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Original Research Article

Study of changing trends and patterns in maternal mortality at a tertiary care hospital

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ABSTRACT

Background: Maternal mortality continues to be a critical indicator of healthcare quality and socioeconomic development, particularly in developing nations. This study analyzes the evolving trends and patterns of maternal deaths at Karnataka institute of medical sciences (KIMS), Hubli, a major tertiary care center serving multiple districts in North Karnataka.

Methods: This cross-sectional observational study combined retrospective and prospective approaches to analyze maternal deaths at the department of obstetrics and gynecology, KIMS, Hubli, from 2019 to 2023. Medical records were reviewed for all maternal deaths occurring within 42 days of pregnancy termination, including complications from pregnancy, labor, puerperium, and related interventions. Data analysis encompassed maternal age, parity, antenatal registration, delivery characteristics, admission-to-death interval, and cause of death. Statistical analysis was performed using proportions and means to establish patterns and correlations in the collected data.

Results: A five-year analysis (2019-2023) at KIMS, Hubli documented 277 maternal deaths among 51,683 live births, yielding an average maternal mortality ratio (MMR) of 542.68 per 100,000 live births. The MMR peaked during 2021 (733.06) and subsequently declined to 437.46 in 2023. The majority of deaths occurred in women aged 20-25 years (53.79%) and primigravidas (57.03%), with hypertensive disorders (53.3%) being the leading direct cause of death. Notable trends included an increase in facility bookings (2.7% to 17.64%), a decrease in referred cases (100% to 70.5%), and a shift from vaginal deliveries (56.7% to 27.4%) to cesarean sections (32.4% to 52.9%). The COVID-19 pandemic's impact was evident through increased indirect causes of death during 2020-2021, with pneumonia/COVID accounting for 36.4% of indirect deaths across the study period.

Conclusions: The study revealed critical gaps in peripheral healthcare services and emphasized the need for strengthening antenatal care at primary healthcare centers. The high proportion of preventable causes highlights the importance of early detection, timely referral, and enhanced critical care capabilities in reducing maternal mortality.

Keywords: Maternal mortality ratio, Tertiary care, Hypertensive disorders, Maternal health, Referral system, Antenatal care

INTRODUCTION

Maternal mortality remains a critical global health issue, serving as a key indicator of a nation's healthcare system and socioeconomic development. Despite significant advancements in medical care and technology, maternal deaths continue to pose a substantial challenge, particularly in developing countries.[1] The world health organization (WHO) defines maternal mortality as 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 .[2]

Tertiary care hospitals play a crucial role in managing high-risk pregnancies and complicated cases, often serving as the last resort for critical maternal care. These institutions are uniquely positioned to provide insights into the changing landscape of maternal mortality, as they handle a diverse range of cases and employ the latest medical interventions.[3]

Over the past few decades, there have been significant shifts in the patterns and causes of maternal deaths. Factors such as improved antenatal care, advancements in obstetric interventions, and changes in socioeconomic conditions have contributed to change of trends in maternal mortality.[4] However, new challenges have emerged, including the rise of non-communicable diseases, increasing caesarean section rates, and the impact of global health crises.[5]

Understanding these changing trends and patterns is crucial for developing targeted interventions and policies to reduce maternal mortality. This study was done to find the incidence, causes, trends and changing pattern of maternal mortality in a tertiary care hospital for a period of 5 years.[6]

By examining these trends, we can identify areas of improvement in maternal healthcare delivery, assess the effectiveness of current interventions, and propose evidence-based strategies to further reduce maternal mortality.[7] This research is particularly relevant in the context of the United Nations sustainable development goals, which aim to reduce the global MMR to less than 70 per 100,000 live births by 2030.[8]

Furthermore, this study will contribute to the existing body of knowledge on maternal mortality in tertiary care settings, providing valuable insights for healthcare providers, policymakers, and researchers.[9] By analyzing the changing patterns, we can better prepare healthcare systems to address emerging challenges and adapt to the evolving needs of pregnant women.[10]

METHODS

This study was a cross-sectional observational study, combining both retrospective and prospective approaches. It focused on women who died due to complications of pregnancy, childbirth, and puerperium admitted in the department of obstetrics and gynecology at KIMS, Hubli.

The research examined medical records of all maternal deaths occurring over a five-year period from 2019 to 2023. The study analyzed and correlated various factors including maternal age, parity, antenatal registration, place and mode of delivery, admission to death interval, and causes of death.

Inclusion criteria for the study encompassed maternal deaths resulting from complications of pregnancy itself, labor, or the puerperium; interventions elected or required due to pregnancy complications; and deaths occurring within 42 days of pregnancy termination, regardless of the duration and site of pregnancy.

Data collected during the study was statistically analyzed using appropriate tests, including proportions and means, to derive meaningful insights from the gathered information.

RESULTS

This table presents the trend of maternal mortality over a five-year period at KIMS, Hubli. A total of 277 maternal deaths were recorded against 51,683 live births, yielding an average MMR of 542.68 per 100,000 live births. The data shows a concerning spike in MMR during 2021 (733.06), possibly attributed to the COVID-19 pandemic, followed by a gradual decline to 437.46 in 2023. The year 2019 recorded the lowest MMR (363.38), while 2021 saw the highest number of maternal deaths (70) (Table 1 and Figure 1).

The demographic trends over the five-year period (2019-2023) reveal significant patterns in maternal mortality. Age distribution showed that women between 20-25 years consistently remained the most vulnerable group, though the percentage fluctuated from 51.3% in 2019 to 64.2% in 2020, eventually settling at 54.9% in 2023. The 26-30 age group showed notable variations, with a concerning peak of 34.92% in 2022. Meanwhile, maternal deaths in extreme age groups (below 20 and above 36 years) remained relatively stable and low throughout the study period, suggesting that targeted interventions for the middle age groups might be necessary.

Parity analysis demonstrates a shifting pattern in maternal risk factors. Primigravida deaths showed a concerning trend, peaking at 70% in 2021 before decreasing to 43.13% in 2023. Notably, there was a significant increase in para 3 deaths from 8.1% in 2019 to 29.41% in 2023, while para >4 showed a gradual decline from 8.1% to 5.8%. This suggests an evolving risk profile where intermediate parity has become increasingly vulnerable.

Religious and geographic distributions reflected changing social patterns. Hindu populations showed fluctuating proportions between 63.49% and 78.4%, while Muslim populations showed corresponding inverse variations. The geographic distribution revealed a gradual shift from predominantly rural cases (70.2% in 2019) to increased urban representation (39.6% in 2023), possibly reflecting changing healthcare access patterns or urbanization effects (Table 2).

Clinical characteristics showed several promising improvements over the five-year period. The majority of maternal deaths each year occurred among mothers who were booked outside and did not have antenatal care at our Institute contributing to 94.22% of the total maternal deaths over five years. The percentage peaked at 100% in

2021. The percentage of maternal deaths among booked cases in our institute is very low each year contributing to 5.77% of the total maternal deaths over five years. The majority of maternal deaths occurred among mothers who were referred, although the percentage decreased from 100% in 2019 to 70.5% in 2023.The total percentage of deaths in this category over the five years is 83.75%. The percentage of maternal deaths among mothers who were not referred has increased over the years, from 0% in 2019 to 29.5% in 2023. Total contribution is 16.24% of the total maternal deaths over five years. Out of 45 unreferred cases 16 cases were booked at KIMS and 29 cases were booked elsewhere. There is a gradual decline in the percentage of referred cases over the years and a noticeable increase in proportion of deaths among unreferred mothers over time. The condition at admission showed variable trends, with stable cases peaking at 52.3% in 2022 before declining to 41.17% in 2023.

Delivery patterns underwent substantial changes, with a clear shift from vaginal deliveries (56.7% in 2019 to 27.4% in 2023) to cesarean sections (32.4% in 2019 to 52.9% in 2023). This trend might reflect either changing obstetric practices or increasing complexity of cases. The admission to death interval showed encouraging trends, with more women surviving beyond 48 hours (37.8% in 2019 to 52.94% in 2023), while early deaths within 6-24 hours decreased significantly from 37.8% to 5.88% (Table 3).

Table 1: Details of maternal deaths from 2019-2023.

Years	Total maternal deaths	Total live births	MMR (per 1,00,000 live births)
2019	37	10,182	363.38
2020	56	9,027	620.36
2021	70	9,549	733.06
2022	63	11,267	559.15
2023	51	11,658	437.46
Total	277	51,683	542.68 (Average)

Table 2: Socio-demographic characteristics of study participants.

Variables		2019	2020	2021	2022	2023	Total
Age (in years)	<20	1 (2.7%)	3 (5.3%)	4 (5.7%)	3 (4.7%)	1 (1.9%)	12 (4.3%)
	20-25	19 (51.3%)	36 (64.2%)	36 (51.4%)	30 (47.6%)	28 (54.9%)	149 (53.79%)
	26-30	10 (27%)	10 (17.8%)	19 (27.14%)	22 (34.92%)	12 (23.52%)	73 (26.35%)
	31-35	6 (16.2%)	3 (5.3%)	8 (11.4%)	6 (9.5%)	8 (15.6%)	31 (11.1%)
	>36	1 (2.7%)	4 (7.1%)	3 (4.2%)	2 (3.17%)	2 (3.9%)	12 (4.3%)
Parity	Primi	21 (56.7%)	30 (53.5%)	49 (70%)	36 (57.14%)	22 (43.13%)	158 (57.03%)
	Para 2	10 (27%)	13 (23.2%)	13 (18.5%)	18 (28.57%)	11 (21.56%)	65 (23.46%)
	Para 3	3 (8.1%)	9 (16.07%)	6 (8.5%)	5 (7.9%)	15 (29.41%)	38 (13.71%)
	Para ≥4	3 (8.1%)	4 (7.1%)	2 (2.8%)	4 (6.3%)	3 (5.8%)	16 (5.7%)
Religion	Hindu	29 (78.3%)	39 (69.6%)	53 (75.7%)	40 (63.49%)	40 (78.4%)	201 (72.56%)
	Muslim	8 (21.6%)	16 (28.5%)	16 (22.8%)	23 (36.5%)	11 (21.56%)	74 (26.71%)
	Christian	0	1 (1.7%)	1 (1.4%)	0	0	2 (0.7%)
Geographic	Rural	26 (70.2%)	39 (69.6%)	55 (78.5%)	38 (60.3%)	34 (66.6%)	192 (69.31%)
	Urban	11 (29.7%)	17 (30.3%)	15 (21.4%)	25 (39.6%)	17 (39.6%)	85 (30.68%)

Table 3: Clinical characteristics of study participants.

Clinical characteristics		2019	2020	2021	2022	2023	Total
Antenatal care	Booked at KIMS	1 (2.7%)	3 (5.3%)	0	3 (4.7%)	9 (17.64%)	16 (5.77%)
	Booked outside	36 (97.2%)	53 (94.6%)	70 (100%)	60 (95.2%)	42 (82.5%)	261 (94.22%)
Referral status	Referred	37 (100%)	50 (89.2%)	59 (84.2%)	50 (79.3%)	36 (70.5%)	232 (83.75%)
	Not-referred	0	6 (10.7%)	11 (15.7%)	13 (20.6%)	15 (29.5%)	45 (16.24%)
Condition at admission	Stable	14 (37.8%)	22 (39.2%)	34 (48.5%)	33 (52.3%)	21 (41.1%)	124 (44.76%)
	Unstable	23 (62.1%)	34 (60.7%)	36 (51.4%)	30 (47.6%)	30 (58.8%)	153 (55.23%)
Mode of delivery	Early pregnancy	2 (5.4%)	2 (3.5%)	8 (11.42%)	2 (3.1%)	4 (7.8%)	18 (6.49%)
	Antenatal	3 (8.1%)	10 (17.8%)	12 (17.1%)	1 (1.5%)	6 (11.76%)	33 (11.9%)
	Vaginal delivery	21 (56.7%)	20 (35.7%)	23 (32.8%)	23 (32.8%)	14 (27.4%)	101 (36.46%)
	LSCS	12 (32.4%)	22 (39.2%)	24 (34.2%)	36 (57.1%)	27 (52.9%)	121 (43.68%)
	Instrumental delivery	0	1 (1.7%)	3 (4.2%)	1 (1.5%)	0	5 (1.8%)

Continued.

Clinical characteristics		2019	2020	2021	2022	2023	Total
Admission to death interval	<6 hrs	6 (16.2%)	13 (23.2%)	13 (18.5%)	6 (9.5%)	9 (17.64%)	47 (16.96%)
	6-24 hrs	14 (37.8%)	14 (25%)	8 (11.4%)	15 (23.8%)	3 (5.88%)	54 (19.49%)
	24-48 hrs	3 (8.1%)	5 (8.9%)	17 (24.2%)	9 (14.2%)	12 (23.5%)	46 (16.6%)
	>48 hrs	14 (37.8%)	24 (42.8%)	32 (45.7%)	33 (52%)	27 (52.9%)	130 (46.93%)

Table 4: Causes of death of study participants.

Causes		2019	2020	2021	2022	2023	Total
Direct	Hypertensive disorders	21 (61.7%)	17 (45.94%)	19 (52.77%)	31 (57.4%)	16 (47.05%)	104 (53.3%)
	Sepsis	9 (26.4%)	10 (27.02%)	6 (16.6%)	11 (20.3%)	10 (29.4%)	46 (23.58%)
	Hemorrhage	4 (11.7%)	6 (16.21%)	9 (25%)	9 (16.6%)	6 (17.64%)	34 (17.43%)
	Amniotic fluid embolism	0	2 (5.4%)	1 (2.7%)	1 (1.8%)	2 (5.8%)	6 (3.07%)
	AFLP	0	2 (5.4%)	1 (2.7%)	2 (3.7%)	0	5 (2.56%)
Indirect	Pneumonia/ COVID	0	8 (44.4%)	14 (43.7%)	2 (22.2%)	4 (25%)	28 (36.4%)
	Cardiac disease	0	4 (22.2%)	11 (34.3%)	3 (33.3%)	3 (18.7%)	21 (27.3%)
	Pulmonary embolism	1 (50%)	1 (5.5%)	0	0	0	2 (2.5%)
	Others	1 (50%)	5 (27.7%)	7 (21.8%)	4 (44.4%)	9 (56.3%)	26 (33.8%)

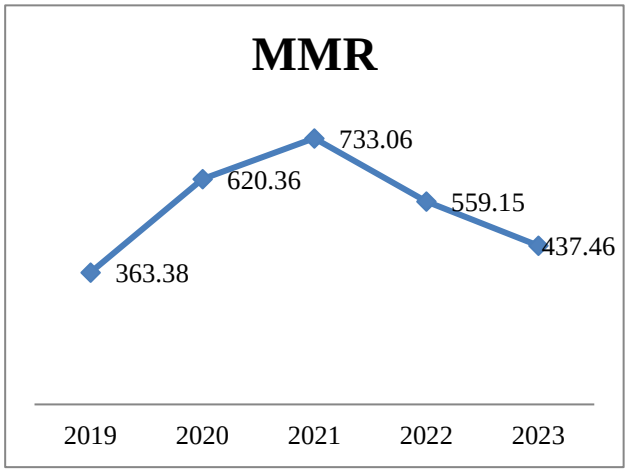

Figure 1: Changing trends of maternal mortality.

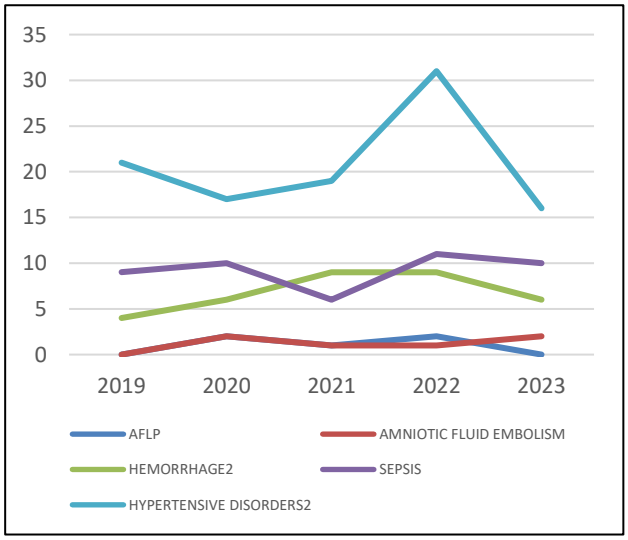

Figure 2: Direct cause of death trends.

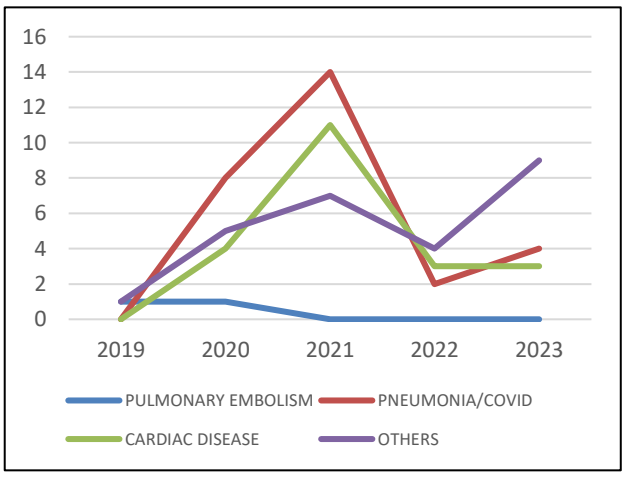

Figure 3: Indirect cause of death trends.

The causes of death showed evolving patterns between direct and indirect causes. Among direct causes, hypertensive disorders showed a declining trend from 61.7% in 2019 to 47.05% in 2023, while sepsis remained relatively stable around 26-29%. Hemorrhage showed slight variations but remained a significant concern. The emergence of indirect causes was notable, particularly during the COVID-19 pandemic years of 2020-2021, with pneumonia/COVID becoming a significant contributor. Cardiac disease peaked in 2021, while other indirect causes showed a marked increase by 2023, reaching 56.3%. Hypertensive disorders were the most prevalent, though the percentage decreased from 61.7% in 2019 to 47.05% in 2023. Despite the decrease, it remained the highest among all conditions (Table 4).

These trends collectively suggest an evolving maternal healthcare landscape with some improvements in healthcare delivery and access, but also highlight

persistent challenges. The shift in cause-specific mortality from predominantly direct obstetric causes to a mix of direct and indirect causes indicates the need for a more comprehensive approach to maternal healthcare. The improvements in survival time and decreased early mortality suggest better acute care management, though the persistence of preventable causes indicates areas requiring continued attention and intervention.

DISCUSSION

Maternal mortality remains a critical indicator of healthcare quality and accessibility in any region. This study, conducted at KIMS, Hubballi, a tertiary care center in North Karnataka with an annual delivery rate of 10,000-12,000, provides valuable insights into maternal mortality trends and their determinants. The institute serves as a major referral center, receiving complex cases from primary health centers (PHCs), community health centers (CHCs), and private hospitals across multiple districts including Dharwad, Haveri, Gadag, Koppal, Davangeri, Bagalkot, Belagavi, and Uttar Kannada. The significance of this study lies in its comprehensive analysis of maternal deaths over a five-year period, examining not only the immediate causes but also the socio-demographic factors, healthcare delivery patterns, and systemic challenges that contribute to maternal mortality in a tertiary care setting.

Our study observed a significant fluctuation in the MMR over the five-year period, with a notable peak during the COVID-19 pandemic. The MMR showed an increasing trend from 363.38 per 100,000 live births in 2019 to a peak of 733.06 in 2021, followed by a gradual decline to 437.46 in 2023. This trend aligns with findings from a systematic review by Chmielewska et al who reported increased maternal mortality globally during the pandemic period.[11] The subsequent decline in MMR post-2021 (from 733.06 to 437.46) suggests improving healthcare delivery and possibly better COVID-19 management protocols.

The study conducted at KIMS, Hubballi, a tertiary care center with 10,000-12,000 deliveries per year, revealed an MMR of 542.68/100,000 live births between 2019-2023. This was significantly higher than the national (97/100,000) (year-2020) and state (69/100,000) (year 2018-2020) MMR, primarily because 94.22% of cases were booked outside and 83.75% were referrals, often arriving in critical condition. Similar results were seen in studies by Pratima et al (361.71), Rajal et al (518), Verma (623), Khandale et al.[12-15] Most maternal deaths occurred in the 20-25 years age group (53.79%), followed by 26-30 years (26.35%), with primigravida accounting for 57.03% of deaths. The demographic analysis showed 69.31% were from rural areas, 65.58% from lower socioeconomic class, and 72.56% were Hindu, comparable to studies by Pratima et al, Khandale et al, Rajal et al, and Verma et al.[12-15] The high risk of death among young mothers may be due to incomplete pelvic growth, leading to higher chance of obstructed labour, and also there is higher risk of hypertensive disorders and are more prone to complications like preeclampsia, eclampsia, and preterm labour, and socio-economic factors such as limited access to prenatal care. The increased incidence of maternal death in primigravida compared to multigravidas unlike the usual norm of multigravidas being at increased risk, maybe due to early marriage, higher risks of complications such as preeclampsia, prolonged labor, and delivery interventions (e.g., caesarean sections). Lack of experience with pregnancy symptoms and labor can lead to delays in seeking care. Death in multigravidas is due to reduced birth spacing, and associated with increased risks of complications such as uterine atony, placenta previa, and obstetric haemorrhage, pre-existing health conditions that can complicate pregnancy and childbirth

The cases will be referred from PHC's, CHC's, taluka and district hospitals. Around 55-60% of the referrals will be unjustifiable and due to the various reasons like non availability of blood and blood products, non-availability of NICU care or OT facilities, non-availability of cardiologist, neurologist, nephrologist, and for ICU care. majority of patients were referred for better management of labour, previous caesarean section, hypertensive disorder of pregnancy, antepartum haemorrhage (APH), postpartum haemorrhage and anaemia. Other common causes were obstructed labour, failure to progress, premature rupture of membrane (PROM), intrauterine death (IUD), post term, fetal distress, hand prolapse, cord prolapse, twins, pre term, mal presentation, cephalopelvic disproportion (CPD), intrauterine growth retardation (IUGR), respiratory distress, heart disease, no specific cause mentioned in few cases.

In our study, 94.22% of maternal deaths were of cases not booked at our institute and were referred with complications from peripheral centers, similar to findings by Pratima et al (94.22%), Khandale et al (88.46%), and Verma et al (100%).[12,14,15] This highlights the critical need for quality antenatal care at peripheral centers, which often lack basic resources for routine ANC checkups. Regarding survival duration, 46.93% of cases in our study survived beyond 48 hours, demonstrating improved institutional care facilities, though mortality remained inevitable due to critical conditions at admission. This survival pattern aligns with other studies: Khandale et al reported 83.33% survival beyond 48 hours, while Mittal et al and Rajal et al reported 35.16% and 44.8% respectively, indicating similar challenges across tertiary care centers in managing referred critical cases.[12,13,15]

The high proportion of referred cases in our study, with 83.7% of maternal deaths coming from other facilities, suggests significant gaps in the quality and timeliness of primary care. Many of these referred patients did not receive adequate initial treatment, including proper medication dosages, appropriate complication assessment, and prompt referral, leading to delayed presentation and increased morbidity by the time they reached our tertiary center. This highlights the critical need to strengthen primary healthcare services, ensure proper antenatal and

intrapartum care, and empower healthcare personnel at the peripheral level to recognize complications early, provide initial stabilization, and refer patients in a timely manner. Reducing unjustified referrals and improving the management of patients at the district hospital level could significantly reduce maternal mortality by preventing the "missing of the golden hour" and decreasing the burden on tertiary care facilities, thereby enhancing the quality of care provided to individual patients.

Direct obstetric causes accounted for 70.39% of deaths, with hypertensive disorders being the leading cause (37.54%), followed by sepsis (16.60%) and hemorrhage (12.27%). This distribution pattern was similar to studies by Pratima et al (69.81%), Khandale et al (61.51%), and Rajal et al. (65.50%).[12,13,15] Indirect causes contributed to 27.79% of deaths, including respiratory diseases (10.10%) and cardiac diseases (7.50%). The COVID-19 pandemic impacted these figures, with 20 maternal deaths being COVID-positive cases. Notable complications included DIC (17.6%), AKI (14.07%), and pulmonary edema (13.35%).

Similar to findings in literature, the classical triad of causes of maternal mortality remained hypertensive disorders, hemorrhage, and sepsis in our study too.

The leading cause of death over the years has changed to hypertensive disorders from hemorrhage, making a change in trend of maternal mortality, whereas anemia remains almost a constant factor.

Deaths due to hemorrhage is in decreasing trend due to increased institutional care and facilities, rigorous management of PPH and various management options in our institution like paracervical clamps, internal artery ligation, peripartum hysterectomy, pelvic floor packing with tamponade etc. and bank facilities with round the clock with availability of various blood components.

The incidence of deaths due to medical disorders, cardiac disease has increased. There has been a noticeable shift in the causes of maternal mortality, with medical diseases increasingly contributing to maternal deaths rather than traditional obstetric causes. It is due to improved obstetric care, better management of labor and delivery complications. Also due to rising prevalence of hypertension, diabetes, and heart disease, and improved diagnostic tools and increased health awareness have led to the early detection of pre-existing medical conditions that can complicate pregnancy.

There is decrease in deaths due to prolonged labour, obstructed labour, and rupture uterus in our institution due to vigilant monitoring of cases and early recognition of the complications and timely intervention.

The effective management of maternal mortality is significantly impacted by administrative and critical care aspects of healthcare institutions. Critical challenges include timely availability of blood products and quality medications (such as oxytocin, misoprostol, anesthetic agents, labetalol, and nifedipine), which can lead to delays in patient resuscitation and treatment. With 1-3% of obstetrical patients requiring intensive care, and the increasing complexity of cases, there's a growing burden on healthcare providers who may have limited experience with critical illnesses.

A key solution lies in implementing a structured diagnostic and care algorithm managed by a multidisciplinary team comprising obstetricians or gynecologists, intensivists, anesthesiologists, and neonatologists. The current practice of admitting patients under primary consultants who may not specialize in intensive care can be suboptimal; instead, having dedicated intensivists has been proven to enhance patient safety, reduce morbidity and mortality, shorten hospital stays, and decrease costs through their specialized expertise in medical management, patient monitoring, interdisciplinary coordination, critical procedures, family communication, staff education, and quality improvement initiatives.

CONCLUSION

This five-year study at KIMS, Hubli, with an institutional MMR of 542.68 per 100,000 live births, reveals significant challenges in maternal healthcare delivery. The comprehensive analysis of maternal mortality trends from 2019 to 2023 reveals both improvements and persistent challenges in maternal healthcare delivery. While there were positive trends such as increased facility bookings (2.7% to 17.64%), decreased referrals (100% to 70.5%), and improved survival intervals (>48 hours increased from 37.8% to 52.94%), certain concerning patterns emerged. The persistence of deaths among young women aged 20-25 years (53.79% overall), predominance of primigravida (57.03%), and high rural representation (69.31%) highlight vulnerable populations requiring targeted interventions. The shift in delivery patterns towards cesarean sections (32.4% to 52.9%) warrants careful evaluation. Although hypertensive disorders showed a declining trend (61.7% to 47.05%), they remained the leading direct cause of death, while the emergence of indirect causes, particularly during the COVID-19 pandemic, emphasizes the need for a more comprehensive approach to maternal healthcare.

These findings suggest that while institutional care has improved, there is a critical need to strengthen early identification of high-risk cases, timely referral systems, and comprehensive emergency obstetric care, particularly focusing on preventable causes of death and vulnerable populations to further reduce maternal mortality.

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