Maternal Mortality Review, an Open Window on the Experience of Safe Motherhood in Low-Resource Countries

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ABSTRACT

Maternal mortality (MM) is unacceptably high in many parts of the world, including Sudan, despite the effort to reduce it. This paper will review MM in Elgadarif State in Sudan and how to improve obstetric care quality. This is a hospital- and community-based prospective research study of MM by counting every MD (MD) in the state that has occurred in Elgadaref State, Sudan, during the study period. The state and central offices are notified of the data collected with respect to MD. An expert reviews every MD in a hospital. The investigator looks into every MD in the community. There were 72 MDs; 68 cases were avoidable, while four were unavoidable. The MMR was 176/100000/ live births. Significant factors associated with MM are gestational age, the direct cause of death, existing medical problems and co-morbidities, shortage of antenatal care services, lack of delivery services, and preterm labor (p-value <0.05). Most women who died in this study were hospitalized seriously ill (85.7%) or at home (10.7%). The common cause of MD is postpartum haemorrhage19 (26.5%). In this area, there is a considerable contribution of the Kalazar 6 (8.5%). Poorly financed and weak referral systems are critical determinants of maternity outcomes. Other determinants include poor access, equity of services, and lack of skilled birth attendance, protocols, and essential drug availability. Maternal Mortality Review provides a valuable opportunity to learn from each maternal death and take action to prevent future deaths. By prioritizing safe motherhood and investing in maternal health services, we can ensure that all women have access to the care they need during pregnancy and childbirth.

Keywords: Maternal mortality, Safe motherhood, Low-resource countries, Open window, and Sudan.

INTRODUCTION:

Reducing MM is an essential component of sustainable development. It is the first target of the SDGs on health. Most MDs are concentrated in relatively few countries, with two-thirds occurring in sub-Saharan Africa (Khan KS *et al.,* 2006). Safe motherhood extends beyond the individual woman and has a community and public health goal. (Creanga *et al.,* 2015) Maternal and child survival and well-being are central to family and community life and social flourishing. MM indicates maternal health and the health sector's access, integrity, and effectiveness. Reducing MM is achievable for countries worldwide (Ronsmans, 2006). MM is the ratio of MDs to 100,000 live births. Over half a million women die each year from complications due to pregnancy and delivery (Islam *et al.*, 2022; Nour *et al.,* 2008).

There are limited data on MM in Sudan. However, it has been suggested that MM is relatively high due to widespread genital mutilation. The radical form of genital mutilation results in obstructed labor because the entrance to the birth canal is distorted, and muscles lose tone due to scarring (SDHS report, 1990). Studies show that only 10% of women in Sudan practice family planning. About 93% of them know at least one method of family planning, and 70% know modern techniques. About 40% of pregnant women do not receive prenatal care from trained health workers, and 80% of deliveries occur at home (Horon *et al.,* 2005 & Hill K *et al.,* 2007). MMR is 660 per 100,000 live births (1998 CBS estimate). The ratio is much higher in rural areas (UNFPA, 1999; Sobhy *et al.,* 2016). Sudan faces significant challenges in terms of MM. The current war poses an immediate challenge to the southern provinces (Skupski *et al.,* 2006).

The sustainability of care for pregnant mothers is a crucial consideration for international partners and the Government of Sudan, considering these complex challenges across all development sectors. Women of reproductive age (15-49) represent about 20% of the total population. Despite the early start of organized midwifery services in the 1980s (Achilles S *et al.,* 2011) MM estimates require concerted efforts to improve the situation (Cioffi A *et al.,* 2021). The causes of MM in Sudan, like anywhere in the world (Bolnga *et al.,* 2021 & Vilda *et al.,* 2021). Measures should be taken to reduce MM demonstrably. A referral system is needed to reduce maternal and neonatal mortality (Rüfli I *et al.,* 2021). These services improve the coverage at the community level and allow early intervention in obstetric emergencies (WHO &UNICEF, 1996; Clemente-Suárez *et al.,* 2022). A similar experience was conducted in Gezira State in Sudan, reviewing the MM and the efforts for the MM reduction. The outcome was promising and can be applied to similar areas with the same context (Miskeen E *et al.,* 2022).

Research gaps in registration, obstetrics, social determinants and disparities, and community perspectives and participation were identified after experts from many disciplines assessment. Improving data quality and measurement, understanding affected populations and various causes, clinical research to confirm prevention and intervention strategies, and community participation in the study to reduce MM are the most important scientific opportunities to reduce severe MM. The research objectives are to identify maternal death causes and contributing factors toward improving the quality of maternal healthcare services by identifying gaps and weaknesses in the healthcare system. To highlight the challenges and opportunities associated with implementing maternal mortality review programs in low-resource settings. Also, to share case studies and best practices from successful maternal mortality review programs in low-resource countries.

MATERIALS AND METHODS:
Study Area
Elgadarif State Medical Services hospitals serve more than 1.7 million of the state population. The MMR in this study is 176/100000 live births, although higher than developed countries like UK 6.7|100,000, they are much better than many developing countries, including Arabic countries such as Yemen 1050 (Khan KS *et al.,* 2006). MMR in this study is lower than that obtained in the SDHS conducted in eastern Sudan from 1989-1990. Using the direct estimation method, MMR was 600 MD per 100.000 life birth for 1976 - 1982 and 666 MD for 1983 - 1989. Furthermore, it is also lower than obtained in the last Household Health Survey (SHHS-2006), in which MMR was (660/100.000) (Khan KS *et al.,* 2006).

Study design
This is the research of facility and community-based conducted in Elgadaref State.

Definition of maternal death
In this study, we considered the following purposes Maternal death is the death of a woman during pregnancy, childbirth, or within 42 days of delivery or abortion from a cause related to or aggravated by the pregnancy or its treatment, but not from accidental or unintended causes. It is an important indicator of the quality of maternal health care and access to women's health services. Maternal deaths can be divided into direct obstetric deaths (caused by complications during pregnancy, delivery, or management) and indirect obstetric deaths (caused by pre-existing conditions exacerbated by pregnancy) (WHO, 2022; Swarray-Deen *et al.,* 2022)

Data collection
Data Collected every MD is notified daily by the state focal person and then a notification to the cen-

tral office. Every MD in the hospital is reviewed by a focal person with the help of the investigator. The investigator reviews every MD in the community with the help of the state MD-reviewed center.

Data quality

Using a questionnaire filled and rechecked monthly meeting to discuss the causes of MD and generate recommendations

Data analysis

The data was managed in the Excel sheath and then imported to the SPSS, V 28, for analysis.

Ethical clearance

Obtained from the Medical Specialization Board of Sudan as part of the MD degree.

RESULTS:

MMR of 176/100,000 LB in Elgadrif State. The causes of MM in women in Sudan are mainly the top five causes MM, obstetric hemorrhage 19/72 (26. 3%), eclampsia carried 17/72 (23.6%), sepsis (mainly due to obstructed labor) 10/72 (13.9%), diseases associated with anemia are 7/72 (9.7%). Kalazar accounted for 6/72 (8.3%). However, another valuable contribution was made by other causes, such as miscarriage 4/72 (5.5%) and jaundice 3/72 (4.2%), while other reasons accounted for 6/72 (8.3%). In Sudanese women, parity is the most important risk factor for MM, with 16/19 (84.2%) for obstetric hemorrhage. However, eclampsia and pre-eclampsia

are still essential causes in 12/17 (70.6%) primigravida. Another specific cause in this region of Sudan is Kalazar and anemia in low parity women 5/6 (83.3%). High parity (5 or more) is a higher risk of MM 47/72 (65.2%), and significant associations between the parity and MM caused multiparity MD, which is more common compared to low parity (p-value <0.05). Considering the advanced gestational age (> 37 weeks) and post-partum period was the time most of the MDs occurred 42/72 (58.3%). However, less than 28-week gestational age represented about 18/72 (25%). This reflected clearly that gestational age is a significant factor in MM (p-value <0.05). The antenatal care and the availability of maternal for most women was significant risk factor for MD in the study area. Those women with no antenatal care or irregular visits were the majority, 68/72 (94.4%). A significant association between death during pregnancy and post-partum accounts for most MDs (p-value < 0.05) in all categories of MDs, with particular attention to obstetric hemorrhage, hypertension, and sepsis, which can be prevented by minimum maternal care (**Table 1**). A significant association between death during pregnancy and post-partum accounts for most MDs (p-value < 0.05) in all categories of MDs, with particular attention to obstetric hemorrhage, hypertension, and sepsis, which can be prevented by mini-mum maternal care (**Table 1**).

Table 1: The parameters of MD distribution among (n=72) MM in eastern Sudan

Cause of MD	Parity				Total	p-value
	Primigravida	Grand multipara	Multipara			
Obstetrics Haemorrhage	0	3	16		19 (26.3)	0.05
Eclampsia (HT disorder)	12	1	4		17	0.01
Sepsis (obstructed labour)	4	3	3		10	0.04
Jaundice	1	1	1		3	0.05
Anemia related conditions	2	3	2		7	0.05
Kalazar	3	2	1		6	0.02
Miscarriage	1	2	1		4	0.01
Other	2	2	2		6	0.05
Total	25	17	30		72	
	Gestational age in weeks					
	< 28 weeks	28-36 weeks	37 or more	Puerperium	Total	
Obstetric Haemorrhage	3	3	8	5	19	0.01
Eclampsia (HT disorder)	4	4	5	4	17	0.02
Sepsis (obstructed labour)	1	2	2	5	10	0.04
Jaundice	1	0	1	1	3	0.05
Anemia related conditions	2	1	1	3	7	0.01
Kalazar	3	1	1	1	6	0.02

Miscarriage	4	0	0	0	4	0.04
Other	0	1	4	1	6	0.06
Total	18	12	22	20	72	
Follow up during pregnancy						
Antenatal care	No	Irregular	Regular			
Obstetric Haemorrhage	15	1	2		19	0.050
Eclampsia (HT disorder)	16	1	0		17	0.01
Sepsis (obstructed labour)	4	3	0		10	0.020
Jaundice	4	2	1		3	0.030
Anemia related conditions	5	2	0		7	0.050
Kalazar	4	2	0		6	0.040
Miscarriage	4	0	0		4	0.010
Other	3	2	1		6	0.070
Total	55	13	4		72	

About 71% of the study population was from rural areas, compared to 29% from urban residential areas. Regarding the referral pathway, most patients were admitted to the ED (65%) or referred to the ED (17%), a similar percentage to self-referral from home (17%), and few were electively admitted. Concerning parity, most MDs are among multiparas at 46%. However, the primigravids and grand multiparas constitute around 28% and 26%, respectively. While 16 women's death happened at home, 56 women of the woman's death occurred at the hospital. To compare the gestational age of the carrying baby and the time of death, the puerperium was the highest at 26 MDs, followed by 37 or more weeks for 24 MDs, 11 maternal mortalities for gestational age 28-36 weeks, and 11 MDs for those who carried less than 28 weeks. The significant risk factors for MM are rural residency, emergency admission, and high parity. However, MD can occur at any gestational age. Depicted the Causes of death, there were direct, around 56% compared to 44% for indirect causes. Regarding the medical conditions of the women who died in this study, 30 had no medical problems, 12 had hypertension, 4 had heart disease, 1 had diabetes mellitus, 14 had anemia, 2 had kidney disease, and 9 had other health problems, including Kalazar and malaria. Most women who died did not have antenatal care, 85%, 10% had regular anti-natal care, and 5% added regular antenatal care. Regarding the history of admission, a majority of 79% did not have an account of hospital admission, while 21% they have. About 26 MDs had their baby born at the hospital with the same number at that home, and 20 MDs did not deliver. About 29.2% are normally delivered, while 31.9 % are assisted preterm deliveries, 27.8% are not delivered, 2.8 are administered twin deliveries, and 8.3% are emerge-

ncy cesarean sections. The significant factors related to MM are the direct cause, existing medical problems and co-morbidities, no antenatal care, lack of delivery services, and preterm labour. Regarding the outcome of the babies, 34 were alive and well, 20 babies were not delivered, 14 were macerated stillbirth, and four were born fresh stillbirth. When comparing the MD with localities, women came from as follow:17 is from Elgadarif, nine were from west Elgadrif (inner city), three were from Kassala, four were from Gala Alnahal, nine were from Alrahad, eight were from Algorasha, 14 from Algalabat, six from Alfashga, and two from Alfao. Although Algadarif City is the main referral site and tertiary care hospital, it accounted for most deaths. Other rural areas varied in MM accidents. Concerning who attended the MD, 64.3 % were registrars, then house officers 35.7%. In comparison, medical officers at 14.3%, specialists at 25%, their relatives or one attending at 17.9%, midwives at 3.6%, and anesthetists at 7.1%. Most women who died were hospitalized seriously ill (85.7%) or at home (10.7%). The proportion of women who died at the time of hospitalization was stable at 3.6%, reflecting late admission without much that could be done to save them after they reached the hospital with limited resources. Of women, even if they were brought to the hospital critically ill or died on arrival.

Most women (96%) did not request an autopsy, (and 4%) were denied by their next of kin. Thus, many causes of MM could not be confirmed or accurately determined because this autopsy service did not exist. Cooperation of the families with the health providers to reach a definitive cause of MD that can be prevented in future generations. In this study, 42.9% of respondents reached the hospital too late

because of poor road conditions or a late decision. About 28.6% of respondents received treatment too late after reaching the hospital, affecting 14.3%. 14.3% did not experience any delay.
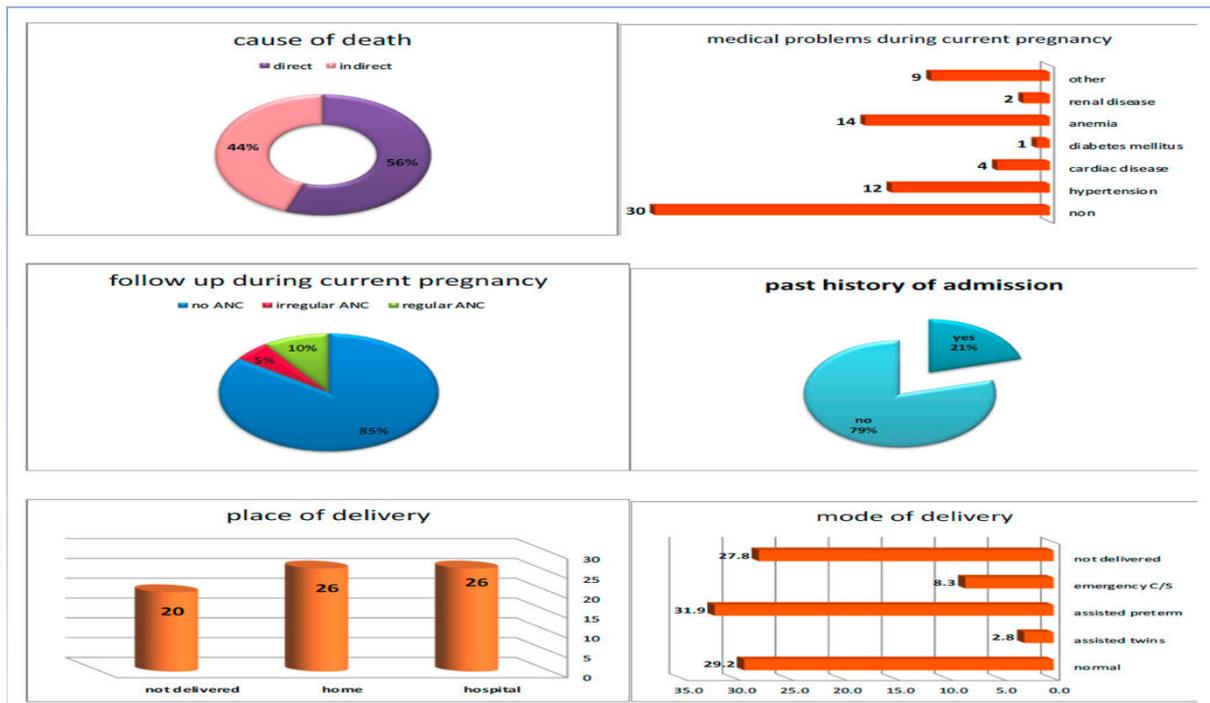
Fig. 1: Distribution of maternal death due to residency, place of birth, rout of admission and gestational age (n=72).
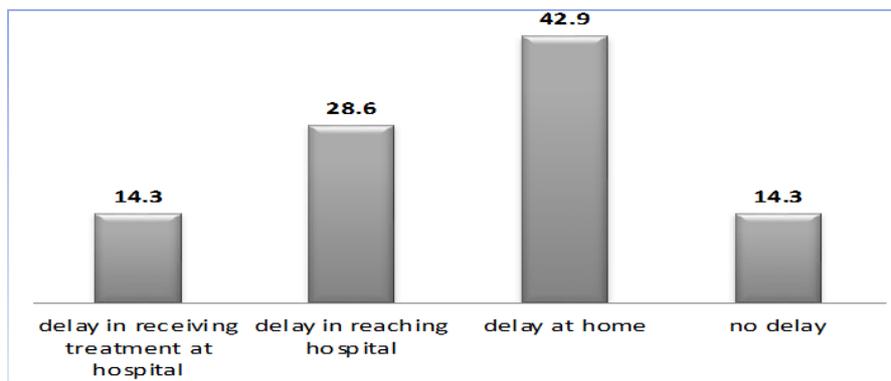
Fig. 2: Distribution by the areas of delay N (72) (percentage).

This reflects most delays in getting the hospital, which leads to further deterioration of the condition when women reach the hospital despite this delay. They present with symptoms that account for 46%, either jaundice or high-grade fever. In addition, labour and delivery complications account for 18%, contractions for 11%, hypertension, eclampsia at 15%, and bleeding, either antepartum or postpartum, accounting for 10% of the total 72 MDs (3).

DISCUSSION:

This study has demonstrated the need to capture all hospitals and community MDs. MM rates reflect the health system of the country. Hospital-based statistics are a valuable alternative to a national MM ratio registry in Elgadrif State. The MMR of 176/100,000 LB in Elgadrif State. The standard level of accurate statistical numbers significantly impacting MM rates can help the government and international organizations make informed decisions about resource allocation and intervention plans. MM is associated with neonatal deaths. Stillbirths and early neonatal deaths increase with increased MM. Research by Elgadrif reported that 47% of women died with fetuses in utero, 13% delivered fresh stillbirths, and only 40% had living babies. Moreover, the study showed that 85.7% of women were either dead or critically ill at admission, while 14.3% were stable. Alternatively, interventions for MMR reduction are also effective in reducing neonatal mortality (Nour *et al.,* 2008 & Horon *et al.,* 2005). Poor funding and weak referral

systems are the main factors affecting maternal care outcomes. Due to geography and poor roads, the lack of skilled birth attendance, treatment guidelines, protocols, and essential drugs and equipment contribute to poor access to quality maternal health services. The risk increases for young women, like in Nigeria, with 58.3% of MDs occurring in those less than 30 years old. This finding of increased MM rates by age differs from developed countries like the USA, where MMR is ten times more often in women between 40 and 44 yrs than those aged 20-25 (Cioffi *et al.,* 2021). Although MMR is remarkably high among teenage mothers in different countries (Cioffi A *et al.,* 2021) our study shows 20 deaths in women 15-20 years of age. Facilities (e.g., blood banks, uterotonics) and capabilities are needed to reduce bleeding-related deaths. MMR has significantly reduced in developed countries due to obstetric hemorrhage, compared to our areas, where it is still the leading cause (26.5%) of MD. According to our study, only three of more than 20 hospitals have blood banks, and even those three are not well-prepared. In developed countries, the thromboembolic disease is the leading cause of MM. According to (Hill K *et al.,* 2007), the causes of heart disease and cerebrovascular accidents are still underreported due to a lack of autopsy data. Hypertensive disorders in pregnancy rank second as a cause of death. This causes 23.8% of deaths, more than in a 1987-2004 study from Bahrain, in which hypertension accounted for 18% of deaths. In a survey from Bahrain, prophylaxis with magnesium sulfate was recommended, but unfortunately, it is not always available in our country. Prenatal care is effective in the early detection of preeclampsia and the prevention of its associated MM (Sobhy *et al.,* 2016).

MM is associated with neonatal morbidity and mortality. A literature review suggests a relationship exists between MM and prenatal mortality. However, stillbirths and early neonatal deaths increased with increased MMR. Moreover, interventions are also effective in reducing neonatal mortality (Nour *et al.,* 2008 & Horon *et al.,* 2005). In Elgadrif state research, 47% of women died with fetuses in utero, 13% delivered FSB, and only 40% were delivered alive & well babies. Moreover, the study shows that 85.7% of women were either brought dead or critically ill at admission, while 15.4% were stable at the time of entry. With fetuses in utero, 13% delivered FSB, and only 40% were delivered alive &

well babies. Moreover, the study shows that 85.7% of women were either brought dead or critically ill at admission, while 15.4% were stable at the time of entry. Poorly financed and weak referral systems are key determinants of maternal outcomes. Another determinant is poor access to quality maternal health care services because of geographical terrain and poor roads. Additional contributory factors are a lack of skilled health providers, treatment guidelines, protocols, and lack of essential drugs & equipment. A low health personnel-to-population ratio is also an additional factor. The risk increases for the ages of 20-30, where 58.3% of MDs occur in women younger than 30. This finding of an increase in MMR by age is the same in both developing countries like Nigeria but different from developed countries like the USA where MMR is ten times more common between the 40-44 years age group than in 20-25 years age group (Cioffi A *et al.,* 2021). Although in different countries, MMR is remarkably high among teenage mothers (Cioffi A *et al.,* 2021) we had twenty deaths 15-20 years of age. Compared to other countries, obstetric hemorrhage is still the leading cause of MDs (Skupski *et al.,* 2006) in Elgadrif state, as it is the major cause of MDs worldwide (Miskeen *et al.,* 2017) Reducing MDs from hemorrhage requires facilities (blood bank, uterotonic agent) and sophisticated skills; in developed countries, highly reduction in MMR due to obstetric bleeding has been achieved. Compared to our areas, it is still the significant and first cause of nineteen cases (26.5%) in Elgadrif State only three hospitals out of more than twenty hospitals have blood banks, and even these three banks are not well prepared.

Thromboembolic disorders represented the leading cause of MM in developed countries (Hill K *et al.,* 2007). This cause is attributed in our report to other cases like cardiac disease and CVA and is still underreported in our situation due to a lack of autopsy information. Hypertensive disorders in pregnancy and their complications caused deaths, ranking as the second cause, making them responsible for 23.8% of deaths, this more than a study had been done in Bahrain 1987-2004 in which hypertensive disorders were 18%, and they recommended prophylaxis magnesium sulfate. Unfortunately, MG sulfate and Hydralazine are not always available in our state. The effectiveness of care in the early detection of preeclampsia and prevention of associated MM is well documented (Sobhy *et al.,* 2016).

Compared to other countries, obstetric hemorrhage is still the leading cause of MDs (Skupski *et al.,* 2006) in Elgadrif state, as it is the primary cause of MDs worldwide (Achilles S *et al.,* 2011). Reducing MDs from hemorrhage requires facilities (blood bank, uterotonic agent) and sophisticated skills; in developed countries, a high reduction in MMR due to obstetric bleeding has been achieved. Compared to our areas, it is still the significant and first cause of nineteen cases (26.5%) in Elgadrif State; only three hospitals out of more than twenty hospitals have blood banks, and even these three banks are not well prepared. Thromboembolic disorders were the leading cause of MM in developed countries (Hill K *et al.,* 2007). This cause is attributed in our report to other cases like cardiac disease and CVA and is still underreported in our situation due to a lack of autopsy information. Hypertensive disorders in pregnancy and their complications caused deaths, ranking as the second cause, making them responsible for 23.8% of deaths. More than a study had been done in Bahrain 1987-2004 in which hypertensive disorders were 18%, and they recommended prophylaxis magnesium sulfate. Unfortunately, MG sulfate and Hydralazine are not always available in our state. The effectiveness of care in the early detection of pre-eclampsia and prevention of associated MM is well documented (Sobhy *et al.,* 2016). Indirect causes were responsible for more than 44 % of the cases. Unfortunately, the causes were preventable, like the one case with malaria. Although the other deaths died because of non-obstetric reasons, pregnancy may have accelerated their disease to cause death. Multi-disciplinary teamwork in managing these cases is of great importance in preventing such deaths. Moreover, the study shows that 85.7% of women were either brought dead or critically ill at admission and while only 3.6% were stable. Poorly financed and weak referral systems are critical determinants of maternal outcomes. Another determinant is poor access to quality maternal health care due to geographical terrain and poor roads. Additional contributory factors are a shortage in SBA, treatment guidelines, protocols, and a lack of essential drugs & equipment. A low health personnel-to-population ratio is also an additional factor.

CONCLUSION:

The Maternal Mortality Review is an essential tool for understanding the challenges and experiences of safe motherhood in low-resource countries. Through this review, we can identify the factors contributing to maternal mortality and develop targeted interventions to address them. The study also highlights the importance of investing in maternal health services, including access to skilled birth attendants, emergency obstetric care, and family planning services. Addressing the social determinants of health affecting women's access to care is crucial to improve maternal health outcomes. This includes addressing poverty, gender inequality, and cultural barriers that prevent women from seeking care or receiving appropriate treatment. Improving health systems' capacity to provide quality maternal health services is critical. Overall, the Maternal Mortality Review provides a valuable opportunity to learn from each maternal death and take action to prevent future deaths. By prioritizing safe motherhood and investing in maternal health services, we can ensure that all women have access to the care they need during pregnancy and childbirth.

CONFLICTS OF INTEREST:

All authors have declared that no financial support was received from any organization for the submitted work and also publish it.

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