TEMPORAL PATTERNS OF MATERNAL DEATHS IN MAJOR STATES OF INDIA

Abstract

Maternal mortality remains a pressing issue in India, with significant regional disparities and socioeconomic implications. According to data from the World Health Organization (WHO), India accounted for nearly 17% of global maternal deaths in 2017. In India maternal mortality is still very high in some states which is more than the national average, where as there are also states like Kerala have very low maternal deaths. There various factors which contributes to variations in maternal deaths across states and regions in India. Considering this an important issue, the present work is intended to understand the temporal patterns of maternal deaths in major states of India. The study is based on secondary sources of data obtained from Special Bulletin on Maternal Mortality in India for five time period such as- (2007-09,2010-12,2011-13,2014-16 and 2015-17). The study result revealed that drastic change in maternal death from 2007-09 to 2015-17 has been seen in the states of Uttarakhand, Uttar Pradesh and Jharkhand which recorded a decrease of (-181), (-112) and (-92) respectively followed by Chhattisgarh and Bihar indicating a change of (-78) and (-53) respectively. The lowest change is found out in the states of Kerala, Haryana and Tamil Nadu, indicating a change of (-6), (-7) and (-8) respectively.

Keywords: Maternal mortality, States of India, WHO, Global Maternal Deaths

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I. INTRODUCTION

Maternal mortality is a significant public health concern worldwide, and India, as the second most populous country, faces substantial challenges in addressing this issue [1]. "Maternal mortality refers to the death of a women while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by pregnancy or its management" (World Health Organizations; International Classification of Diseases(ICD)-10) [2]. Maternal mortality remains a significant global health concern, especially in low- and middle-income countries [1]. According to the World Health Organization, approximately 295,000 women died during pregnancy and childbirth in 2017, and the majority of these deaths occurred in sub-Saharan Africa and South Asia (WHO, UNICEF, UNPFA) [3,4,5]. Efforts to reduce maternal deaths include improving access to skilled healthcare during childbirth, offering better antenatal care, and enhancing family planning services [6]. However, disparities in healthcare quality, socio-economic status, and educational opportunities often contribute to high maternal mortality rates in some regions [6].

Maternal mortality in Asian countries varied widely depending on the level of development, healthcare infrastructure, and access to maternal services [6,7]. South Asia, including countries like Afghanistan, Pakistan, and Nepal, has higher maternal mortality rates compared to East Asian nations like Japan, South Korea, and Singapore [7]. As revealed from Fig-1(Global pattern of Maternal Mortality) showing a high level of disparities in healthcare facilities which results in high rate of MMR in developing countries and Sub-Saharan Africa in comparison to the developed counties which falls below 20 MMR per 10000 live births [8].

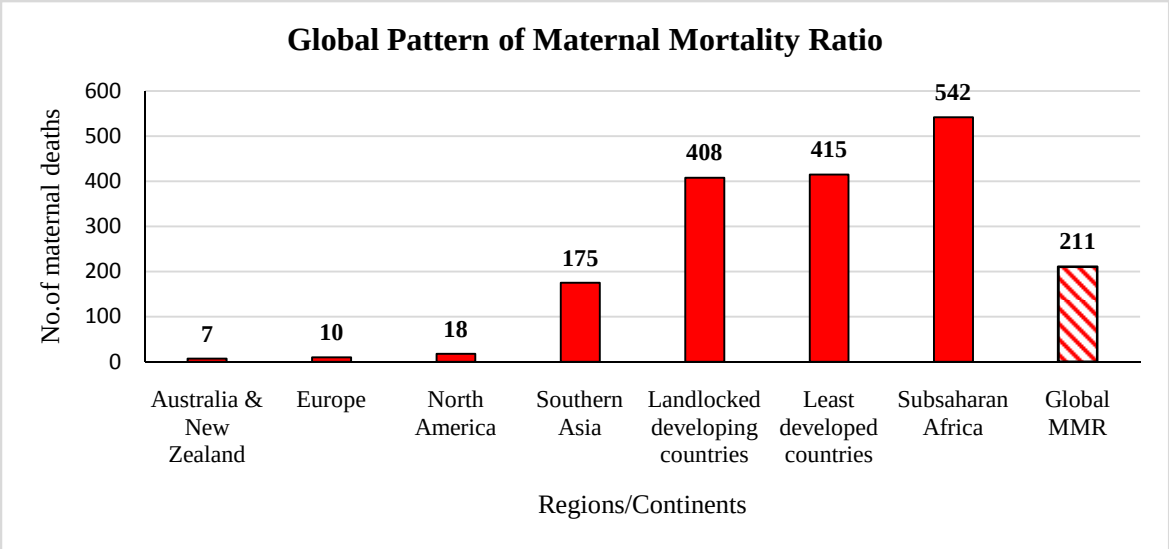

Figure 1: Global Pattern of Maternal Mortality Ratio (MMR)

Source: Trends in Maternal Mortality 2000 to 2017 Estimates by WHO, UNICEF, World Bank

India has made significant strides in reducing maternal mortality since 2005, but challenges remain. According to the Sample Registration System (SRS) by the Registrar General of India, the Maternal Mortality Ratio (MMR) fell from 374 per 100,000 live births

in 2000-04 to 113 per 100,000 live births in 2016-18 [9]. Despite notable progress in recent years, India continues to grapple with high maternal mortality rates, highlighting the need for comprehensive measures to improve maternal healthcare services and outcomes across the country [6]. Maternal mortality remains a pressing issue in India, with significant regional disparities and socioeconomic implications [6]. According to data from the World Health Organization (WHO), India accounted for nearly 17% of global maternal deaths in 2017 [2,3]. The latest available data from the Registrar General of India estimates the Maternal Mortality Ratio (MMR) at 113 per 100,000 live births, indicating a decline from previous years but still falling short of national and global targets [9].

Causes of Maternal Deaths in India

The key causes of maternal deaths in India often include the followings

1. **Haemorrhage:** Excessive bleeding during or after childbirth remains a leading cause.

2. **Hypertensive Disorders:** Conditions such as preeclampsia and eclampsia are significant concerns. This can be fatal if not managed well.

3. **Sepsis:** Infections post-childbirth or following unsafe abortions can lead to maternal death. Infections can lead to severe complications and death if not treated promptly.

4. **Obstructed Labour:** Difficulty in labour and delivery due to the baby's position can result in complications. Often due to a lack of timely medical intervention.

5. **Unsafe Abortions:** Lack of access to safe abortion facilities can lead to life-threatening situations. Such type of practices contributes to maternal mortality.

6. **Lack of Skilled Care:** Insufficient access to qualified medical professionals during pregnancy and childbirth.

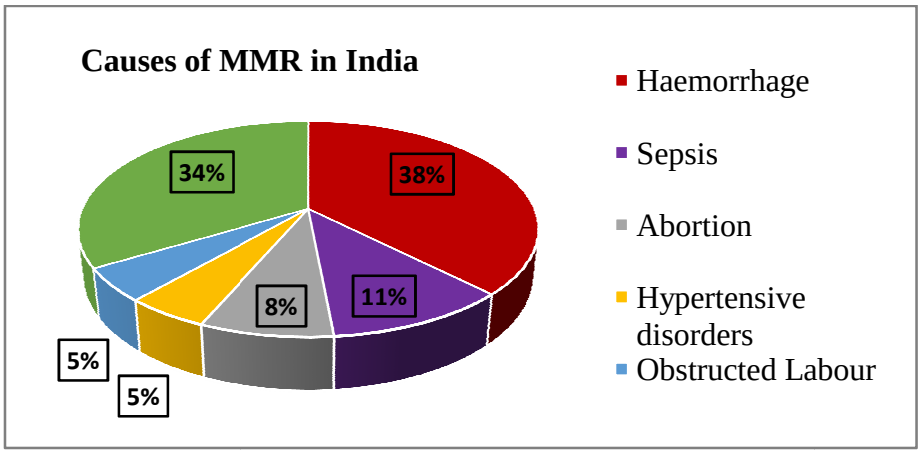

Figure 2: Causes of Maternal Mortality Ratio in India, showing percentage share of MMR by causes

Source: Prepared by authors based on SRS 2001-03

Based on SRS-2001-03 data, Figure 2 gives idea about the major causes of maternal mortality in India, out all *haemorrhage* constitutes 38% of total maternal deaths followed by *sepsis* (11%) and *abortion* (8%).

One striking feature of maternal mortality in India is the substantial regional variations. States in northern and central India have consistently reported higher MMRs compared to the southern and north-eastern regions [10]. Socioeconomic factors, limited access to quality healthcare services, low literacy rates, and cultural practices often contribute to these disparities [6,11]. States such as Uttar Pradesh, Bihar, Rajasthan, and Madhya Pradesh have been identified as high-burden states, requiring focused interventions to address the underlying causes of maternal deaths. Multiple factors contribute to maternal mortality in India [12]. Delayed or inadequate access to antenatal care, lack of skilled birth attendants, limited availability of emergency obstetric care, and delays in accessing appropriate medical interventions are significant factors [13]. Poor infrastructure, including inadequate transportation and healthcare facilities in remote areas, exacerbates the problem [6,7] Additionally, social determinants, such as poverty, low educational attainment, and gender disparities, play a role in hindering women's access to quality healthcare and contributing to adverse maternal outcomes [14].

There are notable disparities in maternal mortality rates across Indian states, reflecting variations in healthcare infrastructure, literacy rates, and socio-economic conditions [6,11]. States like Kerala, Maharashtra, and Tamil Nadu generally have lower Maternal Mortality Ratios (MMRs), thanks in part to better healthcare facilities and higher literacy rates among women [14]. On the other hand, states like Uttar Pradesh, Bihar, and Assam often have higher MMRs. These states face challenges such as limited access to quality healthcare, lower levels of female literacy, and socio-cultural factors that may hinder women from seeking timely medical care [14].

II. REVIEW OF LITERATURE

Pandey et al. (2014**)** adopted data from the Census of India, 2011, and the Annual Health Survey (AHS), 2010-13, to examine the level and trend in the coverage gap of a set of interventions for maternal and child health services. They also looked at the variation in usage of health services for mothers and children in the districts of high focus states of India. According to study's results, Madhya Pradesh has the lowest coverage gap (21%) while Uttar Pradesh has the highest (37%). The study also noted that the absolute change in coverage difference between 2009 and 2013 and there is a negative correlation between socioeconomic development and the gaps in coverage ($r=0.49$, $p=0.01$). The utilization of child and maternal medical facilities across Indian districts has been shown to vary significantly. When it comes to using medical care, resource- rich people (urban residents) much outpace marginalized people (rural residents).

Choudhury et al. (2015) evaluates the risk variables for pregnancy- related mortality in India's nine Empowered Action Group (EAG) states, namely, Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh and Uttarakhand. It was discovered that maternal mortality in India's EAG states is significantly higher than the country's average. The observed risk factors highlight the necessity of raising the standard of

maternity care. An important finding of the study was that universal access to parental and postpartum care could reduce the danger associated with poor socio-economic background.

Prusty et al. (2015**)** used the most recent District Level Household and Facility Survey (DLHS-III, 2007-08) to assess the level and pattern of maternal healthcare service utilization among various subgroups of women in Odisha with a focus on the regional, economic and educational inequality. The study found out that use of maternal healthcare facilities in Odisha is unevenly distributed among different groups, and that it is especially prevalent in underprivileged areas that are inhabited by the poor and illiterate.

Another study conducted by Sundari et al. (2016) sought to identify the factors that could reduce maternal mortality and figure out the causes of maternal death, including whether or not they are preventable. In order to do this, a retrospective analysis of the deaths of mothers from January 2015 to December 2015 was conducted. In accordance to the study's outcomes, there were a total of 56 maternal fatalities out of 6976 live births, yielding MMR of 802 (802 deaths/ 1000 live births). Ages 21 to 25 accounted for the bulk of deaths. Pregnancy- related hypertension was discovered to be one of the primary direct causes of death, based on the study. While there were a lot of bookings, more than 90% of maternal deaths might have been avoided with proper use of IV fluids, blood products, and medications, health education of women, early detection of PIH and care of it and early detection of anemia.

Similar to the previous study, Garg (2016) conducted a retrospective and prospective analysis of all maternal facilities from January 2001 to December 2005. They discovered a total of 204 maternal deaths out of 24,620 live births, providing the MMR of 828.59 per 100,000 live births. The survey also showed that 74% of mother's deaths occurred in unreported cases. The age group of 25-29 years old witnessed the greatest number of deaths. Out of 204 mothers who died, direct causes accounted for 72.06% of the deaths. The leading cause of dying was hemorrhage (36%) followed by pregnancy-related toxemia (19%) and sepsis (13%). Hemorrhage, pregnancy-related toxemia, and sepsis were determined to be the main and direct causes of death. Deaths among mothers was also being caused by anemia and other indirect factors such jaundice, malaria, and heart disease.

Along with aforementioned problem, it was crucial to be concerned about its prevention. In this context, Cornwell et al. (2019) study indicated that Indonesia has used the strategy over the past few decades to lower maternal deaths by boosting the availability of midwives. The provision of midwife services at village health posts has been shown to reduce mortality of mothers, and these reductions have been shown to continue over time. Additionally, it was suggested by the authors that further reductions in maternal mortality in Indonesia might necessitate a change in strategy to improve access to hospitals and the availability of doctors. The authors also recommended gathering information on maternal death in a subsequent census so that it can be useful for research in Indonesia and other nations.

A different study from Indonesia, conducted by Baharuddin et al. (2019), looked at the hospital-based maternal deaths by using data from blinded medical records of 90 women who passed away in 11 hospitals between January and June 2014, and specialists from the Indonesian Society of Obstetrics and Gynecology reviewed the records to determine the

causes of death and identify contextual factors for these deaths. The study found that 75 of the 90 maternal deaths were due to unintentional causes.

In rural India, Chauhan and Ali (2020) looked at the level of inequalities in three areas of maternal health care: complete antenatal care (full ANC), skilled birth attendants (SBA) and postnatal care (PNC). It was found out that there was a sizable disparity in the use of maternal health care across socioeconomic groups, but between 2005 and 2016, this gap had significantly shrunk in rural India and there has been a noticeable improvement in the use of maternal health care, particularly the use of skilled attendants at birth (SBA). The study's conclusion is that the government should make additional efforts to help the north-eastern states, along with states like Uttar Pradesh, Bihar and Jharkhand, in order to provide basic maternal health care services to women with low socio-economic status.

III. STUDY AREA

The current investigation considers 19 key states in India for the examination of maternal deaths. The rationale for selecting each state is outlined below:

Assam is directed by the presence of challenges in healthcare infrastructure. These challenges encompass issues such as the availability of healthcare facilities, the presence of skilled healthcare professionals, and the quality of maternal healthcare services. Additionally, geographical factors in Assam can affect the timely accessibility of maternal healthcare, especially in remote or rural areas where the landscape may pose obstacles in reaching healthcare services.

Bihar is driven by its status as the third most populous state in India, characterized by persistent poverty and suboptimal health outcomes. The literacy levels of women in Bihar are a crucial factor influencing awareness regarding the significance of facility-based maternal and new-born care. Additionally, initiatives aimed at promoting institutional deliveries and other governmental programs are vital considerations in the context of maternal health in Bihar.

Jharkhand is determined by the state's persistent efforts to enhance maternal health indicators, albeit at a gradual pace. Various social determinants, such as low educational levels, early marriage, adolescent pregnancy, inadequate birth spacing, and large family size, contribute significantly to maternal mortality and impact the overall maternal health status in the region. While there is a declining trend in maternal mortality in Jharkhand, substantial risks related to pregnancy persist.

Madhya Pradesh is motivated by the enduring challenges of poverty and limited education among women. These factors contribute significantly to the primary causes of maternal deaths, which are often associated with the 3 Delays framework. This framework includes delays in deciding to seek care, delays in reaching suitable health facilities, and delays in receiving adequate care upon reaching a health facility.

Chhattisgarh for maternal mortality is prompted by persistent poverty, which results in maternal malnutrition and increases the risk of death during childbirth.

Odisha is based on the observation that complications arising from pregnancies constitute the primary factors leading to the deaths of women in their reproductive age. Additionally, other contributors to maternal mortality in the region include the consequences of malnutrition, poverty, lack of education, unsanitary living conditions, infections, and unaddressed economic challenges.

Rajasthan is led by its status as a tribal-dominated state. Maternal health services in rural areas face challenges due to a shortage of human resources, particularly clinical specialists. Additionally, issues like limited institutional deliveries and the lack of accessible safe abortion services contribute to the elevated rates of maternal mortality in the region.

Uttar Pradesh is having the second-highest maternal mortality rate. The primary factors contributing to maternal deaths include complications during pregnancy, challenges related to transportation to health facilities, and issues in receiving timely and appropriate treatment. Among the direct causes, haemorrhage emerged as the leading factor, followed by sepsis and spontaneous home deliveries conducted by relatives. Additionally, indirect causes such as Anemia, jaundice, and postpartum haemorrhage play a significant role in maternal mortality in the region.

Uttarakhand is prompted by issues such as delays in receiving care during labor, deficiencies in the transportation system, and insufficient healthcare facilities for maternal care, all contributing to maternal mortality.

Andhra Pradesh is driven by several factors for maternal mortality. Firstly, the societal status of women within the state hinders the timely referral and access to services. Secondly, an imbalanced emphasis on family planning for population stabilization has diminished the focus on maternal health in peripheral hospitals, leading to limited utilization of these facilities for childbirth. Lastly, inadequate emphasis on the growth of services in Primary Health Centers has resulted in the weakening of the peripheral health system.

The former state of Andhra Pradesh underwent bifurcation in 2014, leading to the creation of the separate state of Telangana. Opting for **Telangana** as a study focus is motivated by its comparatively lower maternal mortality rates in contrast to the BIMARO states of India. This can be attributed, in part, to the prevalence of female sterilization and uterine removal, preventing women from bearing children.

Karnataka is prompted by its assertion of being socioeconomically affluent, despite having the highest maternal mortality rate among the southern states. The primary factor contributing to this is the prevalence of women in the high-risk category during childbirth. This high-risk category encompasses women giving birth at an older age, those having children at a young age, women with short birth intervals, and those with higher birth orders.

Kerala, Tamil Nadu and Maharashtra is motivated by their leadership in public health. The significant reduction in maternal deaths in these states can be attributed to three main factors: widespread access to healthcare, innovative approaches in front-line health delivery, and strong political commitment. It has been observed that a substantial number of maternal deaths are preventable through practices such as safe deliveries and proper maternal care. Having skilled attendants at birth, supported by emergency obstetric care when

necessary, reduces the risks associated with complications during delivery. Moreover, ensuring that expectant mothers undergo a minimum of eight antenatal care check-ups during pregnancy can greatly decrease the risk of maternal mortality.

Gujarat has recognized various challenges, including insufficient managerial capacity, a shortage of skilled human resources, the absence of blood in rural areas, inadequate infrastructure, a shortage of trained medical officers for skilled care, and the need for enhancements in the registration and auditing of all maternal deaths. Implementing these interventions is contingent on a significant increase in political will and heightened social awareness.

The incidence of women succumbing to complications related to pregnancy or childbirth is notably elevated in the state of **Haryana**. The state has lagged behind in providing adequate maternal healthcare. The primary cause of maternal mortality here is identified as postpartum haemorrhage, which refers to severe bleeding after delivery. Additional factors contributing to maternal mortality include infections resulting from inadequate sanitation and poor ambient hygiene, as well as postoperative infections if timely administration of antibiotics to the mother is neglected. Furthermore, illegal or incomplete abortions and limited or no visits to doctors are also thought to play a role in maternal mortality.

The likelihood of a delay in seeking care leading to potential maternal mortality is higher in South Punjab and rural areas of **Punjab** due to specific social and cultural factors. Key barriers to seeking care include poor socio-economic status, limited knowledge about maternal care, and financial constraints among rural individuals. Maternal deaths are attributed to the preference for traditional birth attendants. Furthermore, deeply ingrained cultural values, religious beliefs, and traditions, such as early marriages and the absence of family planning, contribute to this issue. The influence of traditional or spiritual healers also hampers young girls from accessing maternal healthcare.

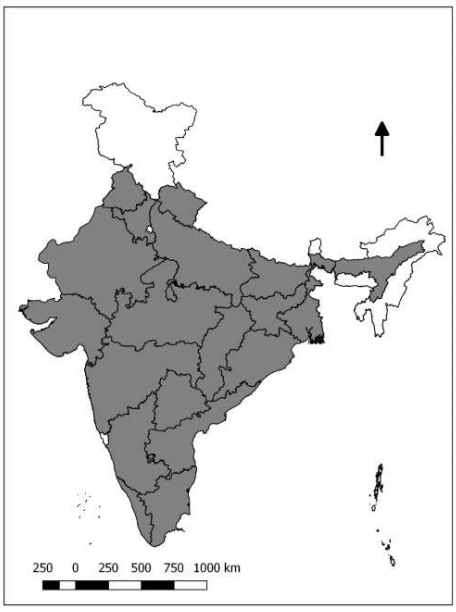

Figure 3: Study Area (select states included in the study)

In **West Bengal**, women face an elevated risk of experiencing preeclampsia and eclampsia, leading to maternal mortality. The risk is influenced by factors such as the frequency of antenatal care visits, the method of delivery, and delays in recognizing eclampsia, all contributing to the heightened risk of maternal deaths.

IV. MATERIALS AND METHODS

The main objectives of the present paper are to study the Spatio- temporal trends in maternal deaths in major states of India and to find out the change in maternal deaths from 2007-09 to 2015-17. The present study is based on secondary sources of data which are collected from Sample Registration System, Census of India, 2011. The data related to maternal death are collected from Special Bulletin on Maternal Mortality in India for five time period such as- (2007-09,2010-12,2011-13,2014-16 and 2015-17). Apart from this books, journals and government reports have been referred for the study. The methodologies used for analysis in the study are comparisons and change detection. The study of the study has been presented in tabular forms, bar diagrams and maps Apart from this newspaper, journals and government reports have been referred for the study. The methodologies used for analysis in the study are comparisons and change detection using percentage. The findings of the study have been presented with the help of choropleth map to show the spatial variations using Arc GIS-9.2 software.

V. RESULTS AND DISCUSSIONS

1. **Spatial and Temporal Trends in Maternal Death:** It has been observed from the table-1 that the maternal mortality of India in the year 2007- 09 is quite high, which is about 926 deaths. It has been seen that Kerala is having lowest number of maternal mortalities which accounts for only 12 deaths followed by Tamil Nadu, Haryana and Punjab i.e., about 22 deaths whereas it is extremely high in the states of Uttar Pradesh and Uttarakhand accounting for 194 deaths.

Table 1: Trends of Maternal Death in Major States of India (2007-09 to 2015-17)

States	2007-09	2010-12	2011-13	2014-16	2015-17
Assam	48	84	39	29	28
Bihar	100	42	81	62	47
Jharkhand	100	84	81	62	8
Madhya Pradesh	89	75	72	64	56
Chhattisgarh	89	75	72	64	11
Odisha	53	47	44	35	33
Rajasthan	87	68	65	46	43
Uttar Pradesh	194	156	152	106	82
Uttarakhand	194	156	152	106	13
Andhra Pradesh	31	25	21	12	12
Telangana	NA	NA	NA	9	8
Karnataka	41	32	29	25	23
Kerala	12	10	9	7	6
Tamil Nadu	22	20	18	15	14

Gujarat	36	29	26	23	22
Haryana	22	21	18	15	15
Maharashtra	23	18	14	14	13
Punjab	22	19	17	11	11
West Bengal	44	35	33	25	23
India Total	**926**	**767**	**718**	**556**	**525**
India	**181**	**150**	**122**	**101**	**82**

Source: Sample Register System (SRS: 2007-09 to 2015-17)

The maternal mortality is found less in Kerala due to proper health care facilities, high per capita income, skilled attendants, high number of hospitals, doctor- patient ratio is also high etc. [15] whereas the reasons behind high maternal deaths because lack of awareness, poor economic conditions, social stigma, unskilled attendants, lack of nutritional food etc. [15] There are only two states of India which are having higher maternal mortality than the national average and the states are Uttar Pradesh and Uttarakhand. Out of 19 states, 13 states 0are having lower maternal mortality than the national average (181) and the states are Assam, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu, Gujarat, Haryana, Maharashtra, Punjab and West Bengal.

The maternal mortality of India in the year 2010-12 is still quite high, which is about 767 deaths as revealed from Table-1. It has been seen that Kerala is having lowest number of maternal mortalities which accounts for only 10 deaths followed by Maharashtra and Punjab which accounts for only 18 and 19 respectively whereas it is extremely high in the states of Uttar Pradesh and Uttarakhand accounting for 156 deaths as like the earlier time period having higher maternal mortality than the national average. Out of 19 states, 13 states are having lower maternal mortality than the national average (150) and the states are Assam, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu,Gujarat, Haryana, Maharashtra, Punjab and West Bengal.

Table 2: Categorization of States based on Maternal Deaths in Major States of India

Study Periods (Years)	**Categorization of States**				
	Very Low (0-40)	**Low (40-80)**	**Medium (80-120)**	**High (120-160)**	**Very High (160-200)**
2007-2009	Kerala, Tamil Nadu, Haryana, Punjab, Maharashtra, Andhra Pradesh and Gujarat. **(07 states)**	Karnataka, West Bengal, Assam and Odisha.	Rajasthan Madhya Pradesh, Chhattisgarh, Bihar and Jharkhand.	NIL	Uttar Pradesh and Uttarakhand
2010-2012	Kerala, Maharashtra, Punjab, Tamil	Bihar, Odisha, Rajasthan,	Assam and Jharkhand	Uttar Pradesh and Uttarakhand	NIL

	Nadu, Haryana, Andhra Pradesh, Gujarat, Karnataka and West Bengal. **(09 States)**	Madhya Pradesh and Chhattisgarh.			
2011-2013	Kerala, Maharashtra, Punjab, Tamil Nadu, Haryana, Andhra Pradesh, Gujarat, Karnataka, West Bengal and Assam. **(10 states)**	Odisha, Rajasthan, Madhya Pradesh and Chhattisgarh	Bihar and Jharkhand	Uttar Pradesh and Uttarakhand.	NIL
2014-2016	Kerala, Telangana, Punjab, Maharashtra, AndhraPradesh, Haryana, Tamil Nadu, West Bengal, Karnataka, Assam and Odisha. **(11 states)**	Rajasthan, Bihar, Jharkhand, Madhya Pradesh and Chhattisgarh	Uttar Pradesh and Uttarakhand	NIL	NIL
2015-2017	Tamil Nadu, Madhya Pradesh, Karnataka, Odisha, West Bengal, Telangana, Andhra Pradesh, Punjab, Gujarat, Maharashtra, Haryana, Assam, Kerala, Bihar and Rajasthan. **(15 states)**	Uttar Pradesh and Jharkhand.	Uttarakhand	NIL	NIL

Source: Computed by Authors based on Table-1

The maternal mortality of India in the year 2011-13 is still quite high, which is about 718 deaths. Kerala is still seen having lowest number of maternal mortality accounting for 9 deaths followed by Maharashtra and Punjab which accounts for only 14 and 17 respectively whereas it is extremely high in the states of Uttar Pradesh and Uttarakhand accounting for 152 deaths. Uttar Pradesh and Uttarakhand are continuing

with higher maternal mortality than the national average (122). Out of 19 states, 13 states are having lower maternal mortality than the national average and the states are Assam, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu, Gujarat, Haryana, Maharashtra, Punjab and West Bengal. Though some states like Odisha, Chhattisgarh, Haryana and Rajasthan need to be improved in terms of hospitals, skilled attendants, proper education, provision of nutritional food etc. as majority parts of these states are dominated by tribal population [16].

The maternal mortality of India in the year 2014-16 is declining but it is still high, which is about 556 deaths. Kerala is still seen having lowest number of maternal mortality accounting for 7 deaths followed by Telangana accounting only 9 deaths whereas it is extremely high in the states of Uttar Pradesh and Uttarakhand accounting for 106 deaths. Out of 16 states, 14 states are having lower maternal mortality than the national average and the states are Assam, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Telangana, Rajasthan, Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu, Gujarat, Haryana, Maharashtra, Punjab and West Bengal.

It has been observed from the above table (Table-1) that the maternal mortality of India in the year 2015-17 is declining but it is still high, which is about 525 deaths. Kerala is still seen having lowest maternal mortality accounting for 6 deaths followed by Telangana accounting only 8 deaths whereas it is extremely high in the state of Uttarakhand accounting for 82 deaths followed by Chhattisgarh which accounts for 56 deaths. Out of 16 states, 15 states are having lower maternal mortality than the national average and the states are Assam, Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Telangana, Rajasthan, Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu, Gujarat, Haryana, Maharashtra, Punjab and West Bengal. Although 15 are coming under national average but many of these states i.e., Assam, Rajasthan, Chhattisgarh, Odisha, West Bengal etc. needs to be taken care of. As these states constitutes some tribal areas, inadequate qualified staffs, teen pregnancy, inadequate equipment for emergency etc. [16,17]. The spatial pattern of maternal deaths for all the study period has been depicted in Figure-3, which clearly revealed the interstate disparity and its changing pattern over time.

The spatial patterns of Maternal deaths in Major States of India during 2007-09,2010-12, 2011-13,2014-16 and 2015-17 has been presented in Figure-4 for a better illustration, which clearly reflects the changing pattern of maternal deaths in over the years.

2. **Spatio-Temporal Change in Maternal Death:** It has been observed that the change in maternal death from 2007-09 to 2010-12 are seen mainly in the states of Uttar Pradesh and Uttarakhand which recorded a decrease of -38 women from the base year taken followed by Rajasthan (-19) and Bihar and Jharkhand (-16). These are the top three states which recorded the highest change and this may be due to the upgradation in the facilities, proper management of government in implementing policies, some change in economic condition, increase in doctor- patient ratio etc. [15,18]. Thus, it is noticed that the states of Uttar Pradesh, Uttarakhand, Rajasthan, Bihar and Jharkhand set down the highest number of maternal deaths. Whereas, the lowest changes are found out in the states of Haryana, Kerala & Tamil Nadu and Punjab indicating a change of (-1), (-2) and (-3) respectively.

The change in maternal death from 2010-12 to 2011-13 are seen mainly in the states of Uttar Pradesh, Uttarakhand, Andhra Pradesh and Maharashtra which recorded a decrease of -3 followed by Assam, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Karnataka, Gujarat and Haryana -2. The lowest changes are found out in the state of Kerala indicating a change of (-1). The lowest change is seen may be due to proper pregnancy care, more births in hospitals or with skilled health care providers present, greater availability of antibiotics, and treatments for complications, knowledge of good personal hygiene practices to prevent infection etc. [17,18]. This change in maternal death mainly depicts the lowering of mothers' deaths by incorporating various means and different strategies [14,17-19].

The major change in maternal death from 2011-13 to 2014-16 are seen in the states of Uttar Pradesh and Uttarakhand which recorded a decrease of (-46) followed by Bihar, Jharkhand and Rajasthan (-19). The lowest change is found out in the state of Kerala indicating a change of (-2). Maharashtra has been recorded no change i.e., death took place same as before may be because overall the facilities were maintained and upgradation were done accordingly. The main reason behind sudden decrease in the mortality may be due to an increase in the economic conditions, construction of hospitals, prenatal counselling to use a skilled birth attendant, prenatal counselling to recognize signs of complications, skilled attendance etc.

Table 3: Change in Maternal Death

States	2007-09 to 2010-12	2010-12 to 2011-13	2011-13 to 2014-16	2014-16 to 2015-17	2007-09 to 2015-17
Assam	-6	-3	-10	-1	-20
Bihar	-16	-3	-19	-15	-53
Jharkhand	-16	-3	-19	-54	-92
Madhya Pradesh	-14	-3	-8	-8	-33
Chhattisgarh	-14	-3	-8	-53	-78
Odisha	-6	-3	-9	-2	-20
Rajasthan	-19	-3	-19	-3	44
Uttar Pradesh	-38	-4	-46	-24	-112
Uttarakhand	-38	-4	-46	-93	-181
Andhra Pradesh	-6	-4	-9	0	-19
Telangana	N.A	N.A	N.A	-1	
Karnataka	-9	-3	-4	-2	-18
Kerala	-2	-1	-2	-1	-6
Tamil Nadu	-2	-2	-3	-1	-8
Gujarat	-7	-3	-3	-1	-14
Haryana	-1	-3	-3	0	-7
Maharashtra	-5	-4	0	-1	-10
Punjab	-3	-2	-6	0	-11
West Bengal	-9	-2	-8	-2	-21

Source: Sample Register System (Census- 2011)

The major change in maternal death from 2014-16 to 2015-17 is seenin the states of Uttarakhand which recorded a decrease of (-93) followed by Jharkhand and Chhattisgarh indicating a change of (-54) and (-53) respectively. The lowest change is found out in the states of Assam, Telangana, Kerala, Tamil Nadu, Gujarat, and Maharashtra indicating a change of (-1). Andhra Pradesh, Haryana and Punjab have been recorded no change as it had samenumber of deaths as previous year i.e., 2014-16

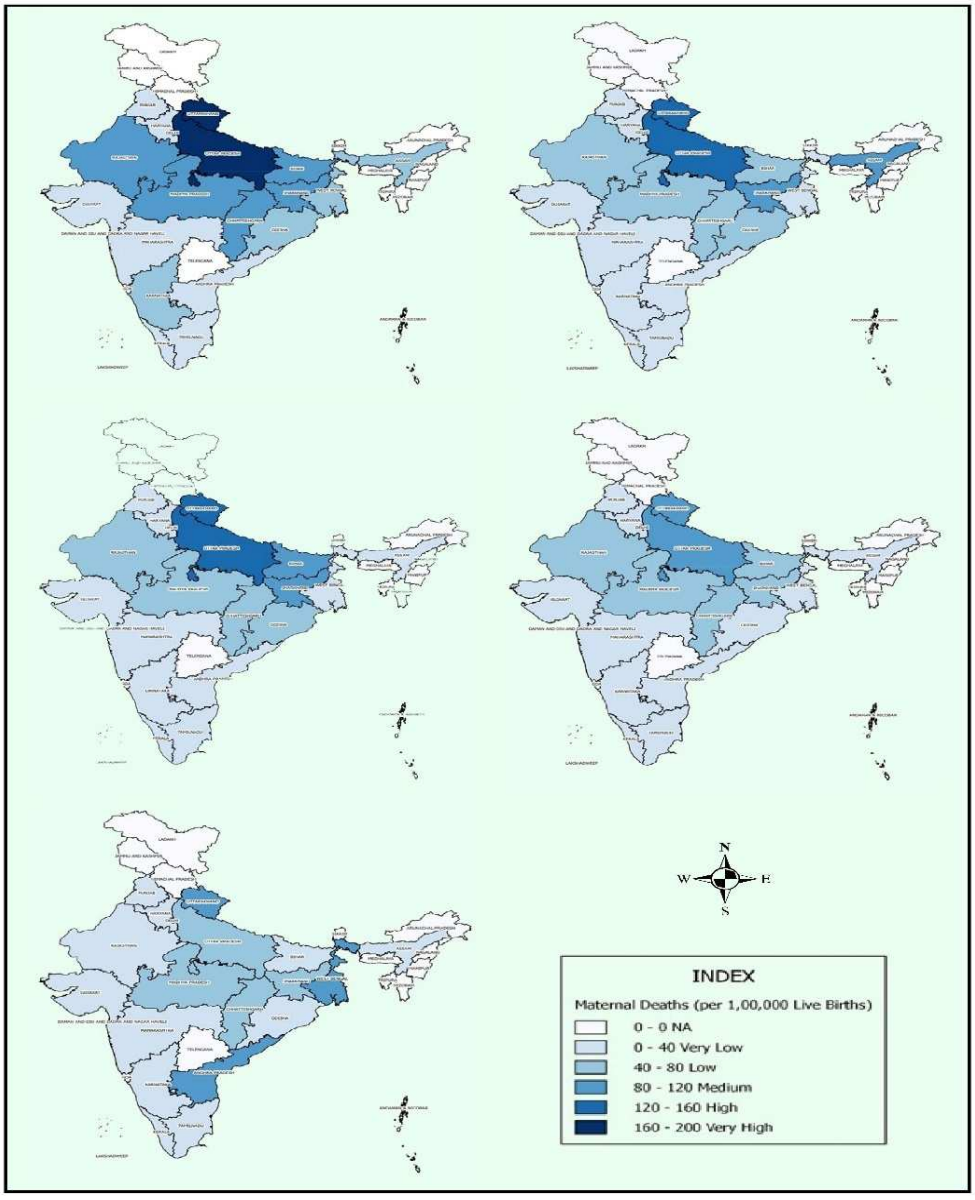

Figure 3: Showing Spatial patterns of Maternal deaths in Major States of India during 2007-09,2010-12, 2011-13,2014-16 and 2015-17.

A drastic change in maternal death from 2007-09 to 2015-17 is seen in the states of Uttarakhand, Uttar Pradesh and Jharkhand which recorded a decrease of (-181), (-112) and (-92) respectively followed by Chhattisgarh and Bihar indicating a change of (-78) and (-53) respectively. The lowest change is found out in the states of Kerala, Haryana and Tamil Nadu, indicating a change of (-6), (-7) and (-8) respectively. But an increase is

noticed in the state of Rajasthan accounting for 44 deaths of mother. Rajasthan was witnessing a decrease in all the years that has been taken in the study but a sudden increase was seen during the calculation of overall difference. This increase is mainly noticed due to poor health conditions of expecting women, infections in the virginal area, blood loss, anesthesia reaction or injury to other organsduring surgery, not due to the facilities related to hospitals, health care centers, shortage of doctors, skilled health workers etc. [6,7,14,16,20]. It is also noticed overall decline in maternal mortality is found in all the major states of India.

3. **Governments Initiative to Reduce Maternal Deaths:** Recognizing the urgency of the issue, the Government of India has implemented several programs/schemes to reduce maternal mortality and improve maternal healthcare services. The National Health Mission (NHM), with its flagship program, the Reproductive, Maternal, New-born, Child and Adolescent Health (RMNCH+A), aims to provide comprehensive care and interventions across the maternal health continuum. Other initiatives include Janani Suraksha Yojana (JSY) and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), which focus on ensuring safe deliveries, antenatal care, and strengthening healthcare infrastructure [21,22]. The (Table-4) gives an overview of important programmes implemented by central government to reduce maternal mortality in India. Each state often tailors these national programs to their specific needs and may have additional state-specific programs to address local challenges.

Table 4: Programmes Implemented for Reduction of Maternal Mortality and Maternal Health Care Services

Name of Program	Year of Launched	Objectives
National Health Mission (NHM)	**2005**	This umbrella program includes the National Rural Health Mission and the National Urban Health Mission, aiming to improve healthcare infrastructure and reach.
Janani Suraksha Yojana (JSY)	**12th April, 2005**	To reduce maternal and infant mortality by promoting institutional delivery. This scheme offers financial incentives to encourage pregnant women to give birth in healthcare institutions. It also provides a cash incentive to the healthcare provider.
SABLA (Scheme for Asolescent Girls)	**19th November, 2010**	Focused on adolescent girls, it aims to improve their nutritional and health status, thereby impacting future maternal health positively.
Janani Shishu Suraksha Karyakram (JSSK) Mother and Child Tracking System (MCTS)	**1st June, 2011**	This initiative provides free antenatal care, institutional deliveries, and postnatal care including free medications, diagnostics, and food. A digital system to monitor and ensure healthcare services to pregnant women and children.

Rashtriya Kishore Swasthya Karyakram (RKSK) under NHM	**7th January, 2014**	To improve nutrition, sexual and reproductive health and enhance mental health (10-19 years including married).
Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA)	**2016**	Provides free antenatal health check-ups for pregnant women on the 9th of every month, focusing on high-risk pregnancies.
Pradhan Matru Vandana Yojana (PMMVY)	**September, 2017**	Cash incentives for first living child and provide partial compensation for wage loss. Improve health seeking behaviour. The target groups include all pregnant women and lactating mothers (excluding employed in state/central govt. and PSUs.
LaQshya Program (under NHM) (Labour Room Quality Improvement Initiative)	**11th December, 2017**	To reduce maternal and newborn morbidity and mortality. Aims to improve the quality of maternity care in labour rooms and operation theatres by training healthcare providers and improving facilities.
Surakshit Matritiva Aashwasan (SUMAN)	**10th October, 2019**	An initiative for Zero Preventable Maternal and Newborn deaths.

Source: Compiled by the authors

Reducing maternal deaths in Indian states requires multi-faceted strategies that address healthcare infrastructure, social norms, and education. Here are some potential approaches:

- **Improve Healthcare Access:** Increase the number of healthcare facilities equipped for maternal care, especially in rural and remote areas.
- **Skilled Birth Attendance:** Train healthcare professionals, including nurses and midwives, in emergency obstetric care.
- **Antenatal and Postnatal Care:** Ensure that women have access to quality antenatal and postnatal services to identify and manage risks early.
- **Awareness Programs:** Educate communities about the importance of antenatal care, nutrition, and birth planning through mass media and community outreach.
- **Financial Incentives:** Programs like Janani Suraksha Yojana offer cash incentives to encourage institutional deliveries. More such programs could be considered.
- **Emergency Services:** Strengthen emergency response systems for maternal care, including timely transportation to healthcare facilities.
- **Family Planning:** Make contraception widely available and educate communities about its use to avoid unwanted pregnancies and unsafe abortions.

- **Cultural Sensitivity:** Address cultural barriers that prevent women from seeking timely healthcare by involving community leaders and using culturally appropriate communication strategies.
- **Telemedicine:** Use technology to provide consultations and follow-up care to pregnant women who can't easily access healthcare facilities.
- **Legislation and Policy:** Ensure that maternal health is prioritized in healthcare policies and budgets.

4. **Challenges and the Way Forward:** Despite the efforts made, numerous challenges persist in addressing maternal mortality in India. Inadequate availability and utilization of healthcare services, especially in rural and remote areas, pose a significant obstacle [23]. Health workforce shortages, insufficient infrastructure, and weak referral systems need to be addressed [24]. Additionally, addressing social determinants of health, empowering women, improving education, and raising awareness about maternal health are crucial aspects of any comprehensive strategy [25]. To make substantial progress in reducing maternal mortality, a multi-pronged approach is required [23]. Strengthening healthcare systems, ensuring skilled birth attendance, promoting comprehensive antenatal care, and investing in emergency obstetric care are crucial steps [23-25]. Collaboration between government bodies, healthcare providers, NGOs, and the community is essential to address the systemic and social factors contributing to maternal deaths [24].

VI. CONCLUSION

The status of maternal mortality and maternal deaths in India remains a matter of concern, but concerted efforts are being made to address this issue. Although progress has been made in recent years, regional disparities and socioeconomic factors continue to impact maternal health outcomes. By implementing evidence-based interventions, improving access to quality healthcare and addressing social determinants, India can work towards achieving its goal of reducing maternal mortality and ensuring a healthier future for its women and children.

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