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Maternal Mortality in Madhya Pradesh, India

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Introduction

In recent years, increasing attention is being directed to improving the maternal reproductive health. The safe motherhood initiative launched in 1987 has been successful in drawing the attention of policy-makers and programme managers at international, national, state and local levels to the tragedy of pregnancy and birth-related deaths which, given the low priorities to the health needs of the women, is better known as the 'silent tragedy'. Among the numerous factors responsible for this silent tragedy, an important one is the difficulties in measuring its magnitude. A female death resulting out of the complications of pregnancy and child-birth is a rare event. Traditional approaches of estimating the levels, trends and differentials of mortality in general such as hospital based studies and sample surveys have serious limitations in capturing levels, trends and differentials in maternal mortality because of the rarity of maternal deaths. Hospital-based studies are not representative of the situation that prevails in the community because majority of women attend the hospital only in case of emergency and so have a high case fatality, especially in populations where access to care is low. On the other hand, field-based studies require a very large sample to be surveyed to estimate the risk of death due to complications of pregnancy and child birth with some degree of statistical reliability. Probably and so obviously, the vital registration system may be the answer but the system is awfully weak in terms of completeness and quality in most of the developing countries. Even in developed countries where vital registration is almost complete, there are problems related to incomplete classification of the cause of death (AbouZahr and Royston 1991; Berg, et al. 1996: Bouvier-Colle et al. 1991; Hibbard 1994; Kaunitz et al. 1985; Magnin and Nicollet 1984; Rubin et al. 1981; Smith et al. 1984; Turnbull et al. 1989). This lack of information about the risk of a death due to complication of pregnancy and child birth is a major hindrance in the identification of crucial areas for action. It is argued that the lack of information about maternal mortality levels, trends and its determinants is one of the major factors that contribute to the neglect of maternal reproductive health (Campbell and Graham, 1996).

In response of the need to collect and analyze information about maternal mortality, a number of alternative approaches have been suggested. These approaches may be grouped into two categories - survey-based approaches and model-based approaches. In the survey-based approach of estimating the risk of death due to complications of pregnancy and child birth, the attempt is to expand the sample by collecting information about all siblings of the respondent. This approach may also be viewed as a way of obtaining information about those who, because they have died, can no longer be surveyed (Stanton et al. 1996). The model-based approach on the other hand estimates the risk of death due to complications of pregnancy and child birth either from the age and sex pattern of mortality or from the empirical relationship between maternal mortality and a number of explanatory variables. This approach is particularly useful for

estimating maternal mortality at the local level where conducting the field survey is a difficult proposition because of time and cost considerations. In the absence of information either from the vital registration system or from the survey, the model-based estimates provide a quick although crude estimates of the risk of death due to complications of pregnancy and child birth.

In this paper, we first briefly review different approaches developed for estimating maternal mortality in situations where vital registration is not complete and reliable. We then develop a simple approach of estimating the risk of a maternal death on the basis of the empirical relationship between the risk of death due to complications of pregnancy and child birth with the risk of death during infancy and the type of attention at the time of delivery and use this approach for estimating the risk of death due to complications of pregnancy and delivery in Madhya Pradesh along with the lifetime risk of maternal death being faced by the women of the state. The approach developed in this paper can easily be used at the local level because of its simplicity and because of the fact that the risk of death in infancy and information about the type of attention at the time of delivery can easily be obtained even at the grass roots level.

Definition of Maternal Mortality

The cause of a maternal death has traditionally been grouped into two categories - direct causes where pregnancy causes death and indirect causes where an underlying disease is aggravated by pregnancy (Macfarlane and Mugford 1984). In the past, most of the indirect causes of maternal death were excluded in estimating maternal mortality as may be seen from the description of pregnancy-related deaths prior to the Ninth revision of the International Classifications of Diseases, Disability and Causes of Death (ICD) prepared by the World Health Organization (WHO 1967). The Ninth revision of the ICD includes direct and indirect causes of death during pregnancy or within 42 days of the termination of pregnancy in defining pregnancy related deaths (WHO 1977). The Tenth revision retains the definition used in the Ninth revision, but adds two new categories. The first category is of 'late maternal deaths' that occur between 42 days and one year. The second category includes a 'time of death' definition among the 'pregnancy related deaths'. This category includes all deaths in pregnancy or within 42 days of termination of pregnancy irrespective of cause (WHO 1983; WHO 1986).

There are at least three issues in measuring maternal mortality according to the definition given in the Tenth revision: (1) the appropriateness of defining a maternal death by a time of death definition, (2) the difficulty of defining the cause of death, and (3) appropriate denominator for illustrating the maternal mortality. A detailed discussion of these issues is given elsewhere (Campbell and Graham 1996). It is argued that adopting the time-of-death definition as proposed in the Tenth revision would facilitate data collection on maternal deaths since special questions could be included in death registers and in survey

questionnaires to ask whether a woman was pregnant or recently delivered. Adopting the time-of-death definition will also eliminate the determination of pathogenic causes of death. It is also argued that many deaths defined as incidental or accidental deaths, such as deaths due to violence, are a direct result of pregnancy and pregnancy outcome. It has been observed that in developing countries, between 80-95 per cent of deaths during pregnancy or the 42 days after the end of the pregnancy are direct or indirect obstetric deaths (Chen et al. 1974; Fortney et al. 1984). In these situations, incidental or accidental deaths represent only a small proportion of total deaths and may not significantly influence the level of maternal mortality.

The second issue in adopting the time-of-death definition is related to appropriate postpartum time interval. The Tenth revision makes provision for recording two time intervals: pregnancy and 42 days postpartum and 43 days to one year postpartum. The available empirical evidence suggests that about 75 per cent of maternal deaths occur in the last trimester and first week following the end of pregnancy (Alauddin 1986; Chen et al. 1974; Greenwood et al. 1987). It may however be stressed that the proportion of maternal deaths occurring beyond 42 days vary by setting. In any case, there may be residual and cumulative effects of childbearing on long-term mortality even after adjusting social class (Green et al. 1988).

The third issue in defining the maternal death is related to the desirability and feasibility of distinguishing between direct, indirect and incidental causes of death. A number of reasons have been cited to suggest that no distinction should be made between direct, indirect and incidental causes of maternal death. First, it is suggested that many deaths classified as incidental may stem from pregnancy. Second, there is no clear consensus on indirect obstetric deaths. Third, classification of the cause of death normally requires assessment by a qualified and medical practitioner. In the developing countries, most of the maternal deaths occur outside hospitals offering little possibility of ascertaining the cause of death. There are also problems in determining which specific condition is the underlying cause of death.

In situations where the cause of death cannot be ascertained medically, the normal practice is to reconstruct them using verbal autopsy or lay reporting techniques that rely on symptom reporting. There is however a great diversity of approaches adopted to identify the cause of death in this manner and the whole approach is very subjective in nature. The problem is further complicated by the fact that in typical settings many of the complications associated with pregnancy are not treated as complications per se and are viewed as normal signs of pregnancy.

Determining that a death is maternal is only the first step in estimating population-based risk of death due to complications of pregnancy and child birth; equally complex issue is the assessment of the person-years of exposure to this risk which is required for the estimation of the probability of death. Since the

period of exposure to the risk of a maternal deaths starts with conception, the number and duration of conception should ideally be assessed to estimate the person-years of exposure to the risk of a maternal death. The complexity and difficulty involved in estimating the number and duration of conceptions calls for using surrogates of person-years of exposure to a maternal death. The World Health Organization recommends using the number of live births as denominator for measuring the risk of a maternal death.

The most commonly used indicators for measuring the risk of a maternal death are maternal mortality ratio and lifetime risk. The maternal mortality ratio may be defined as the risk of a maternal death per live birth; it excludes pregnancy outcomes other than the live birth. It measures the risk of a maternal death once a woman has become pregnant. The life time risk of a maternal death, on the other hand, takes into consideration both the probability of becoming pregnant and the probability of dying as a result of this pregnancy which are cumulated across a woman's reproductive years. In theory, the lifetime risk is a cohort measure like the total fertility rate but it can be calculated on the basis of the maternal mortality ratio and the total fertility rate. Other commonly used indicators include: total number of maternal deaths in a population within a given time period, the maternal mortality rate and the proportion of female deaths of reproductive age due to causes related to pregnancy and child birth. The definitions and measurement implications of these indicators are described elsewhere (Campbell and Graham 1990; Koblinsky et al. 1995). In practice, however, the choice of the indicator reflecting the risk of maternal death is driven by the availability of denominator data. Since information about the number of live births is most easily available or can be estimated, maternal mortality ratio is most commonly used as an indicator of maternal mortality.

Population-based Approaches of Estimating Maternal Mortality

Population-based approaches developed to estimate maternal mortality can be divided into two categories - approaches that use one or the other type of routine data source and approaches that require special studies. In all these approaches primary data on maternal mortality is collected either through one or a combination of data collection techniques. Brief description of these approaches is given below.

a. Vital registration. The vital or the civil registration system is perhaps the most widely available source of information on maternal death. The problem in the use of the registration data, however, is that in most of the developing countries, the coverage of registration is poor and even if the registration may be complete or nearly complete, information on maternal death may not be complete in terms of the underlying cause of death and many other factors. Evidence available from United states, England and Wales and Scotland, Latin America, Egypt, Bangladesh and Jamaica suggest that a substantial proportion of maternal

deaths are either missed or mis-classified (Barno et al. 195; Jewett 1957; Rochat 1981; Rubin et al 1981; Smith et al. 1984; Speckhard et al. 1985; Ziskin et al. 1979; Scottish Home and Health 1987; Turnbull et al. 1989;Puffer and Griffiths 1967; Ehypt MOH 1994; Walker et al. 1986).

b. Health services. Hospital records constitute a second routine source of data on maternal death. A major problem with information available through the health services is the problem of incomplete coverage - in a country like India, majority of maternal death do not take place in health facilities. Moreover, in the health services based information, the problem of denominator remains - hospital records can provide information about the number of maternal deaths taking place in the hospital but they do not provide information about the person-years of exposure to the risk of a maternal death.

The suitability and appropriateness of the vital registration system and health records as the information source for preparing population-based estimates of maternal mortality have been examined by a number of researchers. The general consensus is that the usefulness of the routine data in estimating maternal is at best limited even in countries where the registration system is almost complete (WHO 1986; 1987).

c. Vital registration plus record linkage or interview. One approach of using routine source of information like vital registration in estimating the risk of maternal death is to supplement the information available from vital registration through further inquiry. The approach is particularly suitable where registration is fairly complete but scientific information on cause of death is not available. Generally, three approaches are used to supplement the vital registration data: (1) birth-record linkage, (2) family interview, and (3) hospital linkages. Birth-record linkage involves linking birth registration records to adult female death records. This approach has been tried with some success in United State (Rubin et al. 1981) and in Bangladesh (Koeing et al 1988). One limitation of this approach is that it excludes those women who die undelivered or where infant dies and the birth goes unregistered. A good registration system, preferably computerized, is a pre-condition.

Alternatively, all female deaths of reproductive age registered may be identified and family interviews may be conducted with the relatives of the deceased so as to ascertain maternal deaths. This approach is also known as reproductive age mortality survey approach. It has been successfully used in Egypt (Egypt MOH, 1994).

The third approach consists of tracing hospital records of all female deaths of reproductive age identified through the vital registration system and ascertains the cause of death on the basis of these records. In settings where the hospital records are either not available or incomplete, verbal autopsies involving intevriews with relatives of the deceased would have to be carried out in conjunction with the hospital records.

All the three approaches described above require extensive completeness of the vital registration system. In Jamaica, for example, the vital registration system is regarded as complete but when multiple sources were used to ascertain the cause of death, it was found that only 56 per cent of maternal deaths had been registered (Walker 1989).

The use of routine vital registration or health services data has however little relevance to developing countries as data from these sources are either unavailable or, if available, are inadequate or of poor quality (Hill and Graham 1988). In such settings, household surveys are the only way out to obtain a representative sample of maternal deaths. The problem with household survey is that since maternal death is a rare event, very large sample of households is required to be surveyed to obtain sufficient number of maternal deaths directly, especially if the recall time span under consideration is short. To circumvent this problem, three methodological alternatives or refinements to the direct household survey approach have been proposed. One of these approaches is termed as indirect approach while the other two are termed as direct approaches.

d. The sisterhood method. The sisterhood method is the indirect approach suggested to circumvent the problem of large sample size needed to collect information about maternal deaths in household surveys. This method asks both men and women about their adult sisters who died and then ascertains whether they died during pregnancy, delivery or puerperium (Graham et al. 1989). Asking both men and women increases the number of respondents per household. The method also increases the number of women about whom the information is collected. The main weakness of the method is that it gives retrospective, not a current estimate of the risk of maternal death; estimates of maternal mortality available through the method date 12 years back to the survey date.

e. The Demographic and Health Survey Approach. Like the sisterhood method, the approach adopted in the demographic and health surveys consists of collecting information about the death of adult sisters in the pregnancy or 42 days postpartum. However, rather than modelling the time location as is done in the sisterhood approach, the year of death is also ascertained at the time of the survey. This enables derivation of more recent estimate of the risk of maternal death.

f. The 'networking' or 'snowballing' approach. In this approach, respondents in a survey are asked to identify any maternal death of which they are aware (Boerma and Mati 1989). The method has the potential of identifying many more maternal deaths than the conventional direct method. However, the overall usefulness of the technique is yet to be validated.

All approaches of estimating maternal mortality described in this section require large scale household level surveys to collect primary information about maternal deaths. Organization of large scale household survey incur high costs, difficulties in sample selection, determination of desired sample size, representativeness of the sample and the organizational, managerial and technical

capacity to organize such surveys either at one point of time or at repeated intervals. Since maternal death is a very rare event, this household survey is invariably a massive field exercise despite all innovations in expanding the sample size discussed above. As such, household survey based approaches of estimating maternal mortality have limited use in small populations and in situations where the required resources and technical and managerial capacity for organizing such surveys are not available. In such situations modelling approach may be used to estimate maternal mortality.

Model-based Approaches of Estimating Maternal Mortality

Model-based approaches of estimating the risk of maternal death are most suited in situations where an adequate system of vital registration is lacking or where population based information about maternal deaths is not available from household surveys. Model-based approaches are also suitable at the local level where organization of large scale household surveys at repeated intervals is not feasible. These approaches are either based on the modeling of age pattern of mortality or they are built upon the empirical relationship between the risk of a maternal death with a number of other variables for which the information is readily available. An overview of different approaches is given below.

The first type of model-based approach of estimating maternal mortality consists of developing an empirical relationship between the risk of maternal death and a number of other variables which are found to be correlated with the risk of maternal death on the basis of information from those countries for which reliable estimates of the risk of maternal deaths and other related variables are available. This empirical relationship is then used for estimating maternal mortality either for countries for which no information about maternal deaths are available or for within country lower level administrative units like states and districts. This approach was first used by the World Health Organization for estimating maternal mortality in 85 countries for which no information on maternal mortality was available at that time (WHO, 1991). The World Health Organization used the empirical relationship between maternal mortality ratio and the expectation of life at birth to estimate maternal mortality in these countries. Similar approach has been proposed by Devraj et al. (1994). This approach utilizes the empirical relationship between the maternal mortality ratio and the infant mortality rate for estimating the risk of maternal death. Ranjan (1998) has also used a similar approach to estimate the risk of maternal mortality for the districts of Madhya Pradesh on the basis of empirical relationship between maternal mortality ratio, infant mortality rate and proportion of deliveries attended by professionally trained persons. Recently, World Health Organization in collaboration with United Nations Children's Fund and John Hopkins University has used the regression approach to estimate the proportion maternal of reproductive age female deaths. This proportion is used to estimate the risk of maternal death from the female adult mortality.

Another approach of this kind has been employed by Bhat et al. (1995). Their strategy is to model the ratio of female to male reproductive age mortality as a function of a maternal and non-maternal mortality. The non-maternal component is assumed to change linearly with age, though this assumption may be relaxed. The maternal component is assumed to follow the pattern of age-specific fertility modified by age-group specific risk factors. The data requirements of the approach, however, are substantial, age specific mortality rates, an age pattern of fertility and an age pattern of excess maternal mortality risk relative to the base age group. Boerma (1987) has also developed a model for estimating maternal mortality based on the overall level of adult mortality, the level of fertility and a set of varying assumptions regarding the proportion of female reproductive age deaths due to maternal causes.

A different approach has been adopted by Blum and Fargues (1990) to estimate maternal mortality using existing life tables. Blum and Fargues suggest three approaches of estimating maternal mortality from the age-sex pattern of mortality. One approach requires cause of death data; the second is based on a comparison of the ratios of female to male age-specific mortality rates while the third method provides an approach based only on female age-specific mortality rates. The last approach is based on the assumption that in the absence of maternal mortality, female mortality would follow a Gompertz curve and that the observed positive deviations that are frequently seen in developing country data for women under 45 are attributable to maternal deaths.

It is well known that both male and female age pattern of mortality show a hump during the period 15-49 years. For males, this hump is due to accident related deaths whereas for females, this hump is due to accident plus reproduction related deaths. Analysis of the size and shape of this hump provides useful information about female reproductive age mortality. Ranjan (1999) has characterized this hump through a log-normal function. Once the hump is characterized, the risk of maternal death was estimated with the help of the proportion maternal of female reproductive age deaths.

Ranganathan and Rode (1994), on the other hand, have used an innovative approach to estimate the risk of maternal death. The method used by them uses the proportion of maternal deaths out of total deaths from all ages of both sexes combined in conjunction with the birth rate and death rate to estimate maternal mortality ratio for different states of India. The total number of maternal deaths is estimated on the basis of observed death rate and the proportion of maternal deaths out of total deaths from all causes combined.

An important feature of all model-based approaches of estimating maternal mortality is that they are based either on empirical relationship between the risk of a maternal death and a number of other variables or on empirical patterns of age and sex-specific mortality rates. Since both empirical relationship between variables and empirical patterns of age-specific mortality rates keep on changing with time, the models developed for estimating the risk of maternal

death also keep on changing. In other words, all models of estimating maternal mortality require regular updating as and when new empirical data are available. One implication of this requirement is that model-based estimates of maternal mortality for different time period may be based on different models of estimation and so may not be strictly comparable. It may however be expected that since the causal relationship between the variables in the model remains unchanged, the margin of error resulting out of the change in the specifications of the model may not be significant enough to hamper the comparability.

The Method

The method that we use here to estimate the risk of maternal death is based on an analysis of the determinants of maternal mortality. Efforts to develop a framework through which a maternal death can be linked with a set of proximate and background variables are rare. Fathalla (1987) has described 'the road to death' that women follow. This road to death starts with underlying social and economic conditions facing women and continues to include demographic and health related factors including attention and care at the time of pregnancy and delivery. Thaddeus and Maine (1990), on the other hand, have developed the three delays framework that examines various factors that influence delays in deciding to seek care, in reaching a place where appropriate care is available, and in actually receiving appropriate care. McCarthy and Maine (1992) have also developed a framework for analyzing the determinants of maternal mortality which is similar to proximate determinants framework of fertility and child survival (Davis and Blake 1956, Bongaarts 1978, Mosley and Chen 1984). They argue that any framework for analyzing the determinants of fertility should be organized around three general components of the process of maternal mortality. The first and closest to maternal mortality of these components is pregnancy and pregnancy related complications. A woman must be pregnant and experience some complications of pregnancy and child birth or have a preexisting problem that is aggravated by pregnancy, before her death can be defined as maternal death.

Pregnancy and related complications, in turn, are influenced by a set of intermediate or proximate determinants and a set of distant determinants. The proximate determinants of pregnancy and complications of pregnancy include general health status of the woman and her reproductive status and access to and use of health services including obstetric care services. Finally, the distant determinants include the level of social, economic and cultural environment, quality of life and availability of health services, especially obstetric care services at an affordable cost.

The above specifications suggest that factors that determine the risk of a maternal death may be grouped into three broad categories. The first category of factors are related to general social and economic conditions - income, education, infrastructure, transport and communication, etc. This category of factors also

include factors that determine the availability of health care services at an affordable cost. The second category of factors are those that influence the reproductive status of the woman - the determinants of fertility while the third category of factors are those which help in the management of complications of pregnancy.

The above framework suggests that an indirect estimate of the risk of maternal death may be obtained by establishing a relationship between a measure of the risk of maternal death, a measure of general living conditions, a measure of fertility transition and a measure of management and treatment of complications during pregnancy and at the time of delivery. This can be ascertained by establishing an empirical relationship between the indicators of the risk of maternal death and its determinants.

In this paper, we employ the aforesaid approach. We use the maternal mortality ratio to reflect the risk of maternal death, infant mortality rate as surrogate of general living conditions and the level of fertility and the proportion of births attended by professionally trained persons as surrogate of management and treatment of complications of pregnancy and delivery to establish the empirical relationship between the risk of maternal death and its determinants. The basis of empirical relationship is the regression analysis of an appropriate transformation of maternal mortality ratio on a transformation of infant mortality rate and the proportion of births attended by professionally trained persons; for maternal mortality ratio, the logit transformation is used while logarithm transformation is used for the infant mortality rate.

Information about maternal mortality ratio, infant mortality rate and proportion of births attended by professionally trained persons is available for 114 countries of the world (United Nations Population Fund, 2000). On the basis of this information, the simple, least square regression analysis resulted in the following empirical relationship

$$\begin{aligned} &\textit{logit}(\text{MMR}) = 0.518\ \textit{ln}(\text{IMR}) - 0.862\ \text{TRA} + 0.155\ \text{C} - 0.989 \\ &\qquad \text{SE} \quad (0.062) \qquad (0.158) \qquad (0.122) \quad (0.240) \\ &\qquad R^2 = 0.897; \quad F = 322.404 \end{aligned}$$

where *logit*(MMR) = 0.5 *ln*[MMR/(1-MMR)]. Here *ln* stands for natural logarithm, MMR is the maternal mortality ratio, TRA is the proportion of births attended by professionally trained persons and C is a dummy variable which has a value 1 for a developing country and a value 0 for a developed country. The figures given in brackets are the standard error of the regression coefficient.

The above equation suggests a strong empirical relationship between maternal mortality ratio, infant mortality rate and the proportion of births attended by professionally trained persons. Inter-country variations in the infant mortality rate and the proportion of births attended by professionally trained persons account for almost 90 per cent of the inter-country variations in the

maternal mortality ratio. Moreover, the regression coefficients of infant mortality rate and proportion of births attended by professionally trained persons are in expected direction and statistically significant. In other words, fairly reliable estimates of maternal mortality ratio can be obtained from the above relationship if information about infant mortality rate and proportion of births attended by professionally trained persons are available.

The predictive model described above suggests that both living conditions as reflected through the infant mortality rate and appropriate medical care and attention during pregnancy and at the time of delivery as measured by the proportion of births attended by professionally trained persons are responsible for regional and inter-district variations in maternal mortality ratio. The model also suggests that the role of appropriate care and attention during pregnancy, at the time of delivery and in the postpartum period play a more significant role in deciding the risk of death due to complications of pregnancy and child birth than the general living conditions. Improving the availability, access and quality of obstetric care services, therefore, play a significant role in reducing maternal mortality.

Maternal Mortality in Madhya Pradesh

Estimates of maternal mortality ratio and associated life time risk of maternal death in Madhya Pradesh are given in table 1 for the most recent date. These estimates vary by the level of infant mortality rate and proportion of births attended by professionally trained persons. The table suggests that maternal mortality ratio in the state ranges between 582 to 700 maternal deaths per 100,000 live births around 1998-99 and one in every 36-37 women in the state carry the risk of due to reproduction associated causes during their entire life time. The 95 per cent confidence interval presented in the table reflects the variability in the estimates of maternal mortality ratio and reflect the range of error associated with the estimates. In any case, the women of the state carry both a substantially high risk of death due to complications of pregnancy, delivery and in the postpartum period and a substantially high lifetime risk of death due to reproduction associated consequences.

Estimates of maternal mortality ratio for Madhya Pradesh, available from a number of other sources. Direct estimates of maternal mortality ratio obtained by the Registrar General of India on the basis of information available from the Sample Registration System suggest a maternal mortality ratio of 498 maternal deaths per 100,000 live births for the state (Government of India, 1999). These estimates are based on very small sample and the Registrar General of India, has reservations about the reliability of these estimates; the sample registration system, in fact, is not designed for estimating the risk of death due to complications of pregnancy and child birth. Using the sex differentials in male and female mortality and adopting a regression approach, Bhat (2002) has estimated a maternal mortality ratio of 700 maternal deaths for every 100,000 live

births for the state during the period 1987-96. The United Nations Children's Fund has estimated a maternal mortality ratio of 738 maternal deaths per 100,000 live births on the basis of empirical association between maternal mortality ratio and infant mortality rate (1995).

An important feature of the risk of maternal death in Madhya Pradesh is some very strong rural urban differentials. The maternal mortality ratio in the rural areas are 3-4 times higher than that in the urban areas and this gap is even higher in terms of the life time risk of a maternal death. The wide gap in the risk of a maternal death between rural and urban areas of the state primarily reflects both poor availability and access to both essential and emergency obstetric care services and facilities in the rural areas. In the rural areas of the state, there is a serious shortage of even the essential obstetric care services. The Madhya Pradesh Population Policy envisages developing at least one fully functional referral centre in all the 313 development blocks of the state to deal with obstetric emergencies but the progress in this direction is slower than expected. Rural areas are also affected by poor communication system and this has a direct implication on the risk of maternal death. A sizeable proportion of villages in the state remain cut off from rest of the world for major part of the year as they are not connected through all-weather approach road. On the other hand, the private health care delivery system is concentrated mostly in the urban areas and the cost of this system is substantial.

The good sign however is that the risk of maternal death in the state is decreasing. The Sample Registration System suggests that the maternal mortality ratio has decreased by more than 50 per cent from around 1332 maternal deaths per 100,000 live births in 1981 to about 582 maternal deaths for every 100,000 live births in 1999. On the other hand, the National Family Health Survey suggests a decrease of about 26 absolute points between 1992-93 and 1998-99. The life time risk of a maternal death has also followed a declining trend in between 1981 and 1999. In 1981, one in every 12 women of the state had the risk of a maternal death during their entire life span; this ratio improved to one in 37 women in 1999.

The risk of maternal death has also been estimated to vary widely by social and cultural characteristics of the population (Table 3). Estimates based on the information available from National Family Health Survey suggests that the risk of maternal death decreases sharply with the increase in the education of the mother as well as with the increase in the standard of living. Similarly, the risk of maternal death has been estimated to be substantially higher in Hindu population as compared to the Muslim counterparts. Among different caste groups, the risk of maternal deaths has been estimated to be highest in the scheduled tribe population and lowest in upper caste population. One reason for very high risk of maternal death in the scheduled tribe population may be the fact that the proportion of institutional deliveries as well as deliveries conducted by professionally trained persons in the scheduled tribe population are very low.

The risk of maternal death varies widely among different socio-cultural regions of the state as well as across its constituent districts. Among different regions of the state, the risk of maternal death has been estimated to be highest in the Vindhya region located in at the north-east corner, and lowest in the Malwa region. Vindhya region is the only region of the state where the risk of maternal death has been estimated to be more than 1000 maternal deaths per 100000 population. In general, both maternal mortality ratio and the life time risk of maternal death is high, on average, in the northern and north-eastern parts. The risk of maternal death, on average, is particularly low in the western part of the state. The regional variations in the risk of maternal death suggest some significant linkages to social and cultural values as they relate to human reproduction.

Among the districts of the state, the risk of maternal death has been found to be highest in district Sidhi (1295) followed by district Chhatarpur (1077) and district Jhabua (1056). These three are the only districts of the state where the maternal mortality ratio has been estimated to be more than 1000 maternal deaths per 100,000 live births. In these districts, the life time risk of a maternal death is estimated to be less than 25 - one in less than 25 women face the risk of death due to complications of pregnancy and delivery during their entire life span. On the other hand, the risk of maternal death has been found be the lowest in district Indore where the maternal mortality ratio is estimated to be 202 maternal deaths per 100,000 live births. Indore is the only district in the state where one in every 156 women face the risk of a maternal death during their life span. Other districts of the state where the maternal mortality ratio is estimated to be less that 400 maternal deaths for every 100,000 live births are Mandsaur and Neemuch (313), Bhopal (354), Shajapur (356) and Ujjain (389). In most of the districts of the state, however, the risk of a maternal death as measured by the maternal mortality ratio has been estimated to vary between 600-800 maternal deaths per 100,000 live births; in 8 districts, this risk varies between 800-1000 maternal deaths whereas in 7 districts it ranges between 400-600 maternal deaths per 100,000 live births. In the context of Madhya Pradesh Population Policy 2000, district Indore has already achieved the goal of the maternal mortality ratio of 212 maternal deaths per 100,000 live births. On the other hand, the analysis carried out here suggests that there is a possibility that in Mandsaur, Neemuch, Bhopal, Shajapur and Ujjain districts, this goal is likely to be achieved by the year 2011. However, in the rest of the districts of the state, there is little possibility of achieving the goal unless efforts directed towards reducing the risk of maternal death are planned and implemented in a sustained manner. In any case, the present analysis suggests that reducing the inter-district disparity in the risk of death due to complications of pregnancy, delivery and in the postpartum period as well as reducing the inter-district disparities in the lifetime risk of a maternal death is are major challenges in achieving the maternal mortality goals of Madhya Pradesh Population Policy.

Causes of Maternal Deaths

Cause of a maternal death can be either direct or indirect. A direct cause is one which is associated with complications of pregnancy, delivery and postpartum period. Haemorrhage, infections, sequels of induced abortion, pregnancy induced hypertension, obstructed labour, etc. are some of the important direct causes of maternal death; in most of the situations, there is considerable amount of overlap between these causes - a haemorrhage may result from a ruptured uterus or a serious infection could be a sequella of prolonged or obstructed labour. Indirect causes, on the other hand, are those medical conditions which are made worse by pregnancy and delivery; they are primarily related with women's general health status and are largely an outcome of the living conditions and the level of social and economic development. Perhaps the most important of these causes is malnutrition. Malnutrition results in severe anaemic conditions during pregnancy and at the time of delivery that ultimately result in a death. According to the World Health Organization (1985), approximately three-fourths of the total maternal deaths in developing countries are due to direct causes. Another interesting pattern of causes of maternal death is that a very small number of causes are responsible for nearly all maternal deaths, a fact that makes reducing maternal mortality relatively simple, at least conceptually.

Some information about the causes of maternal death in the state are available through the Sample Registration System (Government of India, 1999). This information, although based on the analysis of very small number of maternal deaths, indicates that haemorrhage and complications predominantly related to puerperium are responsible for nearly half of total maternal deaths. In addition to these two direct obstetric causes of maternal death, anaemia has been found to be a major indirect cause of maternal death responsible for more than one fifth of the total maternal deaths reported. The analysis also suggests that nearly 70 per cent of the maternal deaths reported were due to direct obstetric causes. A survey carried out in public hospitals in five districts of the state recently have also revealed that nearly 80 per cent of the maternal deaths that occurred in these hospitals were due to direct obstetric causes (Chaurasia et al. 2003). Although, a little outdated, information available from the survey of causes of death in the rural areas of the state also suggests that nearly one fourth of the total maternal deaths in the rural areas of the state were due to haemorrhage alone (Government of Madhya Pradesh, 1996). This survey is based on the concept of lay reporting of health information using the verbal autopsy technique. There are some efforts to ascertain the causes of maternal death under the scheme Medical Certification of Cause of Death being implemented by the Government of India (1995) which is a hospital based scheme. Unfortunately, results of this scheme are not revealing as far as causes of maternal deaths are concerned. Under this scheme, 1175 maternal deaths were reported in Madhya Pradesh and in case of 1158 deaths, the cause of death was ascertained as 'other obstetric complications' (Government of Madhya Pradesh, 2000).

Preventing maternal deaths due to direct obstetric causes is a major challenge to reducing the risk of death due to complications of pregnancy and child birth. Since direct obstetric complications cannot be accurately predicted in advance, the only way out to prevent maternal deaths is to ensure universal availability and access to emergency obstetric care services. The very fact that most of the maternal deaths in the state are due to direct obstetric causes also suggests that the conventional preventive and health promotive approach of addressing the reproduction related health problems of women may not be sufficient in preventing most of the maternal deaths. Rather, a comprehensive reproductive health care system that takes into account both the preventive and health promotive aspects of the risk of death due to complications of pregnancy and child birth as well as management and treatment obstetric emergencies is essential to prevent majority of maternal deaths in the state thereby reducing the risk of death due to complications of pregnancy and delivery.

Determinants of Maternal Mortality

Causes of maternal death are basically manifestations of the prevailing social, economic and cultural factors that influence the health seeking behaviour of the community and the availability, access and quality of reproductive health care services bot emergency and essential. An examination of the underlying social, economic and cultural environment and the state of reproductive health care services is therefore essential for understanding the dynamics of maternal mortality. There are a number of factors that lead to maternal morbidity which, if not attended properly, becomes fatal. These include nutritional deficiency diseases including anaemia and malnutrition and many infectious and metabolic disorders that affect pregnant women more seriously than other women or men. Social causes of poor reproductive health of women include poverty and illiteracy, low status of women in the family and the society, expected role of women as bearer of many children and low age at marriage. Traditional social norms, customs and belief related to pregnancy and child birth prevalence in the society also harm women's health.

Availability, access and quality of health care services constitutes another dimension of the determinants of maternal mortality. Majority of the health problems of women in general and reproductive health problems in particular continue to persist primarily due to the lack of appropriate health care services either in terms of availability or in terms of access or in terms of appropriateness. The survey of reproductive health care facilities recently carried out in five districts of Madhya Pradesh has starkly revealed that there is near total absence of comprehensive reproductive health care services at the development block and below development blocks levels (Chaurasia et al. 2003). A woman in need of reproductive health care has to travel long distances in arduous traveling conditions to receive required reproductive health care; this seriously limits the access to even the basic reproductive health care services.

Current Approach to Reducing Maternal Mortality

In order to address the reproductive health problems of women, a 'risk approach' is being followed. This approach is a component of the framework developed by the World Health organization as part of the strategy to achieve the goal of 'Health for All' (Backett et al. 1984, WHO 1984). It is based on the concept that vulnerability to illness results from the possession of a number of interacting biological, genetic, environment, psycho-social and other characteristics that can be measured and converted into scores as 'shorthand expression of the probability of future need and care'. The 'risk approach' uses these estimates of mother's need for help as 'guides to action, resource allocation, better coverage and referral and family and clinical care'. It may be viewed as both a method measuring the need of individuals and groups for care thus providing a means of assisting them to determine their priorities and a tool for reappraisal and reorganization of health care services, especially reproductive health care services (Backett et al. 1984). The concept of reductive risk that is now used in service design and delivery for maternity care and for reducing the risk of maternal death is a logical outcome of the conceptual foundations of this 'risk approach'.

It is now being increasingly recognized that the 'risk approach' has only a limited role in preventing a maternal death for a number of reasons (Rooks and Winikoff 1990, Winikoff et al. 1991). It has been argued that while it is possible to identify a group of women that will experience a higher or lower incidence of problems and bad outcomes associated with pregnancy, it is not possible to predict accurate which individual woman will experience serious complications during labour and at delivery - it is possible to make predictions for a group but not for individuals who comprise the group. Empirical evidence available from different parts of the world also suggest that women in the so-called low-risk group have relatively higher chances of experiencing severe complications at the time of delivery than the women in the high-risk group.

The bare fact is that maternal deaths are not avoidable by traditional preventive health care. In order to save maximum number of maternal deaths, good quality reproductive health care services must be available and access to the people when emergencies leading to death are most likely to occur - near the time of labour and delivery. A comprehensive approach is needed to ensure a reduction in maternal mortality. There are two critical issues in this regard - development of skills and competency of health care providers and establishment of referral networks. It is stressed that even the community level traditional health service providers must be able to provide some emergency care at the time of need such as breech delivery and to take measures to check postpartum haemorrhage. The health care service providers must also be able to provide women and their family members accurate information about absolute rather than relative risk.

The recently announced Madhya Pradesh Population Policy aims at establishing one fully functional referral unit at the development block level to reduce maternal mortality (Government of Madhya Pradesh 2000). The Policy is conspicuously silent about comprehensive reproductive health care services below the development block level. The foregoing discussions suggest that the approach outlined in the Madhya Pradesh Population Policy may not be adequate enough to reduce the risk of maternal death in the state. Since a number of low-risk women have relatively higher likelihood of developing complications at the onset of labour and immediately after delivery when transportation of the patient to a referral unit is either no longer possible or extremely risky, availability of comprehensive reproductive health care services within the reach of the community is crucial.

Conclusions

The recent emphasis on addressing the health and family welfare needs of women as part of the overall population and health programme has generated the need for assessing the risk of death associated with pregnancy, delivery and during the postpartum period. Since maternal death is a very rare even, the risk of a maternal death cannot be estimated through conventional approaches of demographic estimation either direct or indirect. The alternative therefore is to develop alternative approaches to estimate the risk of death associated with complications of pregnancy and delivery. In this paper, a simple method has been developed to estimate the risk of a maternal death. The method is specially suitable for application at the local level where estimation of the risk of maternal death by widely prevalent methods is not possible. Application of the method for Madhya Pradesh indicates the risk of death due to complications of pregnancy and delivery is quite high and there are some significant inter-district variations in both maternal mortality ratio as well as in the life time risk of a maternal death. The evidence from Madhya Pradesh suggests that special efforts will be needed to ensure that the goal of a maternal mortality ratio of 212 maternal death per 100,000 live births as stipulated in Madhya Pradesh Population Policy 2000. These efforts should focus on universal availability and access to emergency obstetric services as majority of maternal deaths are due to direct obstetric causes.

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Table 1: Estimates of maternal mortality ratio and life time risk of maternal death for most recent date in Madhya Pradesh.

Year		Maternal mortality ratio			Life time risk	Source of IMR and TRA
		Level	Lower bound	Upper bound		
1999	Total	582	320	1050	37	SRS
	Rural	718	409	1248	27	
	Urban	160	74	340	201	
1998-99	Total	700	404	1201	36	NFHS
	Rural	894	533	1484	26	
	Urban	257	135	483	124	

Table 2: Estimates of maternal mortality ratio and life time risk of maternal death in Madhya Pradesh: 1981-1999.

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Total Population				
1981	1332	748	2345	12
1982	1213	682	2134	13
1983	986	536	1794	16
1984	1065	608	1847	15
1985	1081	618	1874	17
1986	969	543	1714	18
1987	1040	591	1810	17
1988	1026	578	1804	17
1989	978	552	1714	18
1990	912	519	1588	19
1991	927	513	1657	20
1992	820	467	1427	22
1993	826	466	1450	24
1994	713	400	1259	28
1995	685	376	1234	29
1996	660	362	1191	31
1997	634	349	1138	33
1998	657	358	1195	33
1999	582	320	1050	37

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Urban Population				
1981	392	200	759	55
1982	368	185	723	54
1983	325	160	653	64
1984	331	164	660	63
1985	351	174	703	59
1986	357	174	727	67
1987	351	171	714	62
1988	343	163	714	74
1989	319	154	656	82
1990	236	118	465	104
1991	278	132	576	88
1992	267	125	567	104
1993	222	103	474	130
1994	171	80	363	174
1995	182	83	395	169
1996	181	83	393	184
1997	168	78	359	198
1998	164	76	349	196
1999	160	74	340	201

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Rural Population				
1981	1706	1008	2858	9
1982	1479	852	2538	10
1983	1361	795	2305	11
1984	1327	786	2218	12
1985	1331	785	2232	11
1986	1247	744	2072	12
1987	1280	755	2147	13
1988	1250	731	2115	13
1989	1201	703	2033	14
1990	1129	662	1906	14
1991	1176	676	2025	14
1992	980	579	1644	18
1993	996	579	1698	18
1994	827	469	1442	22
1995	805	455	1410	23
1996	774	437	1359	24
1997	746	423	1303	26
1998	782	437	1384	26
1999	718	409	1248	27

Table 3: Differentials in maternal mortality ratio and life time risk of maternal death in Madhya Pradesh: 1998-99

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
MP	700	404	1201	36
Residence				
Urban	257	135	483	124
Rural	894	533	1484	26
Region				
Chhattisgarh	654	374	1136	46
Vindhya	1019	623	1653	21
Central	652	367	1149	37
Malwa	501	287	867	49
South-central	879	514	1490	31
South-west	609	371	990	38
Northern	673	367	1223	34
Education				
Ill	940	569	1540	23
Lit<8	506	286	886	51
8	319	165	612	112
10+	85	45	158	512
Religion				
Hindu	738	430	1256	34
Muslim	385	199	738	64
Caste				
Scheduled Caste	823	477	1409	26
ST	969	597	1557	23
BC	664	376	1159	38
OT	387	209	708	87
Status of living				
Low	994	601	1628	20
Med	750	436	1277	34
High	196	104	366	188

Table 4: Inter-district variations in maternal mortality ratio and life time risk of maternal death in Madhya Pradesh.

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Balaghat	603	403	895	47
Bastar	879	532	1437	30
Betul	600	361	988	34
Bhind	659	447	965	34
Bhopal	354	184	672	56
Bilaspur	621	408	936	48
Chhatarpur	1077	605	1897	17
Chindwara	570	360	895	36
Damoh	763	506	1142	34
Datia	818	468	1415	22
Dewas	443	257	755	51
Dhar	713	444	1137	30
Durg	471	280	786	50
East Nimar	655	384	1108	35
Guna	676	372	1217	36
Gwalior	474	243	916	34
Hoshangabad	448	268	741	55
Indore	202	109	373	156
Jabalpur	665	369	1189	34
Jhabua	1056	610	1809	21
Mandla	926	603	1410	28
Mandsaur	313	197	492	82
Morena	486	303	773	41
Narsimhapur	741	451	1207	32
Panna	826	546	1238	31
Raigarh	721	471	1092	41
Rajgarh	540	334	864	50
Raipur	708	436	1139	35
Raisen	896	527	1509	23
Ratlam	615	336	1117	44
Rewa	754	478	1177	34
Rajnandgaon	776	484	1234	33
Sagar	724	425	1223	30
Satna	976	589	1602	20
Sehore	634	380	1046	33
Seoni	681	436	1054	31

Year	Maternal mortality ratio (per 100000 live births)			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Shahdol	866	495	1503	25
Shivpuri	687	416	1126	30
Shajapur	356	219	573	64
Sidhi	1295	787	2112	15
Surguja	696	450	1069	37
Tikamgarh	950	523	1709	23
Ujjain	389	216	696	82
Vidisha	766	453	1284	28
West Nimar	723	462	1121	30

Figure 1

Trends in Maternal Mortality Ratio

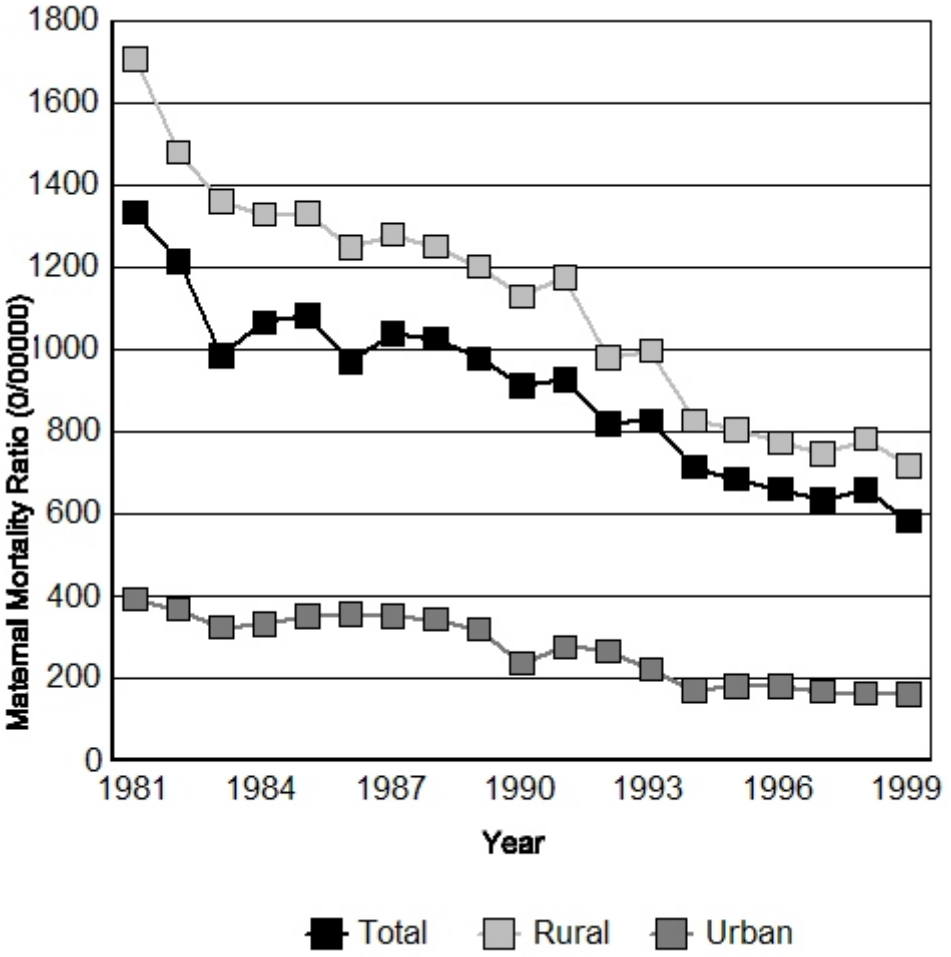

Figure 2

Lifetime Risk of Maternal Death

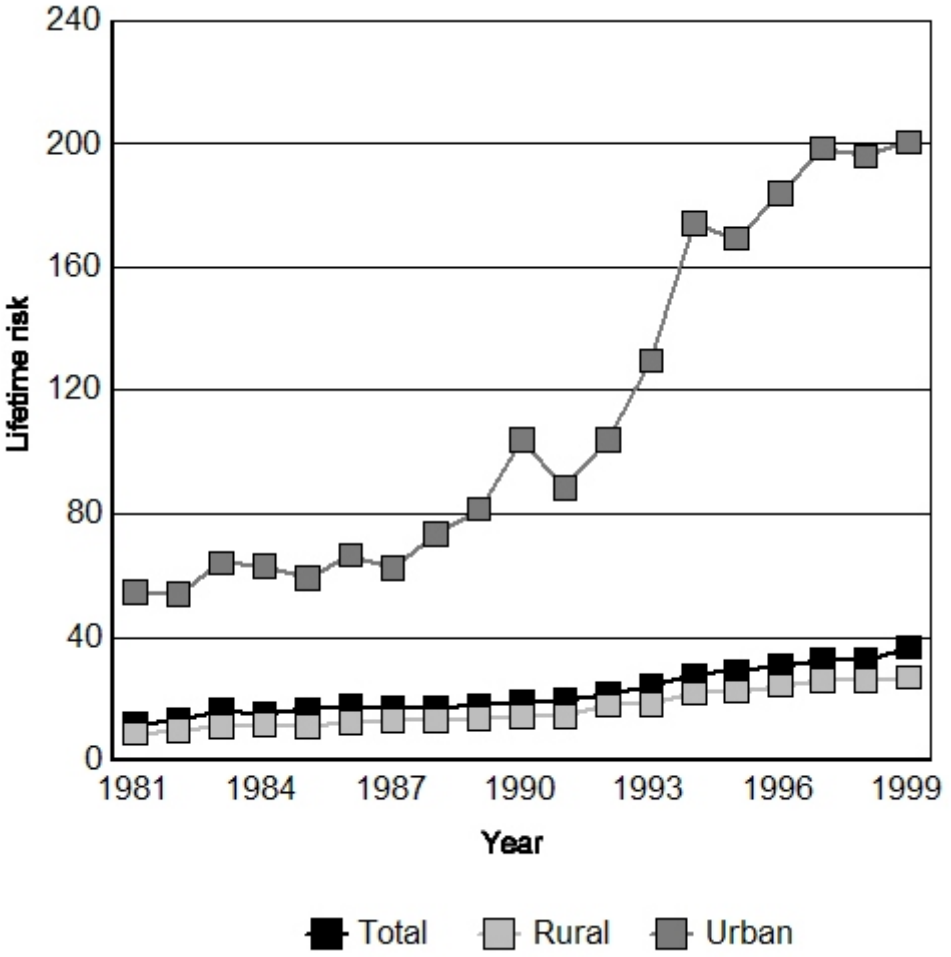

Figure 3

Inter-district Variations in Maternal Mortality Ratio

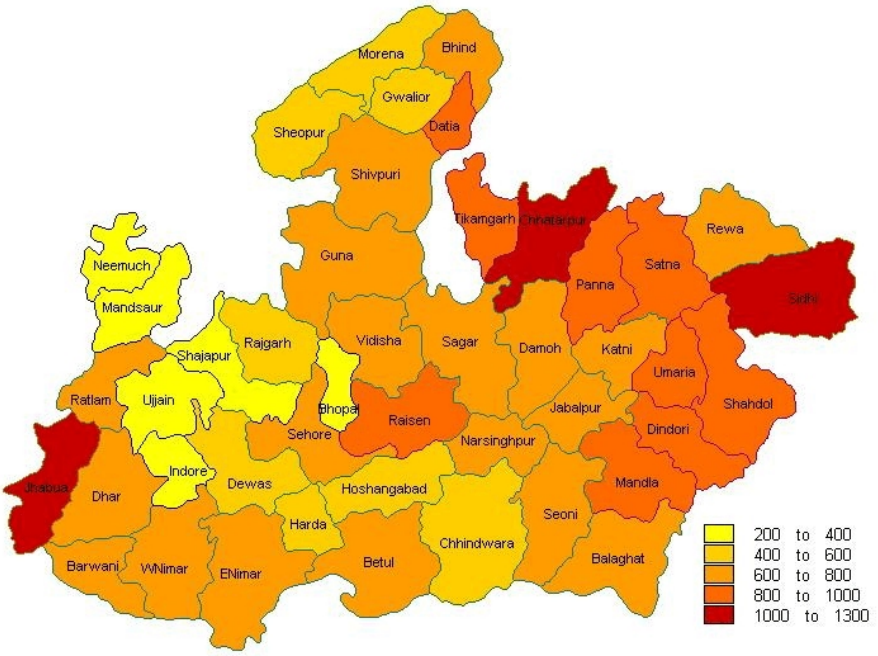

Figure 4

Lifetime Risk of Maternal Death in Madhya Pradesh

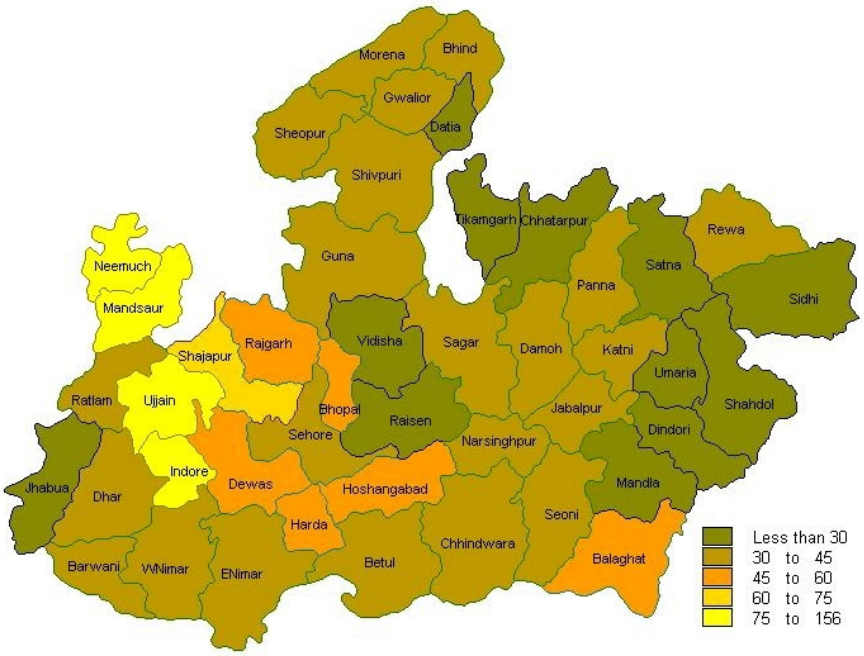

Figure 5

Causes of Maternal Deaths in Madhya Pradesh