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AN ANALYSIS OF MATERNAL DEATH DETERMINANTS IN A SINGLE LARGEST TERTIARY CARE CENTER OF COASTAL KARNATAKA, INDIA: A RETROSPECTIVE REVIEW OF 10 YEARS (2009-2018)

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Abstract

***Introduction*:** *The United Nations has set a target to reduce global maternal deaths to less than 70 per 100,000 live births by 2030. However, despite high rates of institutional deliveries in Karnataka, a state in southern India, maternal mortality remains a significant challenge. This study aims to analyse a 10-year period of pregnancy-related deaths in a healthcare centre in Karnataka to identify the causes and avoidable factors contributing to maternal mortality.*

Material and Methods: *A comprehensive review of records from 2009 to 2018 was conducted, gathering data on socio-demographic features, obstetric and medical history, referral details, duration of hospital stay until death, cause of death, organ dysfunction at admission and avoidable factors contributing to maternal death by inputs from expert committee. The percentages of incidences of causes were determined and analysed using binary logistic regression.*

Results:*One hundred nine maternal deaths were reported during the study period. The majority of these deaths occurred in rural areas, with infections and obstetric haemorrhage being the primary causes. A significant number of deaths occurred within 24 hours of admission, including during the postpartum period, with approximately one-fourth of cases being critically ill and nearly half of the cases had multiorgan dysfunction. Delay in seeking health services (42.8%) and failure to recognize early features of infection (36.3%) emerged as a common contributing factor tomaternal deathss. The presence of any delay in receiving obstetric care (odds ratio [OD]= 3.31), referral status (OD= 3.20), and rural residence (OD=3.06) were significant factors contributing to instability at the time of admission.*

Conclusions: *This study underscores the urgent need to address preventable factors contributing to maternal deaths in Karnataka. Strategies should focus on reducing delays in seeking care, improving recognition and management of infection during pregnancy and enhancing access to emergency obstetric services, particularly for women in rural areas.*

Keywords: *maternal death, obstetric haemorrhage, coastal karnataka, delay in seeking care, organ dysfunction*

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Introduction

By 2030, a target of less than 70 deaths per 100, 000 live births was adopted by the United Nations (UN) in 2015 as Sustainable Development Goals 3 [*WHO, 2015; WHO, 2012*]. This essentially needs an understanding of causes and factors directly or indirectly contributing to maternal deaths besides precise quantification of MD at the subnational level. India shares about 20% global burden of maternal mortality. Nevertheless, India is making progress in reducing maternal mortality, and 3 Indian states have achieved the UN target [*Montgomery AL et al., 2014*]. The maternal mortality ratio (MMR) varies markedly across India and depends upon socioeconomic factors and access to quality healthcare facilities. Karnataka, a southern coastal and 'rich' Indian state, has a relatively higher MMR than its neighbouring five states although 95% of deliveries in Karnataka are institutional. Although it remains comparatively high, MMR has declined from 108 in 2013 to 83 in 2017-2019, according to Offices of Registrar General, India. The five main causes of maternal morality are bleeding, infection, toxaemia, unsafe abortion, and complications from delivery. Other maternal deaths could be attributed to diseases that occur in pregnancy such as AIDS and Malaria. Providing the appropriate intervention in time can prevent maternal deaths [*WHO 2018*] . Delays that cause maternal deaths include delays in deciding to access care by the mothers (or family members) [*Mgawadere F. ert al.,2017*] , once the decision is made, delays in reaching a health facility [*Chavane L et al., 2018*] , and when mothers arrive at a health facility, delays in receiving the care that is required either due to unavailability or incorrect clinical management [*Pacagnella R et al., 2009*].

Reducing maternal mortality and improving maternal health are challenging tasks due to various factors that affect the outcomes, including both modifiable and unmodifiable factors. To effectively address these issues, a comprehensive and multi-faceted approach is necessary. This approach should include promoting social development and gender equality at the national level to tackle the determinants that act upstream in the chain of events leading to severe morbidity and death. [*Souza J et al., 2023*]

The leading determinants of maternal deaths are poverty, inaccessible healthcare, low status of women, and illiteracy, which leads to inadequate healthcare [*Sitaula S. et al., 2021*].To accomplish UN-defined goals for improved maternal health, it needs planning for easy availability of high-quality obstetric services across the country [*van den Broek NR, Graham WJ, 2009*]. A review of maternal deaths occurring in tertiary hospitals will certainly provide factual causes of maternal deaths and aid in identifying the probable factors leading to the death [*Lewis G, 2003*].

We, therefore, initiate a study to identify the probable causes and preventable factors that might have led to maternal death. Towards this end, we reviewed 10-year records of pregnancy-related deaths that happened in a tertiary center.

Materials and methods

Study design, and data collection: The study retrospectively reviewed health records at the Department of Obstetrics and Gynaecology, Kasturba Medical College (KMC), in Manipal, India. Kasturba Medical College is a tertiary healthcare center in Karnataka, a southern state of India, and a referral center for maternity homes, district, and primary health center located in adjoining districts as well as neighboring states. All the records between 1st January 2009 and 31st December 2018 obtained from the labor room, discharge summaries, intensive-care units (ICUs), and out-patient and in-patient databases, were reviewed and designated data of maternal deaths was selected for the analysis. The data included information on sociodemographic features, parity of the patients, obstetric/medical history, ante-natal and pre-hospital care given. The information also included the type of referral centre, deceased mother's condition at the time of admission, amount of time taken for hospital admission till the time of death, and the official cause of the death. Organ dysfunction based on WHO organ dysfunction criteria, at the time of admission was noted.

Determination of the cause of death and avoidable factors responsible for maternal mortality: Maternal death was defined as per WHO criteria which states that 'the death of a woman while pregnant or within 42 days of termination

of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes' [*WHO, 2012*]. Each maternal death review form was reviewed by an expert committee consisting of 5 obstetricians and was distinguished according to the International Classification of Diseases-Maternal Mortality (ICD-MM) [*WHO2012*]. Deaths due to accidents or other incidents were excluded from the analysis as followed in a previous study [*WHO. Health statistics and information systems: Maternal mortality ratio (per 100 000 live births)*]. A common strategy was employed. The committee exhaustedly deliberated and ascertained the reasons for death and circumstantial aspects that may have held back the woman from accessing high-quality emergency services from an obstetrician and most probably caused her death [*Stekelenburg J, van Roosmalen J, 2002*].

Deaths due to obstetric complications in pregnancy were regarded as 'Direct Death'. Obstetric complications included omissions, incorrect interpretation/diagnosis, or a series of events subsequent to anyone of these. 'Indirect Deaths' were categorized as those which happened due to pre-existent diseases not related to pregnancy, or diseases that occurred in the course of pregnancy that became severe due to the biological effects of pregnancy. Death was categorized as nonspecific or unspecific if the underlying reason was unidentified or unknown. Deaths due to coincidence were considered for those that happened during pregnancy, childbirth, or the postpartum period due to extrinsic factors not related to the pregnancy. Hence, each pregnancy-related death was categorized into the following nine groups: direct deaths in groups 1–6, indirect deaths in group 7, unspecified deaths in group 8, or coincidental deaths in group 9.

Organ dysfunction at the time of admission was noted based on WHO organ dysfunction criteria. A total of 25 criteria were included in three groups: clinical, laboratory, and intervention-related groups [*Pattinson R et al., 2009*]. Each system failure was recognized by the presence of at least one WHO near-miss criterion particular to that system [*Say L et al., 2009*]. Epi Info™ (CDC; Atlanta, USA) statistical database was used to collect the information using the WHO near-miss tool [*Say L et al., 2009*].

Data analysis: SPSS version 23 (IBM, ARMONK, NY, USA) tool was used to analyze the data. The variables that were excluded from the analysis were those which missed >30% of the total sample. The number and proportion of maternal deaths were observed from its causes and features. Demographic information, case features, and avoidable factors contributing to maternal deaths were

Table 1:

Distribution of maternal demographic, obstetrics, and delivery details of deceased women.

Demographic/ obstetric characteristics (n=109)	Number (%)	
1. **Age (median, range)** 25 years (19-45yrs)		
<21years	8 (7.3%)	
21-35 years	93 (85.3%)	
>35 years	8 (7.5%)	
2. **Parity index**		
Primigravida	48 (44%)	
Nullipara	28 (25.7%)	
Multipara	33 (30.3%)	
3. **Place of residence**		
Urban	31 (28.4%)	
Rural	78 (71.6%)	
4. **Number of ANC visits**		
< 3 visits (Un booked)	8 (7.3%)	
≥ 3 ANC visits (Booked cases)	101 (92.7%)	
5. **Referral system**		
Referred	99 (90.8%)	
Unreferred	10 (9.2%)	
6. **Type of referral centre**		
a. Primary health care	21 (19.3%)	
b. Secondary health care	18 (16.5%)	
c. Tertiary health care	12 (11%)	
d. Private health care	48 (44%)	
e. Unknown centre	2 (9.2%)	
7. **Delivery method**		
a. Antenatal (undelivered)	22 (20.1%)	
b. Post-partum - Vaginal	19 (17.4%)	}70(64.22%)
c. Post-partum - LSCS	51 (46.7%)	
d. Post aborted.	14 (12.8%)	
e. Ectopic/ molar pregnancy	3 (2.7%)	
8. **Admission to death interval (days)**		
<1 day	28(25.6%)	}72 (66.1%)
1-5 days	44 (40.5%)	
6-10 days	20 (15.6%)	
>10 days	17 (18.4%)	

summarized using frequencies, and percentages. The odds ratio calculation of the unstable condition of mothers at the time of admission was analyzed by binary logistic regression. The significance level was considered $p< 0.05$ and $p < 0.01$.

Consent from Ethics Committee: The Institutional Review Board, Manipal Academy of Higher Education (112/2019) approved the study. The data of deceased women were analysed anonymously.

Results

Over 10 years (2009-2018), there were 19,616 live birth and 109 (0.55%) maternal deaths.

Demographic characteristics: Table 1 lists the epidemiological attributes of maternal deaths. The study group's median age was 25 years (age range: 19-42 years), with 48 women (44%) in primigravida. The maternal deaths were high (71.6%) amongst women residing in rural areas. Most (90.8%) maternal deaths that occurred at our facility were referred from various healthcare units, and nearly half (44%) of them were referred from the private healthcare system. The majority of women had delivered by C-section from the lower uterine segment (46.7%). In 66 % of cases, the time period was less than five days from the admission process at the hospital till the time of death. Surprisingly 92.7% of maternal mortality was found in mothers who had >3 antenatal visits (booked). A larger fraction of women (64.2%) died in the postpartum period.

Case characteristics: We observed that about 1/4th (24%) of the cases were critically ill and half of them (50.4%) had failures in multiple organs when the patients were admitted (Table 2). Incidence of respiratory dysfunction (60.9%; 95% CI: 43.6–78.2) and cardiovascular dysfunctions (55.4 %; 95% CI: 43.4-67.4) were more common in the deceased women. Only 7 women (6.4%) had no organ dysfunction and were stable at admission.

Primary cause of death: In our study, maternal mortality due to direct causes is high (60.0%) compared to indirect causes (44.03 %), and mortality due to indirect causes is also relatively higher than the national average (Table 3).

Pregnancy-related infections (direct causes)

Table 2

Organ dysfunction at the time of admission.

Organ dysfunction	WHO organ dysfunction criterion	Incidence	
		n	95 % CI
Cardiovascular	Shock, use of continuous vasoactive drugs, cardiac arrest, cardiopulmonary resuscitation, severe hypoperfusion (lactate >5 mmol/L or >45 *mg/dL*), or severe acidosis (pH<7.1)	55.4	43.4-67.4
Respiratory	Acute cyanosis, gasping, severe tachypnoea (respiratory rate >40 bpm), severe bradypnea (respiratory rate <6 bpm), severe hypoxemia (PaO2/FiO2 <200, O_2 saturation <90% for 60 min), or intubation and ventilation	60.9	43.6–78.2
Renal	Oliguria non-responsive to fluids or diuretics, dialysis for acute renal failure, or severe acute azotaemia (creatinine >3.5 *mg/dL*)	53.2	44.4–61.9
Coagulation	Failure to form clots, massive transfusion of blood or red cells (5 units) or severe acute thrombocytopenia (<50,000 platelets/mL)	39.7	25.5–53.94
Hepatic	Jaundice in the presence of preeclampsia, severe acute hyperbilirubinemia (bilirubin >6.0 *mg/dL*)	29.7	16.1–43.2
Neurological	Prolonged unconsciousness/coma (lasting>12h), stroke, status epilepticus/uncontrollable fits, or total paralysis	23.3	12.4–34.1
Uterine	Haemorrhage or infection leading to hysterectomy	9.1	2.2–17.1
None	Stable on admission	6.4	0.9–11.8

Number of organ dysfunctions in women on admission	**n**		**%**	
No organ dysfunction (stable)	7		6.42	
One	21		19.26	
Two (Multiorgan dysfunction- MODS)	28	55	25.6	50.4
Three	27		24.7	
≥ four (critically ill)	26		24.0	

Note: pO_2: *partial pressure of oxygen in artery; FiO2: fraction of inspired oxygen*

Table 3.

Classification of causes of maternal deaths with WHO ICD-MM among cases of maternal deaths.

Type: n (%)	Causative factor: N (%)		Undelaying cause of death: N (%)	
Direct 61(55.9)	***1.*** Pregnancies with abortive outcomes	4 (3.66)	Post abortion sepsis	3 (2.75)
			Post abortion haemorrhage with DIC	1 (0.92)
	2. Hypertensive disorders of pregnancy, childbirth puerperium	9 (8.25)	Severe preeclampsia	2 (1.83)
			Eclampsia with HELLP syndrome	7 (6.42)
	3. Obstetric haemorrhage	17 (15.59)	Atonic PPH	6 (5.50)
			Traumatic PPH	3 (2.75)
			Placenta previa, adherent placenta	2 (1.80)
			Abruptio placenta DIC	1(0.92)
			Rupture ectopic pregnancy	3 (2.75)
			Molar pregnancy	1 (0.92)
	4. Pregnancy-related infections	21 (19.26)	Puerperal sepsis	10 (9.17)
			Surgical wound sepsis	4 (3.67)
			IUD sepsis	1(0.92)
			Probable septicaemia	6 (5.50)
	5. Other obstetric complications	10 (9.17)	Thromboembolism	2(1.83)
			Suspected amniotic fluid embolism	2(1.83)
			Acute fatty liver of pregnancy	3 (2.75)
			Peripartum cardiomyopathy	3 (2.75)
	6. Unanticipated complications of management	nil	nil	
Indirect 48 (44.03)	***7.*** non-obstetric complications	48 (44.03)	Cardiovascular disease	8 (7.34)
			Pregnancy-unrelated/incidental infection	31 (28.44)
			H1N1 Influenza	16 (14.7)
			Dengue, haemorrhagic fever	6 (5.50)
			Hepatitis B, E,	4 (3.67)
			Herpes simplex encephalitis	1(0.92)
			HIV with pneumocystis carnie	1(0.92)
			Hospital acquired pneumonia	3(2.75)
			Other Respiratory illness with ARDS	4 (3.67)
			Cerebrovascular vascular thrombosis	2(1.83)
			Anaemia	2(1.83)
			AML neutropenic sepsis	1(0.92)
unspecified	***8***. Unknown/undetermined	nil	nil	
during pregnancy, childbirth & puerperium	***9.*** Coincidental causes*	4 *	Organophosphorus poisoning	2(1.83)
			Thermal burns	1(0.92)
			Road traffic accident	1(0.92)

Notes: ** Excluded from the maternal death and also analysis, DIC: Disseminated Intravascular Coagulopathy; HELLP: acronym for haemolysis with a microangiopathic blood smear, elevated liver enzymes, and low platelets; PPH: postpartum haemorrhage, ARDS: acute respiratory distress syndrome; AML: Acute myeloid leukaemia*

contributed to 21.1%, whereas infections unrelated to pregnancy (indirect causes) contributed to 28.4%, and overall, in 50.4% of cases of maternal death, the primary cause was an infection (including post-abortion sepsis and hospital-acquired infections) (Table 3). It is plausible that the H1N1 pandemic resulted in high infection during pregnancy. Nevertheless, other infections like dengue, hepatitis, and other respiratory illness with ARDS were notable contributors to maternal death. We observed that amongst women who had developed pregnancy-related sepsis, 2/3rd (14 out of 21 cases) had caesarean delivery, and 17 presented with multiorgan fail-

ure/acute renal failure when admitted. Further, uncontrolled diabetes as a risk factor for sepsis was seen in 4 cases whereas the rest cases were found to be normal, yet they died.

Of the 17 cases of haemorrhage, only 5 cases had risk factors such as placenta previa, adherent placenta, and all these cases were either delivered at primary care centre or private health clinics.

Mostmaternal deathss (90.8%) that occurred at our facility were referred from various healthcare units. In 77 (70.6%)maternal deaths cases there were at least one 'avoidable factor'. In addition, delay in seeking care (30.28%, n=33) and failure to recognize/suspect an infection from the primary hospital (25.69% n=28 cases) was the most common factor contributing to maternal death (Fig 1). Logistic regression analysis revealed that chances of being unstable at admission were significantly high in women from rural areas referred from healthcare units or the showed presence of avoidable factors (Table 4). About 77 (70.6%) cases had at least one 'avoidable factor' recognized among deceased women. Thus, the presence of any causative avoidable factor surges the probability by 3.1 folds for the unstable condition at the time of admission. It was observed that women who died in rural areas had greater chances of being unstable at the time of admission.

Table 4.

Logistic regression analysis of factors showing Odds Ratio of being unstable at the time of admission.

Maternal characteristics	P-value	Exp (β)
Age (C)	0.8	1.03
Gravidity (C)	0.5	0.8
Referral status		
Yes (R)	0.05	0.2
No		
Place of residence		
Urban		
Rural (R)	0.03	3.06
Presence of 'avoidable factor' contributing to maternal deaths. \\		
No		
Yes (R)	0.02	3.13
Pseudo r square		0.195
n		109

Notes: *C - Continuous variable; R - Reference category;*

Discussion:

Reducing maternal mortality is a health priority worldwide as it is a set target in the UN Millennium Development Goals [*Pattinson R et al., 2009*]. Currently, the maternal mortality ratio is relatively high in India. Nevertheless, substantial progress has been made by many individual Indian

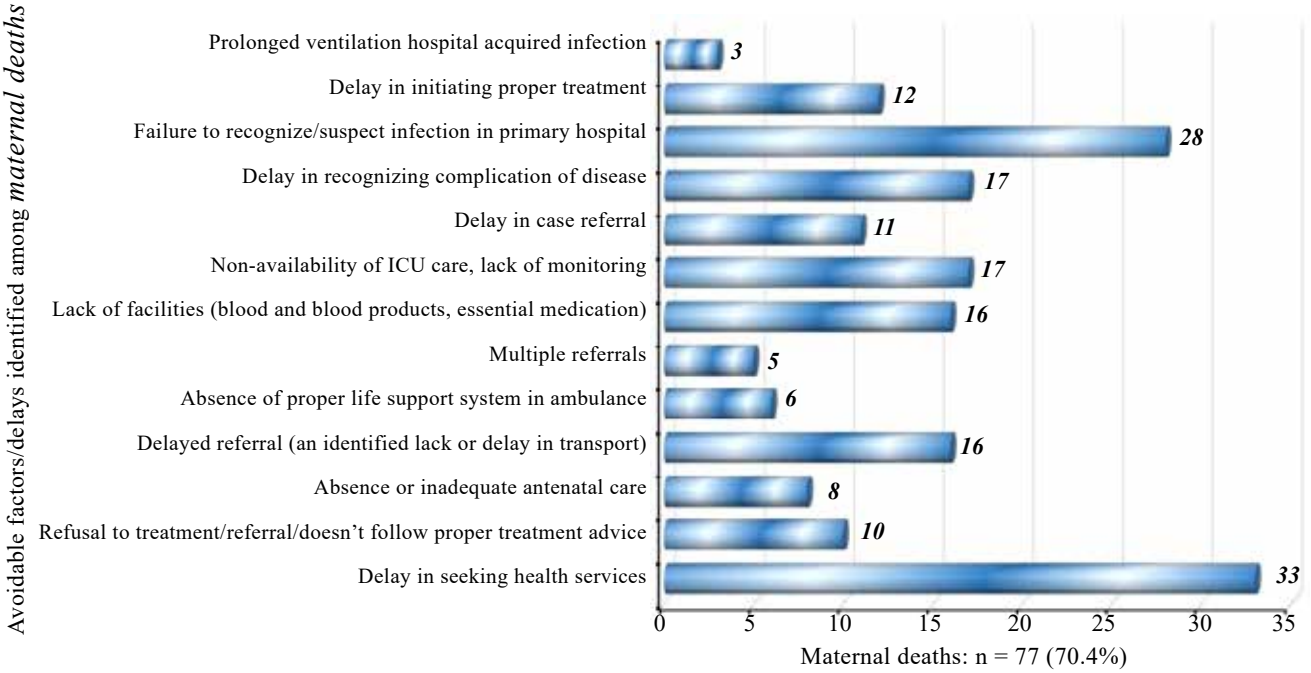

Figure 1. *Frequency of 'avoidable factors'/ 'delays' contributed to maternal deaths.*

states in the past decade to achieve the target, but further advancements are needed. Karnataka, a southern Indian state, still has a high MMR compared to neighbouring states. This study reviewed decade-old data from a large tertiary care hospital attempting to assess probable causes and factors contributing to the high MMR in Karnataka.

In this maiden study, case records as well as monthly audited reviews of all the maternal deaths from the largest tertiary healthcare hospital and referral centre of the Southern region of India, with annual deliveries ranging between 1500-2500, were used to explore the realistic relationship between maternal death and associated factors.

An expert team consisting of 5 obstetricians reviewed the maternal death sheets/hospital summaries of the hospital, and thus, the outcome of the study may be considered more authentic, reliable, and representative of the vast region surrounding the hospital.

The average age of the study group was 25 years, and the maximum number of deaths occurred between the ages of 21 and 35, as reported in previous studies from India [*Kaur D et al., 2007; Verma A et al., 2008; Puri A et al., 2011; Bangal VB et al., 2011; United Nations, 2013; Montgomery A et al., 2014; Shobha R, 2016; Mittal P et al., 2019*]. **I**n contrast, Restrepo-Méndez Victora analyzed the age-specific maternal mortality ratio in many countries and regions across the globe and commented it shows a wide variation between countries and regions [*Restrepo-Méndez MC, Victora CG, 2014*].

The maternal deaths were high (71.6%) amongst women in rural areas. This is consistent with other studies from India [*Jain M, Maharahaje S, 2003; Pal A et al., 2005; Jadhav A, Rote P, 2007; Onakewhor JU, Gharoro E, 2008; Shah R et al., 2008*]. In general, most women from rural India are poor; less educated, and have no easy access to high-quality healthcare, which may be the reason for high maternal mortality in rural women. However, the outcome of nationally representative surveys revealed that the risks of maternal death continue to remain high in rural and tribal areas of India's north-eastern and northern states, even after accounting for education and other variables. The leading causes of maternal death were obstetric haemorrhage, infections arising out of pregnancy and hypertensive pregnancy disorders [*Meh C et al., 2022*].

In our study, 44 % were in primigravida, and they are considered at high risk, especially among rural women, who constituted a large proportion of women in this study. It may be attributed to the tradition of being married early among rural and tribal populations [*Kashyap V et al., 2016*].

In our study, indirect causes of maternal deaths were notably higher than the national average. A study that audited 10-year records of maternal mortality incidences in a tertiary center in Delhi, India, reported that indirect causes were 32.2% (208/647) [*Singla A et al., 2017*]. A recently published (2021) large study which collected 1565 maternal death records from most Indian states, observed that indirect causes ranged between 9.2% to 12.4%, with an overall average of 9.4% [*Meh C et al., 2022*]. The relatively high prevalence of indirect causes in our study may be due to H1N1 pandemics prevailing during the study period, which are unrelated to pregnancy. It is therefore recommended that interventions addressed counteracting high maternal mortality should be both cause specific and target specific.

Our study's overall infection-related mortality contributed to nearly 50% of cases. This may partly be due to low immunity during pregnancy, and this physiological change predisposes to more complications from the infection. In addition, it may be attributed to the emergence of multidrug-resistant strains of bacteria in the urban community, possibly a consequence of the irrational use of higher-generation antibiotics at the peripheral level. This is reflected in a year-wise analysis that showed an increase in maternal death due to sepsis from 20.45% in 2003 to 35% in 2006. [*Puri A et al., 2011*] Globally, sepsis accounts for 15% of maternal deaths. Meh et al. (2022), in their 10-year-audit, observed that 7.1% of maternal deaths occurred due to infective hepatitis, and most had fulminant viral hepatitis due to hepatitis E virus (HEV) and suggested the provision of clean drinking water, creating awareness of better sanitation and early diagnosis.

In our study, obstetric haemorrhage was next the major (15.56%) direct cause of maternal deaths, which is less than the global (27%) and national (17 %) averages [*Meh C et al., 2022; Singla A et al., 2017*].

Kasturba Medical College Hospital is a tertiary referral hospital; 109 maternal deaths occurred out of 19,616 live births over a 10-year period. Most of the pregnant women were referred (90.8%) from the referral centre/ primary/ secondary health centres as well as private maternity homes (44%) in emergency/moribund states. About 1/4th of cases of death occurred within 24 hours after admission, with the larger percentage of women dying (64.2%) during the postpartum period. A systematic review by Khan et al. (2006) pointed out that most deaths happen due to deferred transportation of women to the referral centre, as the median time from detection to death, is 6 hours. Raj et al in their study identified that 27% of maternal deaths occurred en route to a facility [*Raj SS et al., 2015*]. A study from Malawi pointed out that about 50% of women who died at a healthcare facility had experienced delays in either seeking care or reaching the healthcare facility or not receiving adequate treatment at a healthcare centre [*Mgawadere F et al., 2017*]. It warrants easy access to health facilities highlighting the importance of timely transportation. Many women at the time of admission to our centre were critically ill; some of them had a multiorgan failure, which again pointed to a probable delay in seeking care. Obstetric haemorrhage if not attended to in time, may cause a rapid drop in blood pressure, restricting blood flow to the brain and other organs which may lead to organ failure. Out of 14 women admitted to Hannover Medical School, Germany, 13 (92.8%) had acute respiratory distress syndrome [*Busch M et al., 2022*]. Similarly, during the COVID-19 pandemic, 10% (n=41) of pregnant women in the UK needed respiratory support on admission, and one needed extracorporeal oxygenation [*Knight M et al., 2020*]. Almost 51% of pregnant women admitted to intensive care units had at least one organ involvement [*Karnad D et al., 2004; Pérez A et al., 2010; Kallur S et al., 2014*]. Thus, assessment of organ dysfunction and organ failure is essential in managing serious health problems related to maternity. Cardiovascular and respiratory dysfunction is the most commonly involved organ failure in the present study, as reported in other studies as well [*Afessa B et al., 2001; Kucirka LM et al., 2020*].

Consistent with the results of previous studies, we also observed preeclampsia-eclampsia, respiratory failure, abortion pregnancy-unrelated/incidental infection, and cardiovascular diseases also to be notable contributors to maternal deaths [*Afessa B et al., 2001; Munnur U et al., 2005; Muench MV et al., 2008*].

About 70% of maternal deaths were preventable or had at least one avoidable factor**.** Moreover, the presence of any causative avoidable factor surges the likelihood by 3.1 folds, for the unstable condition at the time of admission. Global mortality audits of maternal and perinatal deaths assessed many avoidable factors that most probably contributed to deaths [*Merali HS et al., 2014*]. It identified that health worker-oriented factors were the most common (66.7%), followed by patient-oriented factors (14.3%), administrative/supply factors (11.9%), and transport/referral factors (7.1%) [*Chattopadhyay A et al., 2018*]. Delay in seeking care, poor antenatal care, and financial constraints are notable patient-oriented avoidable factors. Besides, these factors delay in diagnosis/suspecting infection at the preliminary hospital, and delay in referral among health workers factors were major contributors to maternal. Further, rural-urban differences in severe maternal morbidity and mortality need to be addressed. Merkt *et al*. reported that pregnancy-related deaths were 63% higher in most rural areas as compared to urban [*Merkt PT et al., 2021*]. A retrospective US study revealed that in-hospital maternal mortality in 2007–2015 was 9% higher in rural settings as compared with urban settings [*Kozhimannil KB et al., 2019*] indicating that women who die in rural areas are more likely to be unstable on admission. Therefore, a need exists to create awareness among the patient to increase health-seeking behavior, improve the quality of healthcare facilities in preliminary hospitals and provide adequate training to health workers, continue education to doctors. It will certainly aid in reducing maternal deaths.

The strength of the study is that it reviewed 10-year case records of maternal deaths at the largest tertiary hospital and a referral centre of coastal Karnataka, India. An expert committee of 5 obstetricians reviewed all case records, and the out-

come, therefore, may be considered reliable. A majority of pregnant women were referred from rural areas adjoining the hospital with poor access to quality healthcare units. About 70% of Indians live in rural areas; therefore, the study may be considered representative of the national scenario.

The study has a few limitations. It is a retrospective study with a relatively small size. We had to exclude cases where most information was not available. Maternal deaths are indeed underreported. Secondly, information about the socioeconomic and educational status of the deceased mother was unavailable, and these two aspects have a bearing on maternal death and overall health status in general.

Conclusion

Maternal mortality is multifactorial and therefore needs planning of strategies that should address all aspects of this disorder. The focus should be on key issues: avoiding delays due to late diagnosis and transportation to the nearest well-equipped health care center. It also requires awareness about possible factors leading to adverse events during pregnancy. Policymakers should prioritize the development and equipment of healthcare facilities and referral systems, improving transportation. It also requires continuing education for medical and paramedical staff stationed at peripheral centers. It should also focus on the implementation of existing programs and services tailored to prevent maternal mortality, especially for those who are vulnerable and not easy to reach. Besides, a larger percentage of maternal deaths are credited to secondary causes including anemia, diabetes, and cardiovascular and respiratory disorders, to name a few.

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