Research Article

Factors associated with inter-district variation of maternal mortality in Assam

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ABSTRACT

Background: Maternal mortality is an important indicator of the health and socioeconomic status of a nation. Assam has the highest maternal mortality ratio (MMR) in the country. Although maternal death is a biomedical event, the contributory factors are many. **Objectives:** The objectives of the study were to assess the role of demographic, socioeconomic, nutritional, health service availability, and utilization indicators in inter-district variation of maternal mortality in Assam. **Materials and Methods:** We conducted an analysis of maternal mortality using district-level secondary data of 27 districts of Assam. The dependent variable was the MMR, while independent variables were demographic, socioeconomic, nutritional, health service availability, and utilization indicators. Pearson correlation and linear regression analysis were done to assess the relationship between MMR and 14 indicators at the district level using SPSS version 20. **Results:** MMR decreased linearly with increase in proportion of rural population and accounted for 20% variability ($P = 0.018$). Proportion of households with access to safe drinking water had a significant negative linear association with MMR and accounted for 27% of variability ($P = 0.005$). MMR increased linearly with increase in proportion of pregnant women with anemia at the district level ($P = 0.019$). Community health centers (CHCs) per million populations were found to have a negative linear association with MMR and accounted for 15% of variability in MMR at the district level. **Conclusions:** Proportion of rural population, households with access to safe drinking water, pregnant women with anemia, and CHCs per million populations were associated with inter-district variation of maternal mortality in Assam.

KEY WORDS: Maternal Mortality; Correlation; Association; Assam

INTRODUCTION

Maternal mortality is a tragic event and most of it is preventable. It is an important indicator of the health and socioeconomic status of a nation. Although various national programs in India have brought a steady decline in maternal mortality ratio (MMR), yet this decline is rather slow. The MMR of India has declined from 167 in 2011–2013 to 122 in 2015–2017. The decline has been most significant in empowered action group states and Assam from 246 to 188. The MMR of Assam has declined from 300 in 2011–2013 to 229 in 2015–2017.[1,2] Assam has the highest MMR in the country. The immediate cause of a maternal death is always a biomedical event, but contributory causes are many. This includes socioeconomic determinants such as education, income, occupation, women empowerment in society, and access to and utilization of the health system. Some studies have noted the relationship between maternal mortality and socioeconomic factors such as per capita income, gross domestic product, educational level, and availability and functionality of health services.[3-5] Social factors are important determinants of maternal mortality. Early age at marriage, early first pregnancy, decrease spacing and large family, poor educational level, poverty, marginalized population, and geographical isolation are some known

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social determinants.[6-9] The present study was conducted to assess the correlates of maternal mortality in Assam from the available district-level secondary data.

Aim and Objective

This study aims to assess the role of demographic, socioeconomic, nutritional, health service availability, and utilization indicators in inter-district variation of maternal mortality in Assam.

MATERIALS AND METHODS

Study Design, Settings, and Population

Ethical approval for the study was obtained from the Institutional Ethical Committee. We conducted a secondary record-based study using district-level data of 27 districts of Assam to identify correlates of maternal mortality in Assam during the period of 2015–2016. Each district was considered as the unit of analysis. There were a total of 32 districts during 2015–2016 in Assam, but the newly created five districts were not fully functional. We studied the role of demographic, socioeconomic, nutritional, health service availability, and utilization indicators in maternal mortality in 27 districts of Assam.

Study Variables

We studied 14 indicators at the district level. Demographic indicators included proportion of the rural population and marginalized population. Socioeconomic indicators were proportion of households with access to safe drinking water, women with at least 10 years of schooling, and teenage pregnancy in each district. Nutrition-related indicator was proportion of pregnant women with anemia. The number of community health centers (CHCs), primary health centers (PHCs), subcenters per million populations, density of physician, and auxiliary nurse midwife (ANM) per million populations at the district level was health service availability indicators. Health service utilization indicators were proportion of institutional delivery, full immunization coverage, and women who had their first antenatal checkup during the first trimester of pregnancy.

Source of Data and Data Collection Procedure

The data were available from various secondary sources in the public domain. In India, the National Family Health Survey (NFHS) provides information on fertility, family planning practices, including infant and child mortality, utilization of maternal and child health-care services, and nutritional status in addition to socioeconomic and demographic characteristics of a household. Information on determinants of health was used from the NFHS 4 dataset.[10] Population statistics and proportion of schedule tribe and schedule caste population were obtained from the 2011 population Census of India.[11] Workforce and health infrastructure information were obtained from RHS Bulletin 2014–2015 and the Government of Assam official website for health.[12,13]

The maternal death review (MDR) was implemented in India since 2010. Although there was incomplete reporting initially, this system has picked up momentum now. The Government of Assam has started a web-based maternal death reporting system.[14] The data regarding the actual number of maternal deaths in each district during 2015–2016 were obtained from the official website of National Health Mission, Assam.[15] The birth cohort for the estimation of MMR was obtained from the Health Management Information System 2015–2016[16] for each district. Data collected from various sources were entered into an Excel sheet in a systematic manner.

Inclusion and Exclusion Criteria

Fully functional districts were included in the study and districts which were not fully functional were excluded from the study.

Statistical Analysis

The MMR was calculated by dividing the total number of reported maternal deaths during 2015–2016 in each district by the total number of live births for the same district for the same time period and MMR was expressed per 100,000 live births. Data obtained from different sources were entered and compiled into an Excel sheet and checked for completeness and consistency. Descriptive analysis was performed and Pearson correlation coefficient analysis was performed to assess the correlation between maternal mortality and demographic, socioeconomic, nutritional, health service availability, and utilization indicators. This was followed by linear regression analysis to assess the relationship between MMR and the 14 indicators at the district level by calculating the regression coefficient at 95% confidence interval (CI). We also calculated the R^2 to examine the variance in MMR in relation to each indicator. All statistical analyses were conducted using SPSS version 20. The results were considered to be significant at $P < 0.05$.

RESULTS

We included 27 districts in the study. The description of MMR and 14 indicators are shown in Table 1.

There were a total of 1073 reported maternal deaths in Assam during 2015–2016. The mean MMR was 164/100,000 live births, with a calculated range from 46/100,000 live births in Kamrup rural to 450/100,000 live births in Cachar district. Fourteen districts had MMR above the state average. More than 70% of the population in each district lived in rural

Table 1: Description of maternal mortality ratio and health-related indicators among districts of Assam

Indicators	Mean (standard deviation)	Range
Maternal mortality ratio	164 (88.81)	46–450
Demographic indicators		
Rural population (%)	86.19 (14.96)	17.1–98.7
Backward population (%)	31.17 (23.62)	4–83
Socioeconomic indicators		
Households with access to safe drinking water (%)	81.65 (15.89)	48–99
Women with at least 10 years of schooling (%)	26.1 (8.09)	13-48
Teenage pregnancy (%)	14 (5.95)	7–31
Nutritional status indicator		
Pregnant women with anemia (%)	45 (10.61)	36–66
Health service availability indicators (per million population)		
Community health centers	4 (1.93)	1–9
Primary health centers	34 (12.03)	17–58
Subcenters	153 (43.35)	41–304
Density of physician	124 (118.02)	33–505
Density of auxiliary nurse midwife	325 (105.42)	160–719
Health service utilization indicators		
Women who had their first antenatal care during the first trimester (%)	56 (10.54)	36–82
Institutional delivery (%)	72 (15)	44–96
Full immunization coverage (%)	49 (13.97)	20–73

areas with the proportion of ST and SC population ranging from about 4% in Dhubri to 83% in Cachar. The proportion of households with access to safe drinking water was ranged from 48% in Dima Hasao to 99% in the Dibrugarh district. The overall female literacy rate in Assam, according to the 2011 census, was 66.27%. NFHS 4 reported women with at least 10 years of schooling and it ranges from 13% in Karbi Anglong to 48% in Kamrup Metro. We found on average 14% of teenage pregnancy with a range from 7% in Sonitpur to 31% in Goalpara. We found that on average 45% of the women were reported to have anemia during pregnancy (hemoglobin level <11 g/dl) the highest being 66% in Cachar and the lowest 36% in Golahat.

The distribution of workforce and facility varies across the districts with a mean of 325 ANM per million populations ranging from 160 in Morigaon to 719 in Dima Hasao per million population, 34 PHCs per million populations ranging from 17 in Cachar to 58 in Nalbari and 4 CHCs per million populations ranging from approximately 1 in Cachar to 9 in Dima Hasao and Nalbari district. According to the reported data, Dibrugarh district had the lowest number of Subcenters per million population (41 per million) and Chirang had the highest (304 per million population). There was average of 124 physicians per million populations in the state that ranged from only 33 in Karimganj district to 505 in Jorhat district. The proportion of women who had their first antenatal checkup during the first trimester was lowest in Dhubri district (36%) and highest in Jorhat district (82%) with a mean of 56%. On average, 72% of the deliveries were reported to be in health institutions with the lowest 44% in Dhubri and the highest being 96% in Jorhat district. The proportion of fully immunized children was lowest in Dhubri (20%) and highest in Sivasagar (73%).

The Pearson correlation analysis was done to assess the correlation between the dependent variable MMR and 14 district-level indicators (independent variable), as mentioned in Table 2. There was a positive correlation between MMR and proportion of pregnant women with anemia and it is statistically significant ($r = 0.448$; $P = 0.019$).

We observed a negative correlation between MMR and proportion of the rural population ($r = -0.45$) and it was statistically significant ($P = 0.018$). The number of CHCs ($r = -0.38$) per million populations had a significant negative correlation with MMR ($P = 0.049$). There was also a negative correlation between MMR and proportion of households with access to improve drinking water ($r = -0.52$) which was statistically significant ($P = 0.005$).

The linear regression analysis showed that out of the 14 indicators, only four were associated with maternal mortality at the district level at $P < 0.05$ [Table 3]. MMR decreased linearly per proportion increased in the rural population in a district and this factor accounted for 20% of variability in MMR among districts (B = −2.67; 95% CI −4.85–−0.48; $R^2 = 0.203$; $P = 0.018$). The proportion of households with access to safe drinking water which was used as a socioeconomic indicator was found to have a strong negative

Table 2: Correlation between maternal mortality ratio and health-related indicators in Assam during 2015–2016

Indicators	Correlation coefficient (*r*)	*P* value
Demographic indicators		
Rural population (%)	−0.45	0.018
Backward population (%)	0.227	0.255
Socioeconomic indicators		
Households with access to safe drinking water (%)	−0.52	0.005
Women with at least 10 years of schooling (%)	−0.005	0.980
Teenage pregnancy (%)	−0.29	0.142
Nutritional status indicator		
Pregnant women with anemia (%)	0.448	0.019
Health service availability indicators (per million population)		
Community health centers	−0.38	0.049
Primary health centers	−0.35	0.074
Subcenters	0.09	0.665
Density of physician	0.002	0.99
Density of auxiliary nurse midwife	0.025	0.902
Health service utilization indicators		
Women who had their first antenatal care during the first trimester (%)	−0.225	0.258
Institutional delivery (%)	0.007	0.971
Full immunization coverage (%)	0.244	0.22

P<0.05 is considered as statistically significant

Table 3: Factors associated with MMR at the district level in Assam

Factors	MMR		
	Coefficient of association (β) with 95% confidence interval	R^2	*P* value
Demographic indicators			
Percentage of rural population	−2.67 (−4.85–−0.48)	0.203	0.018
Percentage of backward population	0.85 (−0.65–2.36)	0.052	0.255
Socioeconomic indicators			
Percentage of households with access to safe drinking water	−2.91 (−4.87–−0.94)	0.270	0.005
Percentage of women with at least 10 years of schooling	−0.05 (−4.57–4.46)	0	0.98
Percentage of teenage pregnancy	−4.33 (−10.20–1.55)	0.084	0.142
Nutritional status indicator			
Percentage of pregnant women with anemia	3.75 (0.66–6.83)	0.200	0.019
Health service availability indicators (per million population)			
Community health centers	−17.39 (−34.83–0.06)	0.144	0.049
Primary health centers	−2.58 (−5.43–0.27)	0.122	0.074
Subcenters	0.18 (−0.66–1.03)	0.008	0.665
Density of physician	0.001 (−0.31–0.31)	0	0.99
Density of auxiliary nurse midwife	0.02 (−0.33–0.37)	0.001	0.902
Health service utilization indicators			
Percentage of women who had their first antenatal visit during the first trimester	−1.89 (−5.28–1.48)	0.051	0.258
Percentage of institutional delivery	0.04 (−2.39–2.48)	0	0.971
Percentage of full immunization coverage	1.55 (−0.99–4.09)	0.059	0.22

MMR: Maternal mortality ratio

association with MMR and also accounted for the maximum variability in the outcome (B = −2.91; 95% CI −4.87–−0.94; R^2 = 0.270; *P* = 0.005) [Figure 1]. Anemia during pregnancy used as indicators of nutritional status was another factor

that had a significant association with MMR [Figure 2]. MMR increased linearly with each proportion increase in pregnant women with anemia at the district level accounted for 20% variability (B = 3.75; 95% CI 0.66–6.83; $R^2 = 0.200$; $P = 0.019$). None of the indicators included within the utilization of health services were found to be associated with MMR in the linear regression analysis. Out of the health service availability indicators only, the number of CHCs per million population was found to have a negative linear association with MMR [Figure 3] and accounted for about 15% of the variability in MMR at the district level (B = −17.39; 95% CI −34.83–−0.06; $R^2 = 0.144$; $P = 0.049$). Other factors such as proportion of the backward population, women with at least 10 years of schooling, teenage pregnancy, number of PHCs and SC per million populations, density of physician, density of ANM, proportion of women who had their first antenatal care (ANC) during the first trimester, institutional delivery, and full immunization coverage were not found to be associated with variability in MMR at 5% level of significance in the present study.

DISCUSSION

In this study, we found that four indicators were associated with variation in maternal mortality at the district level in Assam. The proportion of rural population, households with access to safe drinking water, and number of CHCs per million populations had a negative linear association with MMR at the district level. The proportion of pregnant women with anemia had a positive linear association with MMR. Indicators for utilization of health service were not found to be associated with MMR at 5% level of significance.

The variation in maternal death by rural population was different from observation of other authors.[15] It may be due to two diverse scenarios. Maternal deaths now mostly occur in the district and tertiary level hospital, which are likely to be concentrated in the urban areas. With accelerated efforts and infrastructural expansion to reduce maternal death, complicated pregnancies and deliveries are referred early to the referral hospitals. These deaths were reported in facility-based MDR and this possibly explains the inverse association of MMR and proportion of rural population. This rationale also explained the wide variation in MMR across districts and low MMR observed in some districts. A second scenario was that maternal deaths in interior rural areas are yet not identified by the maternal death reporting system.

The MMR of Assam was 237 in 2014–2016 as per the report published in the SRS special bulletin on maternal mortality in India, 2014–2016. The estimate for the Barpeta district based on surveillance of all maternal deaths in 2015–2016 was 225 for the district.[17] We found 164 maternal deaths per 100,000 live births in the present study. It may be due to underreporting of maternal deaths in some districts. The

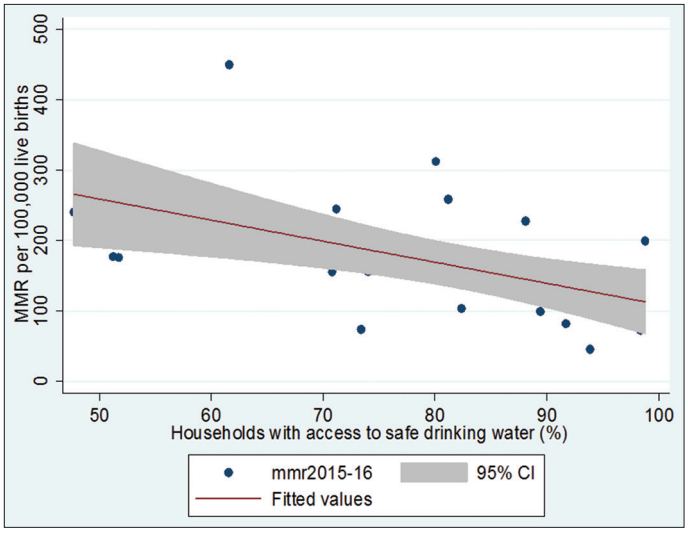

Figure 1: Relationship between maternal mortality ratio and percentage of households with access to safe drinking water at the district level in Assam

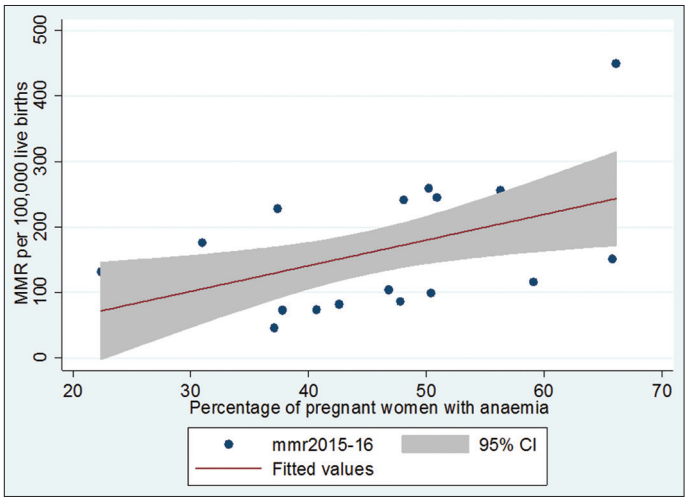

Figure 2: Relationship between maternal mortality ratio and percentage of pregnant women with anemia at the district level in Assam

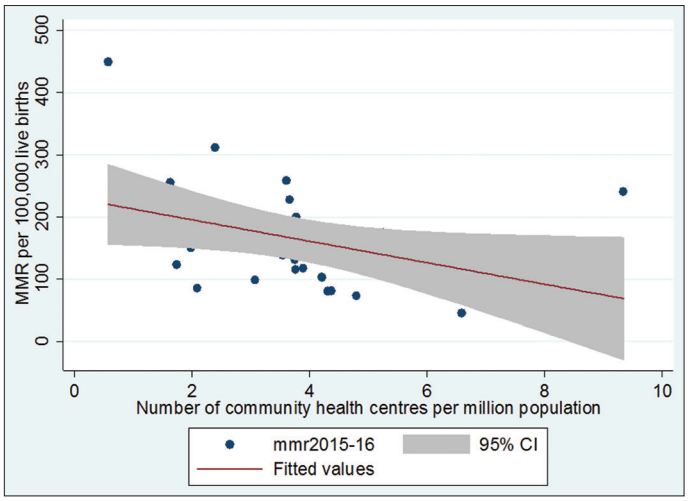

Figure 3: Relationship between maternal mortality ratio and number of community health centers per million population at the district level in Assam

household access to improve drinking water source was used as indicator socioeconomic status and had an inverse relationship with MMR and this indicator highlighted the disparity in maternal mortality by socioeconomic status. Household access to improved drinking water source implies infrastructural expansion in non-health determinants. CHCs have emergency obstetric care which, if functions adequately can prevent maternal death, justifying the plausible inverse association between the proportion of CHCs per million population and MMR. As per population norms for a million populations, there should be 200–400 ANM, 200 subcenters, 34 PHCs, and 10–12 CHCs. Except for ANM, there was inter-district difference in the distribution of health facilities. Anemia during pregnancy has been shown to be an important risk factor for severe complications and deaths during pregnancy and childbirth by many studies[18-20] which substantiates the finding of a positive linear association between the percentage of women with anemia during pregnancy and MMR.

In a study in Kashmir valley found that 9.38% of women received ANC during first trimester at sub-center level which is much lower than our study (56%) and this difference may be due to the utilization of ANC services at different health facilities in our study.[21] We found 72% institutional delivery in our study and a study in peri-urban area of Aligarh found that 77% of deliveries were institutional.[22] The proportion of women utilizing ANC services early in pregnancy and delivering in health institutions has been gradually increasing over the years, mainly due to the cash incentive scheme such as the Janani Suraksha Yojana, but as noted in other studies, increase in institutional delivery or ANC checkup will not lead to a decrease in MMR[23,24] without improvements in quality of care. Women level of education could have an indirect effect on MMR, which could not be captured in this study. Many studies[25-27] on a case basis have identified backward caste, low literacy as statistically significant variables. Our observation could be the result of an ecological fallacy. Furthermore, many variables used as indicators were interlinked and lie in the intermediary pathway and contribute cumulatively to maternal mortality. A robust data set will be required to establish these associations.

Strength and Limitation of the Study

Assam has the highest maternal mortality in the country and the present study attempts to assess the factors associated with inter-district variation of maternal mortality in Assam. To the best of our knowledge, this is the first study in this region to assess the factors associated with inter-district variation of maternal mortality.

This study has many limitations. It is an analysis of district-level data which can only provide a broad overview of the factors that could be associated with maternal mortality in Assam. We only included few indicators as a measure of socioeconomic status, which may not be able to capture the true prevalence of socioeconomic disparity across the state. The observations may not reflect the true picture related to MMR as the analysis was done based on district-level secondary data collected from different sources.

CONCLUSIONS

Demographic, socioeconomic, nutritional, health service availability, and utilization indicators were important correlates of maternal mortality. The proportion of rural population, households with access to safe drinking water, pregnant women with anemia, and CHCs per million populations were associated with inter-district variation of maternal mortality in Assam. Maternal death is a health equity issue and activities in both health and social sectors are needed for its reduction. Macro- and microdeterminants of maternal mortality both at the population level and the individual case level can influence maternal mortality. We believe that the health and social determinants of maternal mortality vary at population and case level. An analysis of these determinants at the district level on a population basis and a case-to-case basis will provide the evidence for purposeful planning for the reduction of maternal deaths. The present study may be useful for future in-depth study of factors associated with maternal mortality and appropriate action may be taken for the reduction of maternal mortality based on the study results.

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