2016-2018**	**Overall**
Live births, no.	149 960	143 153	293 113
Deaths, no.	185	197	382
MMR/100 000 live births	123.4	137.6	130.3
(95% CI)	(106, 142)	(119, 158)	(118, 144)

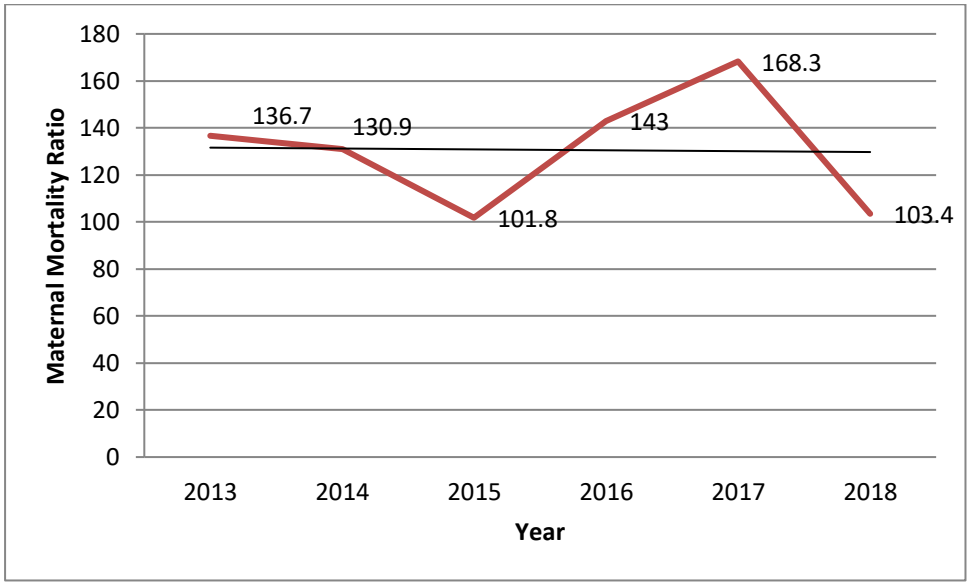

Fig 6.4 GHMU MMR and trend line, 2013-2018

6.7.2 Institutional MMR

The institutional maternal mortality ratio (iMMR) for the corresponding period, including all deaths that occurred within each hospital are shown in table 6.10 and figure 6.5.

Table 6.10 Institutional Maternal Mortality Ratio by year, SMCH and PCH, 2013-2018 (GHMU plus provincial referrals)

Year	SMCH				PCH			
	Live births	Deaths	iMMR/ 100 000	95% CI	Live births	Deaths	iMMR/ 100 000	95% CI
2013	13 505	74	547.9	430,687	9 517	40	420.3	300,572
2014	14 563	80	549.3	436,683	8 736	22	251.8	158,381
2015	11 728	67	571.3	443,725	9 800	37	377.6	266,520
2016	14 155	83	586.4	467,726	8 566	55	642.1	484,835
2017	13 907	87	625.6	501,771	6 388	52	814.0	609,1066
2018	16 762	55	328.1	247,427	5 744	28	487.5	324,704

The overall iMMR for the entire study period for SMCH was 527 (479, 578) per 100 000 (446 deaths, 84 620 live births) whilst that for PCH was 480 (421, 545) per 100 000 (234 deaths, 48 751 live births).

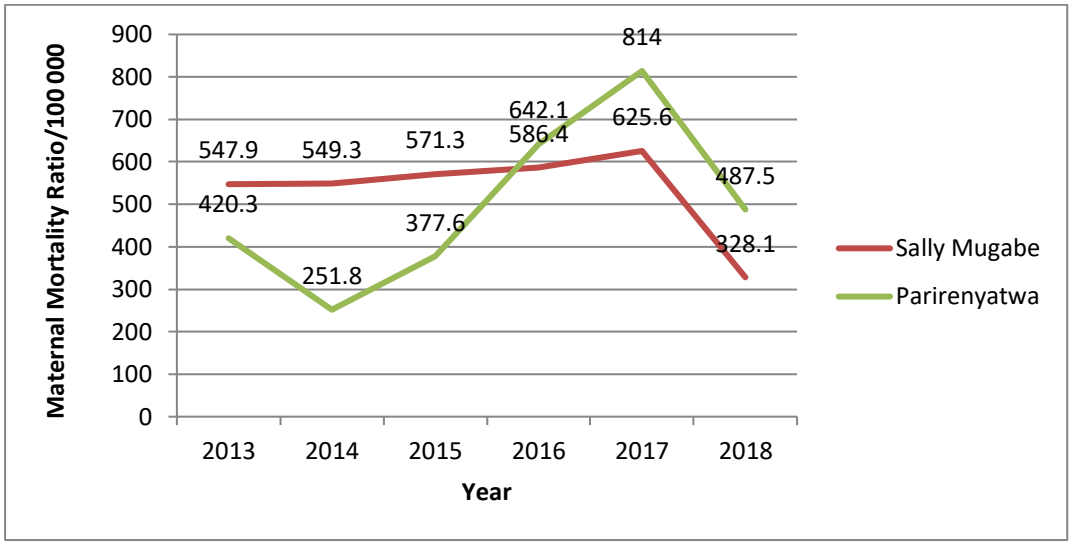

Figure 6.5 Institutional MMR at SMCH and PCH, 2013-2018

The SMCH iMMR increased slowly from 548 in 2013 to peak in 2017 at 626 before declining to 328 per 100 000 live births in 2018. The PCH iMMR initially declined from 420 in 2013 to 252 in 2014, then sharply increased to peak at 814 in 2017 before declining to 488 per 100 000 live births in 2018.

6.7.3 Institutional MMR only considering births originating in the GHMU

Table 6.11 presents the iMMR in each hospital only considering deaths originating in the GHMU over the study period.

Table 6.11 Institutional maternal mortality ratio for each hospital by year, 2013-18 (n=367)

Year	SMCH				PCH			
	Live births	Deaths	MMR/ 100 000	95% CI	Live births	Deaths	MMR/ 100 000	95% CI
2013	13 505	48	355.4	262, 471	9 517	15	157.6	88, 260
2014	14 563	53	363.9	273, 476	8 736	12	137.4	71, 240
2015	11 728	32	272.9	187,385	9 800	15	153.1	86, 252
2016	14 155	42	296.7	215, 401	8 566	27	315.2	208, 458
2017	13 907	52	373.9	279, 490	6 388	23	360.1	228, 540
2018	16 762	38	226.7	160, 311	5 744	10	174.1	84, 320

SMCH had a higher iMMR than PCH, except for the year 2016 when the reverse was true. In 2016, there was a policy change and the old referral zones were removed temporarily and were then re-introduced sometime in 2017.

Table 6.12 Institutional maternal mortality ratio for two trienniums

Year	SMCH				PCH			
	Live births	Deaths	MMR/100 000	95% CI	Live births	Deaths	MMR/100 000	95% CI
2013-2015	39 796	133	334.2	280, 396	28 053	42	149.7	108, 202
2016-2018	44 824	132	294.5	246, 349	20698	60	289.9	221, 373

Table 6.12 presents triennial data over the study period. SMCH had a decline in the MMR between the first triennial and the second triennial period, 334 per 100 000 live births to 295 per 100 000 live births. PCH, on the other hand, had an increase in the triennial MMR, from 150 per 100 000 live births to 290 per 100 000 live births.

6.7.4 Comparison with previous data

The MMR for the GHMU over the study period, compared to an earlier review of the MMR in a study done by Majoko et al. is shown in Table 6.13.[18] Notably, there was

a two- to three-fold increase in the MMR between the early period (1976-1987) and the study period (2013-2018). The number of births almost trebled between 1976 and 1983, peaked in 2013, and was steady for most of the current study period. The difference could also be explained by the fact that the case ascertainment criteria were not similar. This study used the WHO Classification of Maternal Deaths in Pregnancy, Childbirth (ICD-MM), whilst the earlier study did not do the same.

Table 6.13 Comparison of GHMU MMR from 1976 to 2018.

Year	Deaths	Births	MMR /100 000 live births
1976*	10	16 947	59
1983*	25	44 519	56
1987*	17	31 960	53
2013	73	51 194	137
2014	67	49 661	131
2015	54	49 105	102
2016	72	49 636	143
2017	77	45 163	168.3
2018	51	48 354	105.5

*Source: Majoko et al. Trends in maternal mortality for the GHMU, 1976-1987.[18]

6.8 Causes of death

6.8.1 Medical causes of death

Table 6.14 presents a summary of the causes of death over the study period for each hospital. Not all deaths were originally categorised using ICD 10 codes and therefore codes were occasionally assigned by the researcher and a team member from the ZMPMMS, after reviewing the case files.

The commonest cause of death for the GHMU over the entire study period was hypertensive disorders (21.0%), followed by obstetric haemorrhage (19.6%), then pregnancy with abortive outcomes (18.8%) and non-obstetric complications (18.6%) (Table 6.14).

Table 6.14 Clinical cause of death (ICD 10 code) as presented on the death certificate

ICD10 code	Total no. (%)	Hospital	
		SMCH	PCH
Pregnancy with abortive outcome	71 (18.8)	55 (20.5)	16 (14.8)
Hypertensive disorders in pregnancy, childbirth, and the puerperium	79 (21.0)	56 (20.8)	23 (21.3)
Obstetric haemorrhage	74 (19.6)	56 (20.8)	18 (16.7)
Pregnancy-related infection	36 (9.6)	21 (7.8)	15 (13.9)
Other obstetric complications	31 (8.2)	24 (8.9)	7 (6.5)
Unanticipated complication of management	2 (0.5)	0	2 (1.9)
Non-obstetric complications	70 (18.6)	51(19.0)	19 (17.6)
Unknown/undetermined	4 (1.1)	2 (0.7)	2 (1.9)
Coincidental causes	10 (2.7)	4 (1.5)	6 (5.6)
Total	377	269	108

6.8.2 Direct and indirect causes of maternal mortality for the GHMU, 2013-2018

Four-fifths of maternal deaths (79.8%) were due to direct causes and almost a fifth were due to indirect causes (Figure 6.6). One percent was unspecified.

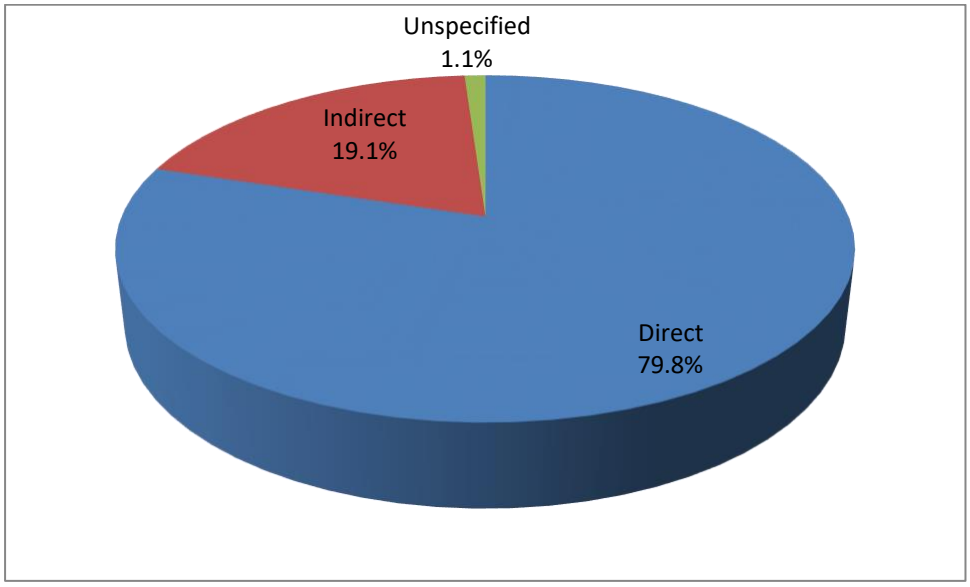

Figure 6.6 Distribution of causes of death in GHMU, 2013-2018.

Of the direct causes of deaths, hypertensive disorders of pregnancy, obstetric haemorrhage and pregnancies with abortive outcomes, each contributed about a quarter to the overall mortality (Figure 6.7).

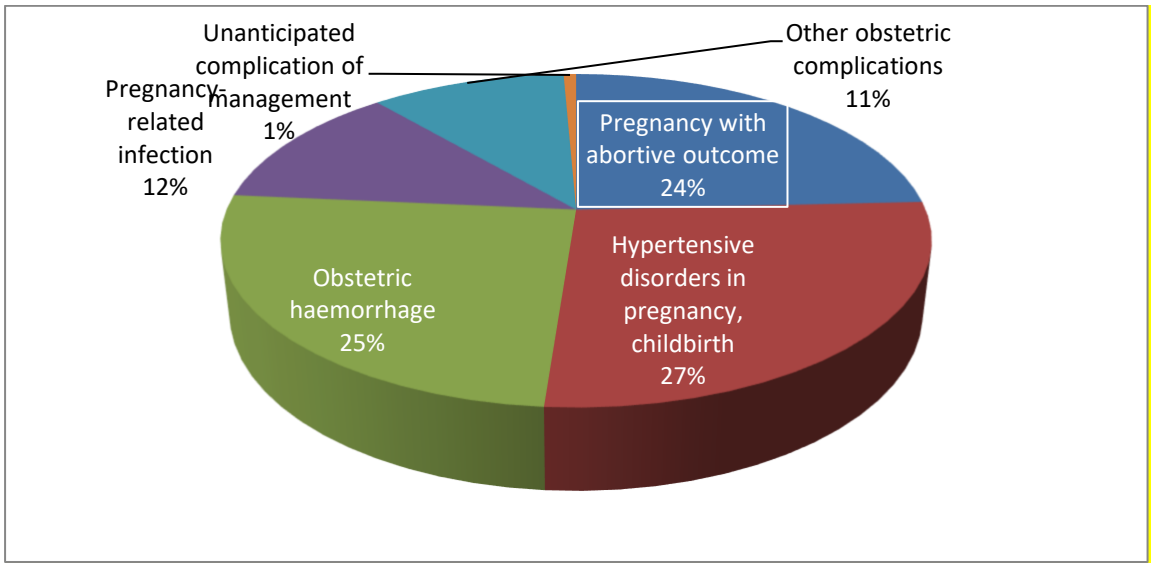

Fig 6.7 Direct causes of maternal mortality for GHMU, 2013-2018.

6.8.3 Comparison of annual cause-specific mortality

When deaths in the years 1976, 1983 and 1987 were compared to those in the study period, an increase in maternal deaths due to non-obstetric complications, as well as deaths due to obstetric haemorrhage was evident. The increase in non-obstetric complications is very likely due to HIV. Pregnancy related infections were on a decline until an increase occurred in 2018 (Table 6.15).

Table 6.15 Causes of maternal deaths in 1976, 1983 and 1987, and over the study period, no. (%), (only using 'old' classification).

	1976*	1983*	1987*	2013	2014	2015	2016	2017	2018
Pregnancy with abortive outcome	19 (34)	9 (18)	8 (21)	12 (19)	11 (16)	11 (22)	13 (19)	13 (17)	11 (22)
Hypertensive disorders in pregnancy, childbirth, and the puerperium	3 (5)	8 (16)	11 (28)	12 (19)	12 (18	8 (16)	19 (27)	13 (17)	11 (22)
Obstetric haemorrhage	0 (0)	11 (21)	7 (18)	15 (23)	11 (16)	6 (12)	16 (23)	14 (18)	12 (24)
Pregnancy-related infection	19 (34)	12 (24)	7 (18)	3 (5)	10 (15)	8 (16)	6 (9)	3 (4)	6 (12)
Other obstetric complications #									
Unanticipated complications of management #									
Non-obstetric complications	4 (7)	3 (6)	4 (10)	16 (25)	14 (21)	9 (18)	7 (10)	15 (20	9 (18)
Unknown/undetermined	1 (1)	7 (14)	2 (5)	0	2 (3)	0	1 (1)	1 (1)	1 (2)
Coincidental causes #									

#Code not assigned in the earlier reviews (prior to ICD 10).
* Source: Majoko et al. Trends in maternal mortality for the GHMU: 1976-1997.(18)

6.8.4 Cause-specific mortality by hospital

Figure 6.8 presents the causes of maternal death at each hospital over the study period. At SMCH, hypertensive disorders in pregnancy, childbirth, and the puerperium and obstetric haemorrhage contributed 20.8% each to the mortality burden whilst pregnancy with abortive outcomes contributed a close 20.5% and non-obstetric complications resulted in 19% of deaths.

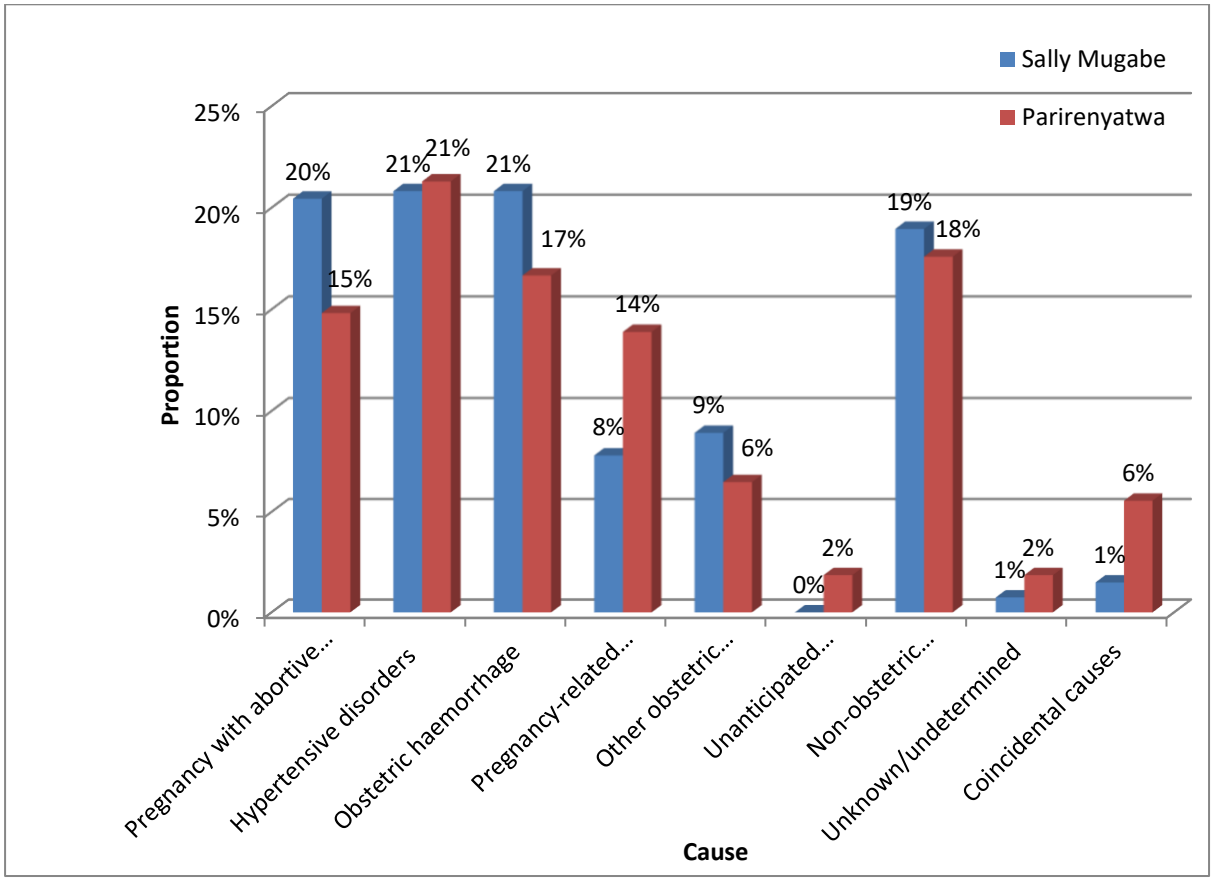

Figure 6.8 Causes of maternal mortality, stratified by hospital, 2013-2018.

At PCH, hypertensive disorders in pregnancy, childbirth and the puerperium contributed 21.3%, non-obstetric complications made up 17.6%, whilst obstetric haemorrhage contributed 16.7% and pregnancy with abortive outcomes was associated with 14.8% of deaths.

Table 6.16 presents the causes of maternal mortality during each triennium for each hospital. For SMCH, there was an increase in pregnancies with abortive outcomes as well as in hypertensive disorders in pregnancy, with a decline noted in non-obstetric complications of pregnancy. For PCH, there was a decrease in pregnancies with abortive outcomes as well as in hypertensive disorders in pregnancies, with a sharp increase in deaths due to obstetric haemorrhage.

Table 6.16 Causes of maternal mortality over two triennia, Sally Mugabe Central Hospital

ICD10 group	SMCH		
	2013-2015	2016-2018	Total
	no. (%)	no. (%)	no. (%)
Pregnancy with abortive outcome	25 (18.4)	30 (22.6)	55 (20.5)
Hypertensive disorders in pregnancy, childbirth, and the puerperium	21 (15.4)	35 (26.3)	56 (20.8)
Obstetric haemorrhage	28 (20.6)	28 (21.1)	56 (20.8)
Pregnancy-related infection	13 (9.6)	8 (6.0)	21 (7.8)
Other obstetric complications	13 (9.6)	11 (8.3)	24 (8.9)
Unanticipated complications	0	0	0
Of management			
Non-obstetric complications	31 (22.8)	20 (15.0)	51 (19.0)
Unknown/undetermined	2 (1.5)	0	2 (0.7)
Coincidental causes	3 (2.2)	1 (0.8)	4 (1.5)
Total	136	133	269

Table 6.17 Causes of maternal mortality over two triennia, Parirenyatwa Central Hospital

ICD10 group	PCH		Total
	2013-2015	2016-2018	
	no. (%)	no. (%)	no. (%)
Pregnancy with abortive outcome	9 (19.6)	7 (11.3)	16 (14.8)
Hypertensive disorders in pregnancy, childbirth, and the puerperium	11 (23.9)	12 (19.4)	23 (21.3)
Obstetric haemorrhage	4 (8.7)	14 (22.6)	18 (16.7)
Pregnancy-related infection	8 (17.4)	7 (11.3)	15 (13.9)
Other obstetric complications	1 (2.2)	6 (9.7)	7 (6.5)
Unanticipated complications of management	1 (2.2)	1 (1.6)	2 (1.9)
Non-obstetric complications	8 (17.4)	11 (17.7)	19 (17.6)
Unknown/undetermined	0	2 (3.2)	2 (1.9)
Coincidental causes	4 (8.7)	2 (3.2)	6 (5.6)
Total	46	62	108

6.8.5 Cause specific mortality related to time from admission

Table 6.18 examines cause of maternal deaths related to time from admission. In the first 24 hours, the commonest cause of death was obstetric haemorrhage (29.7%), followed by pregnancies with abortive outcomes (22.5%) and then hypertensive disorders of pregnancy (21.7%). Between 24 hours and 72 hours post-admission non-obstetric complications of pregnancy (23.5%) tied with haemorrhage (23.5%) as the most common cause followed by hypertensive disorders (18.5%).

Table 6.18. Causes of maternal death based on time of death from admission, 2013-2018, no. (%).

Time of death from admission	Pregnancy with abortive outcome	Hypertensive disorders	Obstetric haemorrhage	Pregnancy-related infection	Other obstetric complications	Unanticipated complication of management	Non-obstetric complications	Unknown/ undetermined	Coincidental Causes	Total
≤24 hours	31 (22.5)	30 (21.7)	41 (29.7)	7 (5)	11 (7.8)	1 (0.7)	12 (8.7)	2 (1.4)	3 (2.2)	138
>24 - ≤72 hours	13 (16)	15 (18.5)	19 (23.5)	7 (8.6)	5 (6.1)	1 (1.2)	19 (23.5%	0	2 (2.5)	81
>72 hours - 1 week	13 (18.8)	19 (27.5)	8 (11.6)	4 (5.8)	4 (5.8)	0	17 (24.6)	1 (1.4)	3 (4.3)	69
1-6 weeks	13 (16.9)	12 (15.6)	5 (6.5)	17 (22.1)	8 (10.4)	0	19 (24.7)	1 (1.3)	2 (2.6)	77
Unknown	1 (8.3)	3 (25)	1 (8.3)	1 (8.3)	3 (25)	0	3 (25)	0	0	12

Table 16.18 examines each cause of death as a proportion over a six-week period. For pregnancies with abortive outcomes, 43.7% of deaths occurred within the first 24 hours, whilst 38.0% of women with hypertensive disorders died in the first 24 hours. More than half of women with obstetric haemorrhage demised in the first 24 hours. Pregnancy related infections, however, had their greatest mortality between week one and week six of the puerperium.

6.9 Post-mortem findings

Information was obtained for 320 post-mortems (84.8% of the GHMU sample). The vast majority (260/320, 81.3%) were conducted at SMCH. At PCH, post-mortems were performed in just over half of maternal deaths (52%). However, data could only be obtained for 12 post-mortems on women who died at PCH (for reasons related to access). Because of this deficiency, it was decided to only focus on deaths at SMCH henceforth.

Table 6.19 Number of post-mortems performed

Post-mortem done	**SMCH**	**PCH**	**Total**
Yes	260	60	320
No	9	39	48
Unknown	0	9	9
Total	269	108	377

Table 6.20 compares the cause of death attributed clinically with that established at post-mortem. In about three-quarter of instances, the clinical diagnosis matched the post-mortem diagnosis (207/269, 76.9%).

Table 6.20. Comparison of clinical cause of death with post mortem cause of death

	SMCH No. (%)	PCH No. (%)	Total
Identical	207 (77%)	8 (7.4%)	215
Similar but major add	32 (11.9%)	3 (2.8%)	35
Similar but minor add	17 (6.3%)	1 (0.9%)	18
Discordant	3 (1.1%)	0 (0%)	3
Unknown	1 (0.4%)	96 (88.9%)	97
Not done	9 (3.3%)	0(0%)	9
Total	269 (100%)	108 (100%)	377

While proportional difference was similar for most conditions, they were highest for pregnancy-related infections and other obstetric conditions (a third each). The following tables (Tables 6.21, Table 6.22 and Table 6.23) give examples of the differences or additional findings noted clinically and at autopsy.

Table 6.21 Examples of similar diagnosis but major additional findings at autopsy

Clinical diagnosis	**Autopsy diagnosis**
Eclampsia	Septic shock, congestive cardiac failure, eclampsia
Pericarditis	Empyema right pleural cavity, eclampsia
Obstructed labour	Hypovolaemic shock due to peritonitis, necrotic uterus due to obstructed labour
Bronchopneumonia	Bronchopneumonia, septic products of conception, retroviral infection
Incomplete miscarriage	Anaemia and septicaemia, incomplete miscarriage consistent with pelvic injury from a foreign body
Septic shock secondary to retained products of conception	Septic shock secondary to perforated viscus
Anaemia	Anaemia, pulmonary oedema, retained products of conception

Table 6.22 Examples of similar diagnosis but minor additional findings at autopsy

Clinical diagnosis	**Autopsy diagnosis**
Post-partum haemorrhage	Hypovolaemic shock, haemoperitoneum post caesarean section
Puerperal sepsis	Septic shock, septic retained products of conception
Right upper lobe pneumonia	Right upper lobe pneumonia, pulmonary oedema
Malaria	Anemia, DIC, malaria in pregnancy

Table 6.23 Examples of discordant diagnosis between clinical and autopsy diagnosis

Clinical diagnosis	Autopsy diagnosis
Septic episiotomy	Left pleural effusion, cardiac tamponade secondary to pericardial effusion
Severe eclampsia	Hypovolaemic shock, ruptured uterus
Cryptococcal meningitis	Septic shock secondary to septic abortion

7. DISCUSSION

7.1 Main findings

This study describes maternal mortality for a defined geographic district using retrospective data from all women delivering within its health facilities. The primary study findings are the following:

a) The MMR in the GHMU increased between the first and the second triennium
b) The MMR in the GHMU, and the iMMR at both SMCH and PCH, are high and not dissimilar to those in other low-resourced settings.
c) Similar to the situation in many neighbouring southern African settings, the MMR in the GHRU deteriorated (by 2013) from the better ratios seen in the 1970s and 80s.
d) The primary causes of maternal mortality are similar to those in other low-income countries.
e) There were differences in the two central hospitals in their overall iMMR, as well underlying demographic associations and medical causes of death.
f) Autopsy-based cause of death determination did not differ much from the clinically assigned cause of death. They, however, help in filling out the finer details.

Each of these key findings are further explored below.

7.2 GHMU Maternal mortality ratio

There were two types of MMRs that were examined in this study - the MMR for the GHMU and the iMMR for each central hospital. The GHMU MMR varied over the study period. The overall MMR over the study period was 130 per 100 000 live births, almost double the SDG target of less than 70 per 100 000 live births by 2030. It was 137 in 2013, peaked at 168 in 2017 and declined to 103 in 2018. A slight decline in the MMR trend line was observed over the study period. Comparing two triennia, there was an increase in the MMR over the later period. The first triennium (2013-15), had an MMR of 123 compared to 138 per 100 000 live births over the second triennium (2016-2018).

By 2015, the end of the Millennium Development Goal era, the global MMR dropped by 44% - from 385 in 1990 to 216 MMR at 2015 - with most high-income countries having MMRs below 7 per 100 000 live births.[27]

According to the Multiple Indicator Cluster Survey of 2019, Zimbabwe had a MMR of 462 deaths per 100 000 live births in that year.[28] This was an improvement from the MMR of 614 per 100 000 live births recorded in 2014. Some 462 clusters and 12 012 households were chosen nationwide. Maternal mortality was estimated using the direct sisterhood method. This method depends on correct information on the number of sisters the interviewee had, on how many had died, and how many had died during pregnancy, childbirth, or within 2 months post pregnancy or childbirth.

A registry-based study of risk factors and trends in mortality from 2010 to 2018 at research sites in six low- and lower middle-income countries (in three continents) observed a MMR of 157 per 100 000 births across all study sites, with a range of

MMRs from 97 in Guatemala to 327 in Pakistan.[29] Variable changes were observed over time in the MMR. Of greatest interest, the Zambian site (outside Lusaka) observed an overall MMR of 107, varying in the three-year running averages from 141 (91, 192) in the earliest interval to 72 (36, 108) in the latest.

A study of the Greater Soweto area in South Africa over the period 1997 to 2012, estimated an overall MMR of 105 per 100 000 livebirths.[30] That study had a similar methodology to this study, and offers some insight about a geographically based MMR in a southern African setting.

Examining the MMR for the GHMU since 1976, sometime between 1987 and 2013 the MMR increased so that in 2013 it was over two and a half times higher than the ratio in 1987. The absence of analysed data prevents any description of when and how steep the increase was over the period. However, based on evidence from other settings in the southern African region, it is highly likely that the worsening MMR was related to the HIV epidemic and its devastating effects.[30, 31] It is also likely that the MMR peak in the GHMU was much higher than that reported in 2013 (by as much as two-fold),[30, 31] and that the availability of antiretroviral therapy was responsible for any turnaround.[30, 31]

It is well known that Zimbabwe has experienced serious economic hardships and decline over the past two decades.[32] This has negatively impacted on the quality of health care offered, including that available to women.[32] The MMR peak in 2017 in the GHMU could be explained by the fact that in that year there was a severe economic deterioration in the country. Central hospital budgets were significantly reduced. In some instances patients were given prescriptions to requested to source their own

drugs and sundry. The progressive economic deterioration resulted in a change in government towards the end of that year.

7.3 Institutional MMR

The hospital-specific iMMRs reported at the two study urban central teaching hospitals is lower than that reported in studies from other less resourced settings.[33, 34] The overall iMMR for SMCH was 527 per 100 000 compared to 480 per 100 000 for PCH. This overall iMMR refers to deaths within the GHMU as well as deaths of women referred in from the provinces.

For comparison, the iMMR at a university teaching hospital in Nigeria, dropped from 1 709 in 2003 to 1 115 in 2012.[34] An investigation of maternal mortality at a tertiary hospital in the Limpopo province of South Africa, suggested an iMMR of 1579 per 100 000 live births.[33] Lady Reading Hospital in Peshawar, Pakistan, had a lower iMMR (431 per 100 000 live births) over a five year study period (2013-2017).[35]

The second iMMR examined was the iMMR for patients referred from the GHMU and who died within these two institutions. The iMMR for SMCH was 334 (280, 396) in the first triennium and declined to 295 per 100 000 live births in the second triennium. This compared to an increase from 150 to 290 per 100 000 live births in the second triennium for PCH. This could be due to the different socio-economic environments from which SMCH and PCH pool their patients. It is noteworthy that in 2016, when the referral zones were temporarily abolished, the iMMR at PCH overtook that of SMCH.

7.4 Cause of death

The distribution of the cause of death over the study period showed an increase in deaths due to obstetric haemorrhage and non-obstetric complications of pregnancy. This was also noted at hospitals in Limpopo, South Africa,[33] Peshawar, Pakistan (where haemorrhage continued to be a leading cause of death),[35] and in Ebonyi State, Nigeria.[36] Preventing death from haemorrhage is dependent on caregiver emergency obstetric care skills,[37] as well as the availability of blood.

Emergency obstetric care training was conducted at the study site over the previous few years, including the study period, but a persistent challenge has been the (un)availability of blood and blood products. Non-obstetric complications declined from 22.8% in the first triennium to 15% in the second triennium for SMCH. However, there was no change at PCH.

7.5 Age

There was no difference in the age distribution of deaths comparing the 1987 and current review period. For example, the 20-29 age group comprised 44% of all mortality in 1987 and 45% in the current study. These findings are similar to findings elsewhere. Rafiq et al. in Pakistan, found that the highest number of deaths to be in the 20-29 year age group[35] as did Ezegwui et al. in Nigeria.[36] This is not unexpected since pregnant populations are younger in less resourced settings and more vulnerable to any adverse social determinant of health. In contrast, in the Limpopo province of South Africa, the highest mortality occurred in the 30 years and older age group.[33]

7.6 Religion.

There was a significant difference in the religious affiliation of deceased women between SCMH and PCH. SMCH had more women that were apostolic church members. The affiliation of women attending the two hospitals was not known, so it is possible that simply reflects more apostolic women attending SMCH. Some apostolic church sect members have been known to shy away from formal medical care, only presenting when the situation is dire. Obiechina and co-authors identified cultural and religious beliefs as contributors to the high MMR in a Nigerian setting.[34]

7.7 Education

Most women who died had at least a secondary school education. Education is a modifier in health seeking behaviour. Illiteracy has been cited as a big factor in maternal mortality.[38] Ezegwui et al. found that in the Ebonyi state in Nigeria, most maternal deaths occurred in women with no formal education.[36] The situation in Zimbabwe is different as its literacy rates are quite high, hence the finding that a disproportionately large number of literate women died.

7.8 Antenatal care

Most maternal deaths are avoidable. The cornerstone of prevention is antenatal care. A third of women who died in this study had not received antenatal care. Ezagwui et al. reported that 82% of their maternal deaths in a Nigerian state were in unbooked mothers. The problem with lack of antenatal care is that it is usually those who need it most who do not avail themselves of the service. As was observed by Onah et al., many fail to receive the antenatal care they need and instead turn up as emergencies with difficult labours and complications that could have been avoided.[39]

In the current study, the median number of antenatal visits for the GHMU was a low single visit. Women dying at PCH attended significantly more antenatal visits than those at SMCH. This could partly be because PCH has a more affluent catchment area than SMCH.

7.9 Direct and indirect causes of maternal mortality

About three-quarter of the maternal deaths were the result of direct causes. The top three causes of maternal death were all direct - hypertensive disorders, obstetric haemorrhage and pregnancies with abortive outcomes. An indirect cause, non-obstetric complications, was fourth. Fifth was non-pregnancy-related infections, mostly associated with HIV infection. HIV contribution to maternal mortality is less than reported by Buchmann et al. in Soweto, South Africa because Zimbabwe reached its peak HIV prevalence before South Africa.[30]

Many direct causes of maternal death are preventable through regular antenatal attendance. About a third of the deaths occurred in women who had not attended antenatal clinics, a much lower proportion than reported by other African studies of maternal mortality.[34, 36, 40] However, as noted previously, the attendance frequency was low.

Hypertensive disorders, as the leading cause of mortality, is a reflection of the lack of antenatal care. Obstetric haemorrhage continues to be one of the leading causes of maternal mortality in most resource-poor settings reflecting inadequate blood transfusion services or mothers presenting too late for effective intervention.[33, 35, 36]

7.10 Timing of death

Most deaths occurred in the postpartum period, although in many cases the circumstances that resulted in the maternal death began in the antenatal and intrapartum period. Similar findings were made in a South African (43% in first 24 hours).[33] and Nigerian (76% in first 48 hours) setting.[34] Hence, the first 24-48 hours are critical in terms of a window of opportunity to reduce maternal mortality.

The commonest causes of death in the first 24 hours were obstetric haemorrhage, followed by pregnancies with abortive outcomes and then hypertensive disorders of pregnancy. Between 24 hours and 72 hours non-obstetric complications of pregnancy tied with haemorrhage as the most common cause. The main obstacles that need to be overcome to address these are human resources for health, availability of maternity intensive care and an adequate supply of drugs and blood products.

7.11 Birth outcomes

Only a third of the women had a live birth, whilst a quarter had a stillbirth and 18% were either undelivered or experienced a miscarriage. Poor perinatal birth outcomes for deceased women are common. Bauserman et al's. six-site study reported that just over half of their deceased women had live births, 21% were stillbirths, and less than 1% were miscarriages or medical termination of pregnancies. A quarter had unknown birth outcomes.[29]

7.12 Post-mortem findings

Zimbabwean government policy is that all maternal deaths must have a post-mortem. This explains the high proportion of deaths that had autopsies performed. In sharp

contrast, in a South African tertiary care setting only 2% of deaths had a post-mortem conducted.[30] There was, nevertheless, a difference in compliance with the directive at the two central hospitals.

Availability of post-mortem records also differed. At PCH, autopsy records were not filed in the patient's record nor was an electronic record available. The post-mortem reports were kept at the police post at PCH for a while and were then archived elsewhere, but access to these was not possible to the study team.

An analysis of deaths at SMCH showed a difference between the clinical cause of death and the post-mortem diagnosis in about a quarter of instances. There is no similar data available from other low-income settings. However, in 2008, a study evaluating the discrepancies between clinical and autopsy findings identified major differences in 17.2% of instances. Differences were less marked in university hospital settings as well as in patients who had a prolonged hospital stay.[41]

7.13 Study strengths

The study has several strengths. First, was the availability of all clinical files sought. This testifies to a good record storage system. This significantly improved the validity and reliability of the analysis. Secondly, a standardised classification for causes of death was employed reducing the chance of misclassification of maternal deaths. A final advantage was the widespread conduct of post-mortems allowing the establishment of a definitive cause of death.

7.14 Study limitations

An obvious limitation is the retrospective study design with dependence on patient records containing information collected for routine clinical use. This potentially meant

that some required information was absent or not collected as rigorously as information collected for research. However, the data required for this study required 'high level' data, such as clinical diagnosis, rather than the specifics of diagnosis or treatment.

A second limitation lies in that though the cases were discussed at mortality meetings, there were no published reports on the investigations of each case for avoidable or modifiable factors. This in turn limits the recommendations that can be made.

A third limitation is the inability to estimate the GHMU MMR because of the absence of data on home deaths and those in private facilities. It is possible that late postnatal home deaths were missed, as well as postpartum hospital deaths in non-obstetric wards of the hospitals if previous pregnancy status was not recognised.

A final limitation was the unavailability of PCH autopsy data, preventing a comprehensive review of the post-mortem data. Nevertheless, the data from SMCH allowed for a reasonable and thorough comparison with clinical data.

7.15 Recommendations

There are many monologues and reports describing different interventions that warrant attention if the SDG target 3.1 related to the MMR is to be met. A few key interventions in the context of the study findings are highlighted below.

7.15.1 General recommendations

- In a time of limited resources in most low- and middle-income settings, funding agencies and foreign donors have a critical part to play in improving the healthcare system. Zimbabwe has been a particular victim of global disinvestment. Prioritising

health spending and funding is more vital now than before. Spending on retaining critical human resources within clinical settings is a key budget item.

- Empowerment of women through education as well as socio-economic empowerment in any nation is important in achieving global health priorities. Socio-economic factors, religious beliefs, gender norms are some of the social determinants of health that have an impact on maternal mortality,[27] and that require deliberate action in the study setting.
- Public health education can assist expectant women to get appropriate and immediate evidence-based pregnancy care. This can be done through radio and television programmes that encourage antenatal care attendance.
- Community-based mortality studies supported by good clinical information must be implemented and be ongoing in southern Africa to better track the successes in reducing maternal mortality.

7.15.2 Specific recommendations

- Discussions with religious sects need to be held on the importance of them promoting maternity services and supporting antenatal attendance.
- Out-of-pocket expenses are a deterrent in achieving health equality and support should be given to those who need it. Extra efforts have to be made to ensure that all expectant mothers attend antenatal care.
- The obstetric units in the GHMU should be self-sufficient. They should run their own laboratory services independent of the main hospital laboratory services. They should have their own blood banks and their own obstetric ICU staffed with their own intensive care specialists.

- A tightening of post mortem record keeping is important. Computerisation will help in this regard. Once the post mortem is done, a copy of the report should also be placed in the deceased's file. This recommendation is most relevant to PCH.
- Clinicopathology meetings should be held, particularly to discuss cases with a differing clinical and post-mortem diagnosis. This will result in better quality of patient care.
- The triennial comparison shows a slight decline in the SMCH MMR whilst a noticeable increase is noted in the PCH MMR. If the SDGs are to be met, a more concerted effort needs to be applied to achieve the targets. All members of the health system need to meet regularly and have an across the board meeting and identify gaps and put measures into place to improve the MMRs. This includes sectors outside health such as transport, housing, water and sanitation and social services.

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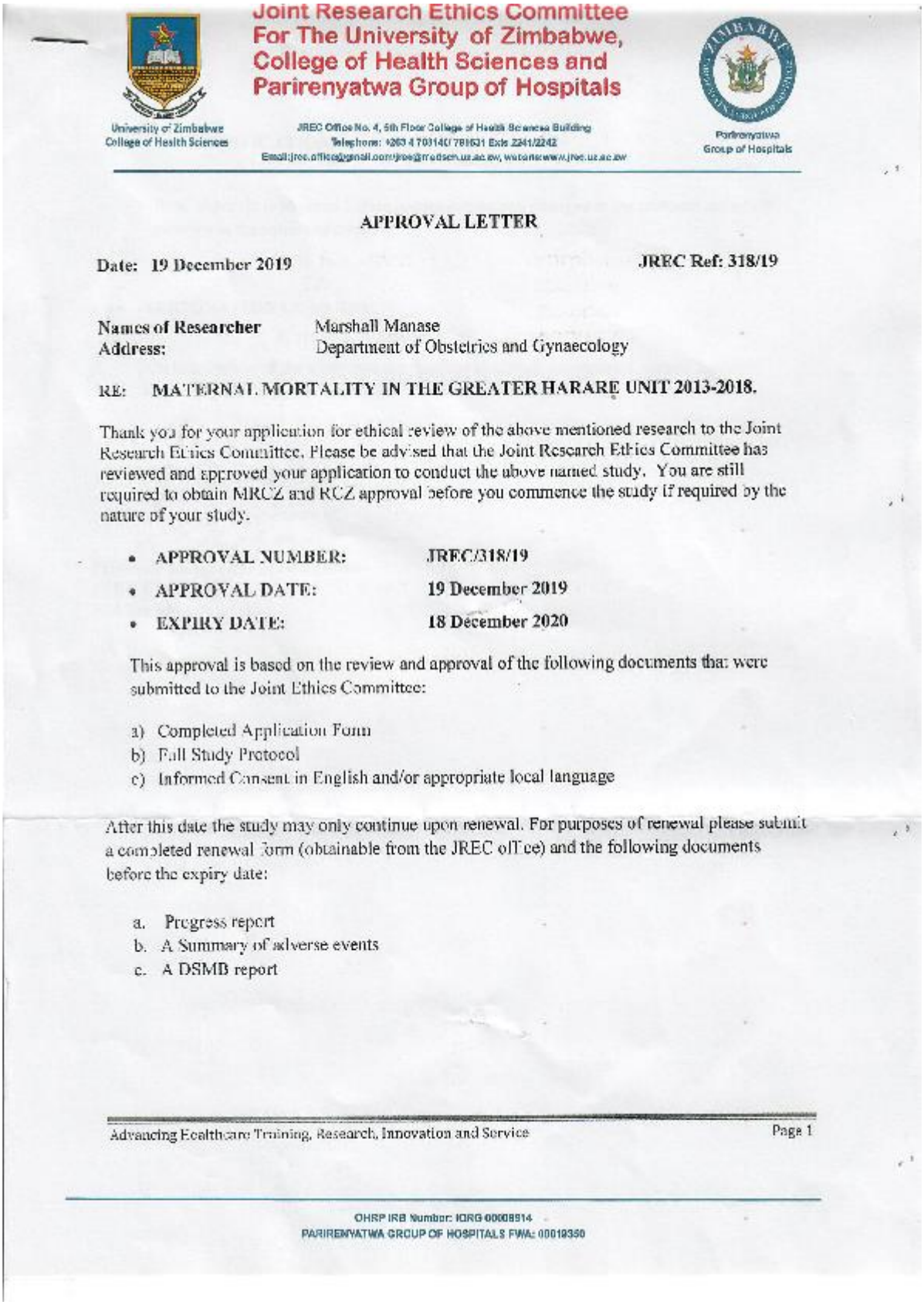
Appendix A

Data collection tool

1.	Study no.	
2.	Mortality record no.	
3.	Date of admission	/ /201_
4.	Time of admission	__h __
5.	Date of death	/ /201_
6.	Time of death	_____ h _____
7.	Length of admission (hours)	
8.	Age (years)	
9.	Marital status	1=married 2=single, 3=co-habiting, 4=divorced, 5=widowed 99=unknown
10.	Religion	1=Catholic/Anglican/Methodist 2=Pentecostal, 3=Apostolic faith, 4=Muslim, 99=unknown
11.	Highest level of education	1=none, 2=primary 3=secondary, 4=college, 5=university, 99=unknown
12.	Parity (no.)	
13.	Gravida (no.)	
14.	Booking status	1=booked, 2=unbooked, 99=unknown
15.	Gestation at booking (weeks)	
16.	Gestation at death (weeks)	
17.	Place where referred from	1=council clinic, 2=district hospital, 3=provincial hospital, 4=rural hospital, 5=private hospital, 6=self-referral, 9=other (specify) _____, 99=unknown
18.	No. of ANC visits	
19	HIV status	1=positive, 2=negative, 99=unknown
20.	Pre-existing medical condition	1=hypertension, 2=diabetes, 3=rheumatic heart disease, 4=cardiac disease, 5=asthma, 6=none, 9=other (specify) _____
21.	Mode of delivery	1=normal vaginal, 2=assisted vaginal, 3=caesarean section,4=miscarriage,5=undelivered, 99=unknown,
22.	Timing of death	1=antepartum, 2=intrapartum, 3=postpartum
23.	If death postpartum, interval between delivery and maternal death(hrs. mins)	_____ h _____ m
24.	Fetal outcome	1=live birth, 2=stillbirth, 3=undelivered, 4= miscarriage , 99=unknown
25	Clinical cause of death (directly as written on death certificate)	
26.	Clinical cause of death (ICD 10 code)	
27.	Was death avoidable?	1=yes, 2= no, 3=undetermined
28.	Post-mortem done	1=yes 2= no 99=unknown,

29.	Post-mortem cause of death (as stated)	
30.	Post-mortem cause of death (ICD 10 code)	
31.	Post-mortem cause of death relationship with clinical cause of death	1= Identical 2 = Similar but major additional finding(s) 3 = Similar but minor (but important) additional finding(s) 4 = Discordant (different cause attributed)

Appendix B



Joint Research Ethics Committee
For The University of Zimbabwe,
College of Health Sciences and
Parirenyatwa Group of Hospitals

University of Zimbabwe
College of Health Sciences

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Parirenyatwa
Group of Hospitals

APPROVAL LETTER

Date: 19 December 2019 **JREC Ref: 318/19**

Names of Researcher Marshall Manase
Address: Department of Obstetrics and Gynaecology

RE: **MATERNAL MORTALITY IN THE GREATER HARARE UNIT 2013-2018.**

Thank you for your application for ethical review of the above mentioned research to the Joint Research Ethics Committee. Please be advised that the Joint Research Ethics Committee has reviewed and approved your application to conduct the above named study. You are still required to obtain MRCZ and RCZ approval before you commence the study if required by the nature of your study.

- **APPROVAL NUMBER:** **JREC/318/19**
- **APPROVAL DATE:** **19 December 2019**
- **EXPIRY DATE:** **18 December 2020**

This approval is based on the review and approval of the following documents that were submitted to the Joint Ethics Committee:

a) Completed Application Form
b) Full Study Protocol
c) Informed Consent in English and/or appropriate local language

After this date the study may only continue upon renewal. For purposes of renewal please submit a completed renewal form (obtainable from the JREC office) and the following documents before the expiry date:

a. Progress report
b. A Summary of adverse events
c. A DSMB report

Advancing Healthcare Training, Research, Innovation and Service Page 1

OHRP IRB Number: IORG 0000914
PARIRENYATWA GROUP OF HOSPITALS FWA: 00019350

- **MODIFICATIONS:**

  Prior approval is required before implementing any changes in the protocol including changes in the informed consent.

- **TERMINATION OF STUDY:**

  On termination of the study you are required to submit a completed request for termination form and a summary of the research findings/ results.

Yours sincerely,

Professor Rangarirai Masanganise
JREC Chairman
RM/llm/uh

Appendix C

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Dr M Manase
School of Public Health
Medical School
University

E-mail: 1464580@students.wits.ac.za

CC: Supervisor: Professor H Saloojee <Harcon.Saloojee@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2020/03/26

REF: *R14/49*

PROTOCOL NO: **M200154** (This is your ethics application study reference number Please quote this reference number in all correspondence relating to this study)

PROJECT TITLE: *Maternal mortality in the Greater Harare maternity unit, Zimbabwe (2013-18)*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University

MSWorks2000\Iain\0007\Clearscan.wps

Appendix D

Telephone: 621100-19
Fax: 621157

ZIMBABWE

Reference: HCHEC 231019/61

HARARE CENTRAL HOSPITAL
P. O. Box ST 14
SOUTHERTON
Harare

31 October 2019

Dr. M.T. Manase
60 Baines Medical Chambers
HARARE

Dear Dr. Manase,

REF: MATERNAL MORTALITY IN THE GREATER HARARE MATERNITY UNIT, ZIMBABWE (2013-18)

I am glad to advise you that your application to conduct a study entitled: **Maternal Mortality in the Greater Harare Maternity Unit, Zimbabwe (2013-18) (Ref: HCHEC 231019/61),** has been Approved by the Harare Hospital Ethics Committee.

This approval is premised on the submitted protocol. Should you decide to vary your protocol in any material way please submit these for further approval.

You are advised to avail the results of your study whether positive or negative to the hospital through the committee for our information.

Yours sincerely,

HARARE CENTRAL HOSPITAL
DEPARTMENT OF MEDICINE
31 OCT 2019
P.O. BOX ST14 SOUTHERTON
HARARE, ZIMBABWE

DR. C. Pasi
Chairman Harare Central Hospital Ethics Committee