CHAPTER IV

A New Approach to Maternal Mortality Estimation

4.1 Introduction

The difference of longevity between male and female is biological as well as social and exact difference lies under the concept of pregnancy and childbirth. During a certain period, this issue creates longevity problems for female. Otherwise female has an obvious advantage of surviving more number of years than male. This crucial period of pregnancy and childbirth puts the women of reproductive age group into a greater risk of death than male. Visalia (1971) in his study on the sex ratio of India’s population singled out maternal mortality as the main cause for deficit of females found in the part of the world. It’s a matter of concern that no one knows how many woman dies from this cause. The subject might not have been given due importance and perhaps the present status itself is indicative of the position accorded to woman in India. Through the situation appears slowly to be changing as a result of the motherhood initiative, its information on the level and trend in maternal mortality remains to be fragmentary in India and
finding often must be based on studies of a small, selective cross section of the society.

4.2 Review of Literature

Review of the literature suggests the above viewpoint. The earliest reference to maternal mortality in India has been seen in the government's Health Survey and Development Committee report of 1946 (also known as the Bhore Committee Report). Analyzing the data available to them, the committee penned down that the country's maternal mortality ratio (MMR) was about 2000 deaths per 100,000 live births (Government of India 1946). Another committee constituted for the same purpose in the late 1950s (known as the Mudaliar committee) concluded that maternal mortality had come down to 1000 deaths per 100,000 live births (Government of India, 1961). The conclusion of the committee might have been subjected to steady decline in the maternal deaths recorded in the Health Research Station at the Poonamalle near Madras, Singur near Calcutta, Ramnagaram near Bangalore. Pregnant woman especially susceptible to malaria infection that had suffered higher fatalities than those who were not pregnant (Visaria, 1971) was thought to be the principal cause of higher maternal mortality in early
days. The decline due to malaria deaths might be considered as the main reason for decline in maternal mortality ratio.

During the first half of seventies, Sen Gupta and Kapoor (1972) undertook a study of maternal morality and concluded that MMR had come down to the range of 400-500 deaths per 100,000 live births. The data from the Survey of Cause of Death (Rural), a scheme of the Registrar General, India's office appeared to support this view. Afterwards it has been established that previous assessments of maternal mortality might have been underestimated the actual levels considerably and that hardly there has been any decline. The study during early nineties based on reviews of hospital data have indicated an MMR of more than 1,000 deaths per 100,000 live births in India (Jejeebhoy and Rao, 1992 and World Health Organization, 1990). The results of the study sponsored by the World Health Organization (WHO) for a community in Anathpur district of Andhra Pradesh have given some credence to this view. An MMR of 798 deaths per 100,000 live births during 1984 to 85 for the district with 830 deaths rural areas 585 deaths in urban areas (Bhatia, 1988 and 1993) had been estimated by the study. This finding was also contradicted by the estimate based on the data available during that in Maternal and Child Health (MCH) division of
the Union Ministry of Health and Family Welfare. The largest collection of hospital based data from 109 hospitals from all over the country for 1992 has shown an MMR of 495 deaths per 100,000 deliveries for the nation as a whole (Government of India, Ministry of Health and Family Welfare {MOHFW}, 1994). The Indian Council of Medical Research undertook a study in 1990 in seven districts of Uttar Pradesh. The study revealed estimated MMR of 620 deaths per 100,000 live births.

The first National Family Health Survey conducted throughout the country in 1992 to 93 estimated an average MMR for the 2 yrs period preceding the survey as 420 deaths per 100,000 live births for the country as a whole, with 431 deaths in rural areas and 380 deaths in urban areas (Kanitkar et al., 1994). The 2\textsuperscript{nd} National Family Health Survey projected an estimated of 540 maternal deaths per 100,000 live births for the country as a whole, with 618 deaths in rural areas and 267 deaths in urban areas for the year 1998-99.

There are always some limitations in all those estimates in which data are based on hospital record and community level investigations as these are highly localized and suffer from the problems of nonrandom case selection, in adequacies of sample size, and incomparable reference period. Though localized studies may be representative of the
specific study area, but generalizing these results for the country like India might not be a justified proposition. Further, surveys stressing upon one issue always runs the risk of over expositing its significance at the expense of other. That's the reason that all these studies provide different levels of MMR. It may be mentioned that in the WHO review, it has been revealed that the estimates of MMR varies from a low of 50 to more than 3,000 deaths per 100,000 live births. It is therefore very difficult to assess the actual level of MMR

4.3 Various Method of Maternal Mortality Estimation

Due to large sample size requirement for direct calculation of MMR, some indirect techniques have been suggested for estimation of maternal mortality. Sisterhood method is one of them. In this method, women and men are asked to recall the number of their sister who died during pregnancy, delivery, and the puerperium among those who were ever married at the time of the survey (Graham et al., 1989). Though the requirement of sample size is considerably lower than direct estimation, it depends heavily on the recall of long past events. On the one hand these estimates suffer from recall lapses, on the other hand it can not be estimated for a recent period and might not be sensitive to the assumed level of fertility. Further the method consistently requires the collection of
data of a specialized nature and, hence, cannot be used in all practical purposes.

In case data on cause of death are not available, another indirect method suggested is to estimate MMR from age and sex specific death rates. This method makes use of information that is routinely collected on a large in censuses, surveys, and registration systems. This does not necessarily reduce the sample size. Blum and Fugues (1990) suggested two methods using this information. For the first method, they assume that the ratio of women’s to men’s mortality would change linearly between ages 10 and 45 in the absence of maternal deaths and the variation of the observed ratio from this norm could be attributed to maternal mortality. In the second method, they assumed that the age schedule of female mortality would follow the Gompertz law under the same condition. During early nineties accidents and violence among adults was one of the major causes of deaths. Blum and Fugues might have ignored these causes as studies of India and China suggests that homicides, accidents and suicide are major causes of women of reproductive age group of women (Bhat, 1991). Further in late nineties, the women in general have an added advantage of surviving more than men. Age Specific Death Rates for Females have declined in
comparison to male. This issue has not been taken into account. Another indirect method has been suggested for estimation of MMR. In this method sex differentials in mortality for people of reproductive age are related to the age schedule of fertility (Mari Bhat, Navaneetham and Irudaya Rajan, 1995). For estimation of MMR, assumptions were 1) data on ASDR from all causes are available for males and females, 2) data on ASFR are also available, 3) the ratio of maternal mortality at different age intervals to that age interval 20-24 is either available or can be borrowed from another population (that is, the age pattern of the maternal mortality is known) and 4) the age pattern of the sex-ratios of death rates in the absence of maternal mortality can be expressed either as a smooth or kinked function of age with a few unknown parameters. This method has many problems. Apart from reliability, it has estimation problems. The availability of data on MMR for age 20-24 is itself a problem. It can be seen that most of the MMR comes from the age 15-29 and in such cases the requirement of estimates on maternal mortality for age 20-24 may not be fulfilled.
4.4 A New Method for Estimating Maternal Mortality

All the above suggested methods lack in one way or the other. The data on MMR have been so precious that no uniform data base for the country or state wise are available to any Government or non-Government agencies, though it is very much required for health planning. The First and Second NFHS have come up with state wise MMR for the years 1992-93 and 1998-99 respectively. The Sample Registration System of Office of the Registrar general, India has provided estimates of MMR for the years 1997 and 1998 and afterwards, the office have stopped publishing MMR on the excuse of small sample size and merging of its Survey of Causes of Deaths (Rural) scheme under the Sample Registration System(SRS). Further area specific studies and other related studies are not going to fill up the vacuum. In view of the above, attempts have been made to find out an way to arrive at a level of MMR for each year based on available data published by National level Surveys like the SRS. As to get data on pregnancy, delivery, and the puerperium has become increasingly difficult, the only way to establish a level of MMR is to look at the age specific death rate for male as well as female. Earlier studies have taken into account the
age specific death rate for estimating MMR, but could not come to a logical end so that it becomes handy for all practical purposes.

In the present study, an attempt has been made to estimate maternal mortality from age-sex specific mortality along with married female. Study of mortality pin-points some caveats through which a level of MMR can be estimated in Indian condition. From the available data, MMR can be estimated on continuous basis for each year. Some patterns have emerged such as:

1) In recent years, in general, age specific death rate (ASDR) of female is comparatively lower than male. It means the female has an added advantage of surviving more number of years than male. Probability of survival in each age group of female except perhaps in age group 0-4 in some areas is more than male.

2) Under the assumption that if biological aspect remains same, the probability of survival of male and female is assumed to follow Binomial Probability Distribution. However it is observed that in the reproductive age group of female, 15-34 in particular, age specific death rate for female is more than the male. Biological difference between the female and male is the difference of reproductive
system. It is assumed that deaths occur due to reproductive activities, though it may not be the sole factor.

3) Due to irregular reporting of age it often runs into problems of distortion of age specific mortality in different age group resulting in underestimation/overestimation of age specific mortality. To remove the irregularities, it is always suggested to smoothen the data with available methods. However smoothing sometimes goes unwarranted due to some undesired values and required to be removed. It has been experienced that replacement of values with trend setters works well to estimate the desired parameter.

4) In earlier studies, age specific mortality has been entangled with age specific fertility for estimation of maternal mortality. In the present method of estimation of maternal mortality, the probabilities of married female in the reproductive age have been considered. It is generally observed that the age specific fertility for the age group 15-19, 20-24 & 25-29 are much higher than any other age group. But the probability of married female in the age group 15-19 is the lowest in most of the states in India. More over the mean age at marriage has gone up over the years. Keeping in view this issue, it is suggested to use probability of married female.
5) The Census provides decadal population. For estimation of maternal mortality on yearly basis, it is required to use projected population based on exponential growth rate.

Under the above assumption, the composite index attributable to a female of reproductive age group dying due to reproductive activities may adhere to the following model

$$\xi_{ijk} = \mu + \alpha_j + \epsilon_{ijk}$$

Where $\xi_{ij}$ is the composite index of probability of dying of $i^{th}$ woman of $j^{th}$ age group; where $-3 \leq \xi_{ijk} \leq 3$. However, the value of $\xi_{ijk}$ comes out to be negative, it is assumed there are no maternal deaths in that age group and number of maternal deaths is taken to be zero.


$$\mu = \Pr.(L_d) - \Pr.(f_d),$$

Where $\Pr.(L_d) = $ Probability of death of a person of any age group,

$\Pr.(f_d) = $ Probability of death of a female of any age group i.e. $\mu$ is the probability of survival of a woman more than man or it's a general advantage of surviving by a woman in the segment/region/state under consideration. The state where this advantage does not exist, the advantage of female survival over male for the country as a whole may be substituted.
\[ \alpha_{ij} = \text{Pr.(} f_{dij} \text{)} - \text{Pr.(} m_{dij} \text{)} \]

where \( \text{Pr.(} f_{dij} \text{)} = \) Probability of \( i^{th} \) female dying in the \( j^{th} \) group (reproductive age group); \( \text{Pr.(} m_{dij} \text{)} = \) Probability of \( i^{th} \) male dying in the \( j^{th} \) group.

\[ \epsilon_{ijk} = \text{Pr.(} f'_{dijk} \text{)} - \text{Pr.(} m'_{dijk} \text{)}, \]

Where \( \text{Pr.(} f'_{dijk} \text{)} = \) Probability of \( i^{th} \) female dying in the \( j^{th} \) group (reproductive age group) being replaced due to absurd fluctuation of \( k^{th} \) year and

\( \text{Pr.(} m'_{dijk} \text{)} = \) Probability of \( i^{th} \) male dying in the \( j^{th} \) group (reproductive age group) being replaced due to absurd fluctuation of probability of death of \( k^{th} \) year. In case replacement is not required to be done keeping in view the level, \( \epsilon_{ijk} = 0 \).

So, \( \xi_{ijk} = \text{Pr.(} L_{d} \text{)} - \text{Pr.(} f_{d} \text{)} + \text{Pr.(} f_{dij} \text{)} - \text{Pr.(} m_{dij} \text{)} + \text{Pr.(} f'_{dijk} \text{)} - \text{Pr.(} m'_{dijk} \text{)} \)

Further \( \xi_{ijk} \)'s are allied with the probabilities of married female and the number of estimated female population of the respective age group. Let \( \xi_{ijk} \) be the probability of \( i^{th} \) married female of \( j^{th} \) group of \( k^{th} \) year or period and let \( p_{jk} \) be the estimated population of \( j^{th} \) group of \( k^{th} \) year, then the number of maternal deaths \( M_{k} \) in a year (say \( k^{th} \) year) is given by
\[ M_k = \sum_{ij} \xi_{ijk} \cdot \xi_{ijk} \cdot p_{jk} \]

If birth rate of kth year is \( b_k \) and estimated population is \( P_k \), then the estimated birth for the kth year is calculated as

\[ B_k = P_k \cdot b_k \]

Therefore, the maternal mortality rate \( \hat{W}_k \) for kth year is given by

\[ \hat{W}_k = \frac{M_k}{B_k} \cdot 1,00,000 \]

**Calculation Procedure**

**Step 1:** Calculation of \( \mu = Pr. (t_d) - Pr. (f_d) \)

As this component arises due to overall advantage of survival of female over male & female (total), the probability of death of male as well as that of female are calculated from state level rates irrespective of age under the assumption that each death is equally probable. In case of the states where female death rates are more than male, this advantage component will be replaced by all India death rates.

**Step 2:** Calculation of \( \alpha_{ij} = Pr.(f_{dij}) - Pr.(m_{dij}) \)

Under the assumption that each death of female in the reproductive age group occurs with equal probability, \( Pr.(f_{dij}) \) can be calculated from the age specific death rates of the state under
consideration. Similarly Pr.(m_{dij}) can also be calculated under the same assumption.

Step 3: Calculation of Pr. (f_{dijk}^\prime) - Pr.(m_{dijk}^\prime)

This needs to be done if required. For this one has to study the trend of step 2. Graphic presentation of age specific death rates for the reproductive age group will suggest which value is to be replaced. Otherwise procedure of calculation is the same as step 2.

Step 4: Calculation of \( \xi_{ijk} \)

The probability of married female for each age group can be calculated from the distribution of female population by age group and marital status.

Step 5: Calculation of \( \rho_{jk} \)

The value of \( \rho_{jk} \) i.e. the projected female population can be estimated using usual theory or it can be taken from the published figures available in various Government of India documents.

Step 6: Calculation of \( B_k \)

Estimated births can be estimated using birth rates of the particular year from the available published data.
4.5 Estimation of Maternal Mortality Rates using the new method

Maternal mortality of Assam has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose number of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Assam for the age group 20-24 of the order of 1300 followed by the age group 35-39. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand.

From the Table 4.1, it reveals that the estimated population for Assam in 1997 is 25275000. Estimated births are 712755 and estimated maternal deaths are 2861. With these values, the MMR has been estimated as 401. The maternal mortality rate for the year 1997 for Assam has been estimated to 401 which are almost close to the estimate provided by Sample Registration System. The MMR estimated by SRS for the year for Assam is 409. The MMR estimated by SRS for
all-India is 407 for 1997. So the status of health for mother in Assam is the same as average Indian mother.

Maternal mortality of Bihar has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose number of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Bihar for the age group 25-29 of the order of 4500 followed by the age group 35-39. Estimated number of maternal deaths by the prescribed method has come out to close to fifteen thousand.

From the Table 4.2, it reveals that the estimated population for Bihar in 1997 is 96371000. Estimated births are 2997138 and estimated maternal deaths are 15054. With these values, the MMR has been estimated as 502. The maternal mortality rate for the year 1997 for Bihar has been estimated to 502 which are almost close to the estimate provided by Sample Registration System. The MMR estimated by SRS
for the year for Bihar is 451. The MMR estimated by SRS for all-India is 407 for 1997. So the status of health for mother in Bihar is poorer than an average Indian mother.

Maternal mortality of Andhra Pradesh has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Andhra Pradesh for the age group 25-29 of the order of 1200 followed by the age group 15-19. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand.

From the Table 4.3, it reveals that the estimated population for Andhra Pradesh in 1997 is 74171000. Estimated births are 2032285 and estimated maternal deaths are 3275. With these values, the MMR has been estimated as 161. The maternal mortality rate for the year 1997 for Andhra Pradesh has been estimated to 161 which are almost close to
the estimate provided by Sample Registration System. The MMR estimated by SRS for the year for Assam is 159. The MMR estimated by SRS for all-India is 407 for 1997. So the status of health for mother in Andhra Pradesh is much better than an average Indian mother.

Maternal mortality of Tamil Nadu has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose number of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Tamil Nadu for the age group 20-24 of the order of 2000 followed by the age group 15-19. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand.

From the Table 4.4, it reveals that the estimated population for Tamil Nadu in 1997 is 76934000. Estimated births are 1461746 and estimated maternal deaths are 2629. With these values, the MMR has been estimated as 180. The maternal mortality rate for the year 1997 for
Tamil Nadu has been estimated to be 180 which are little away from the estimate provided by Sample Registration System. The MMR estimated by SRS for the year for Tamil Nadu is 79. The MMR estimated by SRS for all-India is 407 for 1997. So the status of health for mother in Tamil Nadu is much better than an average Indian mother.

Maternal mortality of Assam has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Assam in 1998 for the age group 30-34 of the order of 2000 followed by the age group 25-29. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand.

From the Table 4.5, it reveals that the estimated population for Assam in 1998 is 25646000. Estimated births are 692442 and estimated maternal deaths are 3846. With these values, the MMR for Assam in
1998 has been estimated as 537. The maternal mortality rate for the year 1998 for Assam has been estimated to be 537 which are little far off from the estimate provided by Sample Registration System. The MMR estimated by SRS for the year for Assam is 401. The MMR estimated by SRS for all-India is 407 for 1998. So the status of health for mother in Assam for the year 1998 was poorer than an average Indian mother.

Maternal mortality of Assam for 1999 has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Assam for the age group 30-34 of the order of 2000 followed by the age group 20-24. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand.

From the Table 4.6, it reveals that the estimated population for Assam in 1999 is 25275000. Estimated births are 682425 and estimated
maternal deaths are 3008. With these values, the MMR has been estimated as 441. The maternal mortality rate for the year 1999 for Assam has been estimated to be 441. The MMR has not been estimated by SRS for the year 1999. So it is not possible to compare. However with this method MMR can be estimated for any year on the existing set of data.

Maternal mortality of Assam for 2000 has been estimated with the probabilities of deaths for mother with respect to total for the reproductive age group and advantage of survival with respect to male deaths with certain sort of adjustment wherever required as already explained above. Probability of married female has been taken into account including estimated number of female of 15-49 age groups for the purpose of estimated number of maternal deaths. The following table provides the estimates of all these values. From the data it reveals that the maximum number of maternal deaths has been estimated in Assam for the age group 30-34 of the order of 2500 followed by the age group 15-19. Estimated number of maternal deaths by the prescribed method has come out to close to three thousand six hundred.

From the Table 4.7, it reveals that the estimated population for Assam in 2000 is 26295000. Estimated births are 707336 and estimated
maternal deaths are 3666. With these values, the MMR has been estimated as 518. The maternal mortality rate for the year 2000 for Assam has been estimated to be 518 which is the lone estimate. The value suggests that the condition is becoming worse than before. So the status of health for mother in Assam seems to be at either deteriorating or at stand still.

4.6 Data Analysis

The following Table 4.8 provides a brief of the above results. It provides estimated number of maternal deaths in the states. Seven results have been estimated by the new method. The purpose was to check out the status of Assam and that’s the reason that estimates for Assam for four years have been shown. The estimates for all the years for all major states can be given. However, it is given for the purpose of Assam. It has been seen that estimated number of maternal deaths are not declining though not increasing. Like infant mortality, which is constant in the state for last ten years, the maternal mortality is also stagnant in the state; rather the absolute value is on the higher side. The maternal deaths in 1997 were 2861 with MMR as 401. It has increased to 3846 maternal deaths in 1998 with 537 MMR. It has declined to 3008
maternal deaths in 1999 with 441 MMR and further increased to 3666 with 518 MMR.

It is therefore concluded that Maternal Mortality Rate in Assam lies in the range of 400-500 for last several years. It is not coming down. Rather some times goes up. Special efforts required to be taken up to bring down the rates.

Tables pertaining to the chapter IV are given in Annexure III.