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Obstetric Risk in Central India

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Introduction

The risk of death due to complications of pregnancy and delivery, popularly known as maternal mortality, is generally measured in terms of maternal mortality ratio which is defined as the number of maternal deaths per 100,000 live births according to the World Health Organization. Another measure of the obstetric risk that is being increasingly used at present is the life time risk of a maternal deaths. This measure takes into consideration both the probability of becoming pregnant and the probability of dying as the result of the complications associated with pregnancy childbirth which are cumulated across a woman's reproductive years. 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 obstetric risk 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.

From the statistical and measurement point of view, a maternal death resulting out of the complications of pregnancy and child-birth is a rare event. As such 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. 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 ensure some degree of statistical reliability. 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 like India. Even in the 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). In any case, the lack of information about the obstetric risk is a major hindrance in the identification of crucial areas for action (Campbell and Graham 1996).

In response of the need to collect and analyse information about the obstetric risk, 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, 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 the obstetric risk 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, model-based estimates provide a quick although crude estimates of the risk of death due to complications of pregnancy and child birth.

This chapter briefly reviews different approaches developed for estimating the obstetric risk in situations where vital registration is not complete. Subsequently, a simple approach of estimating obstetric risk has been developed on the basis of the empirical relationship between the risk of a maternal death with the risk of death during infancy and the type of attention at delivery. This approach is then used for estimating the obstetric risk in the central Indian States along with the lifetime risk of maternal death. The approach can easily be used at the local level because of its simplicity and because of the fact that the estimates of the risk of death in infancy and information about the type of attention at 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 (World Health Organization 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 (World Health Organization 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, on the other hand, 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 (World Health Organization 1983; 1986).

There are at least three issues that need attention in measuring maternal mortality according to the definition given in the Tenth revision of ICD: (1) appropriateness of defining a maternal death by a time of death definition, (2) 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, it is now increasingly being recognised that there may be residual and cumulative effects of the result of childbearing on long-term mortality even after adjusting social class (Green et al. 1988).

The third issue in defining a death as the death due to complications of pregnancy and delivery is related to the desirability and feasibility of distinguishing between direct, indirect and incidental causes of maternal 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 related complications. 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 it using verbal autopsy or lay reporting techniques. There is however a great diversity of approaches adopted to identify the cause of death in this manner and the 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 whether a death is a maternal death is only the first step in estimating population-based risk of death associated with the complications of pregnancy and child birth. Another equally complex issue is the assessment of the person-years of exposure to the obstetric 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 the conception, the number and the 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 such as live births calls for using surrogates of person-years of exposure to a maternal death.

Population-based Approaches of Estimating Obstetric Risk

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 is 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 (World Health Organization 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 (Koenig 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 for the application of this approach.

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 ascertaining 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).

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 either 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. Since maternal death is a rare event, household survey very large sample to obtain sufficient number of maternal deaths directly, especially if the recall time span. 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 the 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. Organizing large scale household survey incur high costs in terms of time and money. There are difficulties in the selection of the sample and determination of desired sample size to ensure the representativeness of the sample. Moreover, substantial organizational, managerial and technical capacity is required to organize such large scale surveys either at one point of time or at repeated intervals. Since maternal death is a relatively very rare event, such 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 applicability in situations where the required resources and technical and managerial capacity for organizing such surveys are not available. This is especially the case for local level administrative units such as a district. In such situations, model based approaches developed for the estimation of maternal mortality appears to be the most feasible option.

Model-based Approaches of Estimating Obstetric Risk

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 modelling 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. 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 (World Health Organization 1991). The World Health Organization used the empirical relationship between maternal mortality ratio and the expectation of life at birth to estimate maternal mortality. Similar approach has been proposed by Devraj and others (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 obstetric risk 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 incorporates various factors that influence the delay 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 analysing 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 analysing 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 childbirth 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 variables or proximate determinants and a set of distant determinants or contributing variables. The proximate determinants of pregnancy and complications of pregnancy include general health status of the woman and her reproductive status and access, affordability and quality of health services including obstetric care services and the use of these 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 obstetric risk 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 obstetric risk may be obtained by establishing a relationship between a measure of the obstetric risk, 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 chapter, we employ the aforesaid approach. We use the maternal mortality ratio to reflect the obstetric risk, 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. The logit transformation is used for both the maternal mortality ratio and the infant mortality rate.

Information about maternal mortality ratio, infant mortality rate and proportion of births attended by professionally trained persons is available for 86 countries of the world (World Health Organization, 2000). Only those countries were included in the regression analysis where estimates of maternal mortality ratio were available either through the vital registration system or through the application of one of the direct approaches of estimating maternal mortality discussed above. Those countries where the

estimates of maternal mortality were estimated on the basis of one of the indirect, model based approaches were not included in the regressions analysis.

On the basis of this information, the simple, least square regression analysis resulted in the following empirical relationship

$$\textit{logit}(\text{MMR}) = 1.1031\ \textit{logit}(\text{IMR}) - 0.5657\ \text{TRA} + 0.1203\ \text{COU} - 1.3232$$
$$\text{SE} \quad (0.123) \qquad (0.206) \qquad (0.099) \qquad (0.208)$$
$$R^2 = 0.879$$

where $\textit{logit}(\text{MMR}) = 0.5\ \textit{ln}[\text{MMR}/(1\text{-MMR})]$, MMR is the maternal mortality ratio, TRA is the proportion of births attended by professionally trained persons and COU 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 regression 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 are found to be accounting for almost 88 per cent of the variations in the maternal mortality ratio across the countries of the world. Moreover, the regression coefficients of both the infant mortality rate and the 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 empirical relationship if information about the infant mortality rate and the proportion of births attended by professionally trained persons are available. Since information about the infant mortality rate and the proportion of births attended by professionally trained persons are generally available with a fair degree of accuracy at lower level administrative units, the above relationship can effectively be used for estimating maternal mortality.

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 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 comprehensive obstetric care services, therefore, play a significant role in reducing maternal mortality.

Obstetric Risk in Central India

Central India comprises of the States of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and Uttaranchal of the Republic of India. Except Orissa, these States also constitute what is known as the Hindi-speaking belt of the country. According to the 2001 population census, total population of these States was 459.13 million at 0.00 hours of 1st March 2001 which was approximately 45 per

cent of the population of the country. Selected indicators of population and development for central India and for its constituent States are given in tables 1 and 2. Both the tables highlight the contrast between central India and rest of India in terms of demography and development. The proportion of population 0-6 years to the total population in central India is substantially higher than that in the rest of India indicating relatively higher fertility. The same is the case with the proportion of scheduled castes and scheduled tribe population which are higher in central India as compared to the rest of India. On the other hand the population sex ratio in central India is relatively more unfavourable to females than in rest of India. The only good sign is that the sex ratio of 0-6 years population in the central India is marginally more favourable to females as compared to the rest of India.

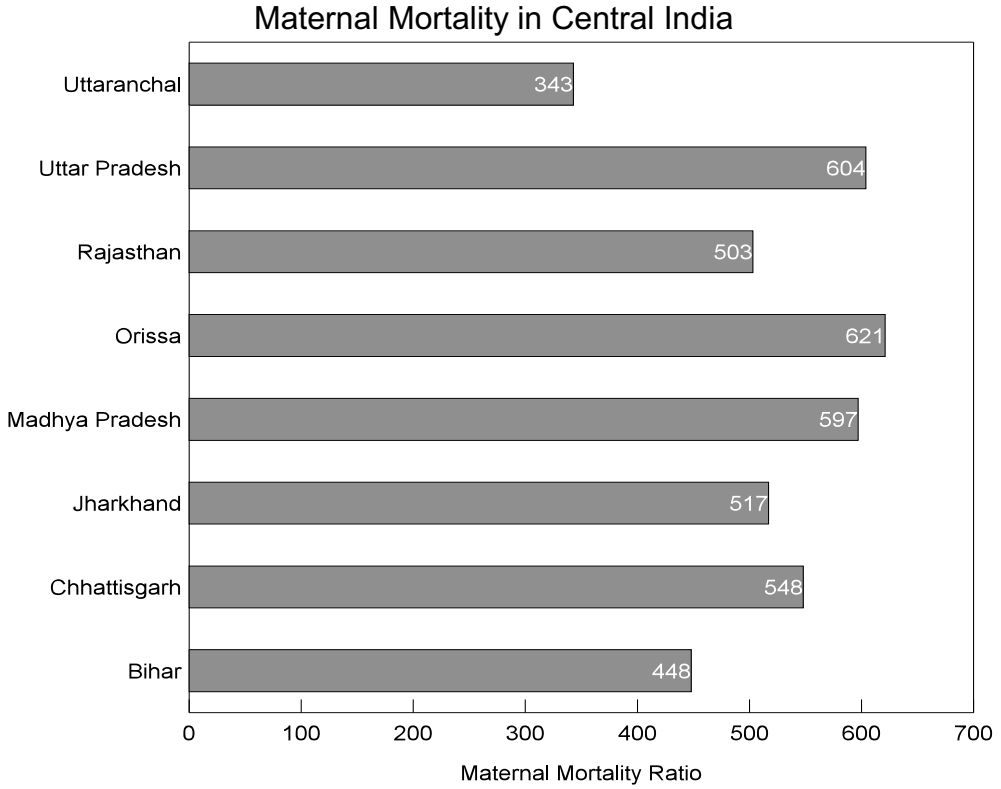
In terms of development, central India lags far behind than the rest of India. Literacy rate is substantially lower in central India as compared to the rest of India and, in case of female literacy, the gap is a whopping more than 18 per cent. Similarly, the proportion of main workers to the total population in the central India is substantially less than that for the rest of India which reflects the relatively poor state of economy.

The estimates of maternal mortality ratio along with the 95 per cent upper and lower bound in different States that constitute the central India are presented in figure 1. These estimates and their upper and lower bounds are based on the estimated levels of infant mortality and proportion of births attended by professionally trained persons. As such, variations in the infant mortality rate and the proportion of births attended by professionally trained persons result in a variation in the estimates of maternal mortality ratio as well as in the life time risk of maternal death.

Our estimates suggest that the risk of death due to complications of pregnancy and childbirth in all States constituting the central India is, in general, well above the national average. The application of the regression model described in the previous section to the infant mortality rate obtained from the sample registration system (Government of India 2002) and the proportion of births attended by professionally trained persons obtained from the rapid household survey organised under the Reproductive and Child Health Project (International Institute for Population Sciences *not date*) suggests that in six of the eight central Indian States, the maternal mortality ratio is estimated to be more than 500 maternal deaths for every 100,000 live births. In Madhya Pradesh, Orissa and Uttar Pradesh, the maternal mortality ratio appears to be more than 600 maternal deaths for every 100,000 live births with Orissa topping the list with a maternal mortality ratio of 621 maternal deaths per 100,000 live births per year. Our estimates also suggest that these three States have the highest risk of death due to complications of pregnancy and childbirth among different States and Union territories of the country. In fact, Uttaranchal is the only State in central India where the risk of death due to complications of pregnancy and childbirth is estimated to be below the national average.

Estimates of the risk of death due to complications of pregnancy and childbirth for different States constituting the central India have also been obtained using different data set and different approach of estimation (Mari Bhat 2002, Government of India 1999, Ranjan 2004). These estimates, however, apply to the undivided States of Bihar, Madhya Pradesh and Uttar Pradesh. It may be pointed out that, in the year 2000, the erstwhile States of Bihar, Madhya Pradesh and Uttar Pradesh were bifurcated into the

Figure 1



States of Bihar and Jharkhand; Madhya Pradesh and Chhattisgarh; and Uttar Pradesh and Uttaranchal respectively. As such, the estimates of maternal mortality, prepared for the undivided States may not be strictly applicable to the States that came into existence after reorganisation of States in the year 2000. It is however still useful to compare the estimates of maternal mortality ratio with the estimates prepared in this paper.

Estimates based on the sample registration system suggest that the maternal mortality in the undivided Uttar Pradesh was highest in the country in the year 1997 and was well above the national average. According to Mari Bhat (2002) also, the risk of death due to complications of pregnancy and childbirth was highest in the undivided Uttar Pradesh for the period 1982-86 as well as for the period 1987-96. Using the information available through the National Family Health Survey and applying the regression model described above, Ranjan (2004) has estimated that maternal mortality was highest in Orissa amongst the major States of India.

In any case, all estimates of the risk of death due to complications of pregnancy and childbirth obtained through the application of different methodologies and using different data sets clearly indicate that the probability of a maternal death in central India remains highest in the country and is well above the national average. It also appears that the relatively higher risk of death due to complications of pregnancy and child birth in central India has persisted over time. Since the central India constitutes nearly 45 per cent of the population of the country according to the 2001 population census, accelerating reduction in the risk of death due to complications of pregnancy and

childbirth in central Indian States is the key to reducing maternal mortality in India as a whole.

Obstetric Risk in Madhya Pradesh

The State of Madhya Pradesh is one of the States of central India which came into existence for the first time in 1956 as the result of the reorganisation of Indian States on a linguistic basis. The State has undergone some significant boundary changes in the year 2000 as the result of which estimates of maternal mortality prior to the year 2000 are strictly applicable to the Madhya Pradesh as it exists today. The erstwhile State of Madhya Pradesh as it existed on 30 September 2000 was divided into the States of Madhya Pradesh and Chhattisgarh on 1 October 2000. At present, estimates of maternal mortality ratio in India are available prior to the year 2000 only. Recently, the Government of Madhya Pradesh carried out Madhya Pradesh Family Welfare Programme Evaluation Survey 2003 throughout the State which covered 25 per cent of the rural population of the state (Government of Madhya Pradesh, 2004). This survey provides estimates of maternal mortality ratio for rural Madhya Pradesh only.

In order to have some idea of the risk of death due to pregnancy and childbirth that prevails in the existing Madhya Pradesh, we carried out two exercises. The first exercise was based on the information available through National Family Health Survey, 1998-99 (International Institute for Population Sciences and ORC Macro 2001). This survey provides information about the infant mortality rate and proportion of births attended by professionally trained persons and proportion of institutional deliveries for different geo-political regions of the State. Of the seven geo-political regions of the erstwhile Madhya Pradesh, the Chhattisgarh region has now been separated to constitute the new State of Chhattisgarh. As such, the unweighted average of the maternal mortality ratio for the remaining six geo-political regions gives an idea of the risk of a maternal death in the existing Madhya Pradesh.

The second exercise utilises the district level information on the proportion of safe deliveries available through the rapid household survey carried out under the Reproductive and Child Health Programme (Government of India *no date*). The unweighted average of this proportion limiting to the districts in the existing Madhya Pradesh was used along with the estimate of infant mortality available through the sample registration system to obtain an estimate maternal mortality for the State.

Results of our exercises are summarised in table 4. According to the Madhya Pradesh Family Welfare Programme Evaluation Survey 2003, the risk of death due to complications of pregnancy and childbirth in the rural areas of the State was 763 maternal deaths for every 100,000 live births (Government of Madhya Pradesh 2004). On the other hand, application of the regression model described in this chapter to the infant mortality rate and the proportion of deliveries attended by professionally trained persons available through the survey suggests a maternal mortality ratio of 627 maternal deaths for every 100,000 live births for the rural population.

For the total population, estimates based on the infant mortality rate from the sample registration system and proportion of safe deliveries from the rapid household survey suggests a maternal mortality ratio of 597 maternal deaths for every 100,000 live births for the year 1999. Similarly, the unweighted average of the risk of death due to complications of pregnancy and child birth in the six geo-political regions of the State

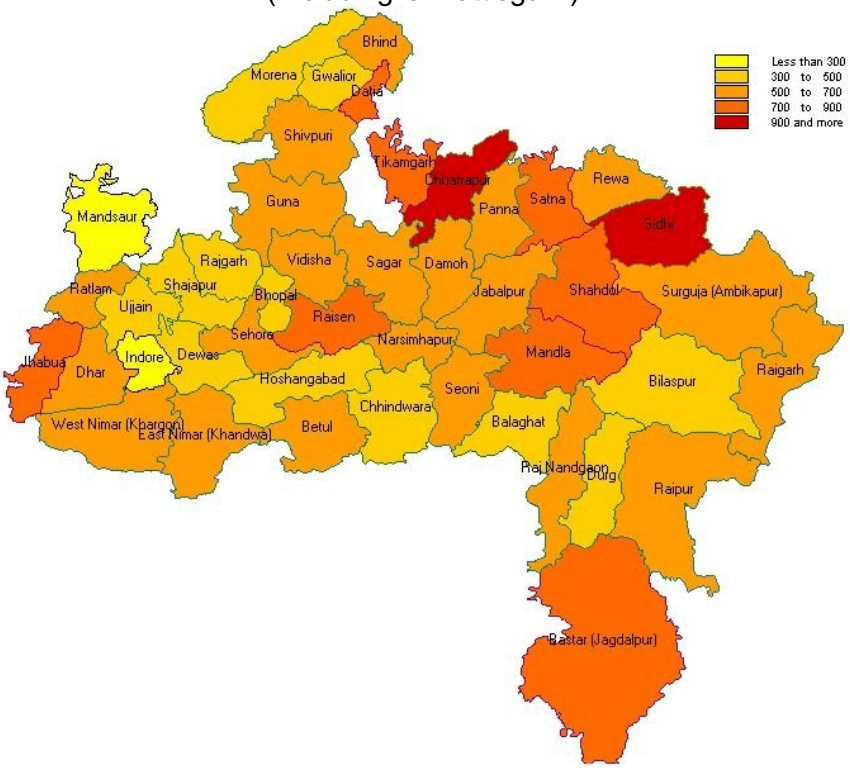
gives a maternal mortality ratio of 623 maternal deaths for every 100,000 live births for the period 1995-99. All these estimates clearly suggest that the women of the State carry both a substantially high risk of death due to complications of pregnancy, delivery and in the postpartum period and a substantially high lifetime risk of death due to reproduction associated consequences.

Estimates of maternal mortality ratio for the undivided Madhya Pradesh (including Chhattisgarh) are available from a number of 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, however, 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, Mari 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 (United Nations Children's Fund 1995).

The risk of maternal death varies widely among different geo-political regions of Madhya Pradesh. This risk has been estimated to be highest in the Vindhya region located in at the north-east corner of the State. In this region, more than 800 mothers are estimated to die of complications of pregnancy and childbirth for every 100,000 live births every year. In general, both maternal mortality ratio and the life time risk of maternal death is estimated to be high, on average, in the north and north-eastern parts of the State. 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 in the State indicate towards some significant linkages of obstetric care with the social and cultural value system in different parts of the State.

It is possible to analyse differentials in the risk of death due to complications of pregnancy and childbirth in the undivided Madhya Pradesh on the basis of the information available through the National Family Health Survey 1998-99. An important feature of the risk of a maternal death in the undivided Madhya Pradesh is some very strong rural urban differentials. The maternal mortality ratio in the rural areas of undivided Madhya Pradesh are estimated to be 3-4 times higher than that in the urban areas. 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 primarily reflects both poor availability and access to comprehensive obstetric care services and facilities in the rural areas. There is a serious shortage of even the essential obstetric care services in the rural areas. The Madhya Pradesh Population Policy envisages developing at least one fully functional referral centre in all the 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

Figure 2
Maternal mortality ratio in undivided Madhya Pradesh
(Including Chhattisgarh)



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 risk of maternal death has also been estimated to vary widely by social and cultural characteristics of the population (Table 6). Estimates for the undivided Madhya Pradesh suggest that the risk of a 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 the Hindu population as compared to its Muslim counterparts in the undivided Madhya Pradesh. Among different castes of the Hindu religion, the risk of maternal deaths has been estimated to be highest in the scheduled tribes and lowest in the upper castes. One reason for very high risk of maternal death in the scheduled tribes population may be the fact that the proportion of institutional deliveries as well as deliveries conducted by professionally trained persons in scheduled tribes, as revealed through the National Family Health Survey are very low.

Among the districts of the undivided Madhya Pradesh (including the State of Chhattisgarh), the risk of maternal death has been found to be highest in district Sidhi (1044) followed by district Chhatarpur (932), district Jhabua (895) and district Satna (804). These three are the only districts of the State where the maternal mortality ratio has been estimated to be more than 800 maternal deaths per 100,000 live births per year. In these districts, the life time risk of a maternal death is estimated to be less than 25 - one in less than 25 women in these districts face the risk of death due to complications

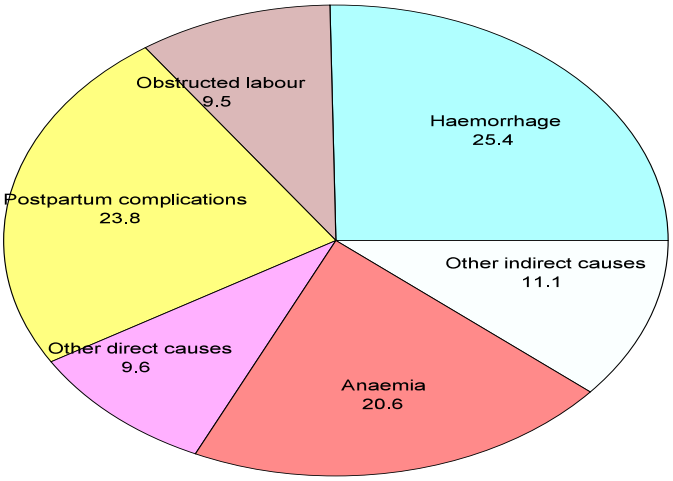
of pregnancy and delivery during their entire life span. On the other hand, the life time risk of maternal death has been found be the lowest in district Indore where the maternal mortality ratio is estimated to be 208 maternal deaths per 100,000 live births. Indore is the only district in the State where one in every 152 women face the risk of a maternal death during their life span. Other districts of the undivided Madhya Pradesh where the maternal mortality ratio is estimated to be less that 400 maternal deaths for every 100,000 live births are Mandsaur (including Neemuch 276), Bhopal (351), Shajapur (315) and Ujjain (367). In most of the districts of the State, however, the risk of death due to complications of pregnancy and childbirth, as measured by the maternal mortality ratio, has been estimated to vary between 600-800 maternal deaths per 100,000 live births; in 21 districts, this risk varies between 400-600 maternal deaths whereas in 6 districts it is estimated to be less than 400 maternal deaths per 100,000 live births. In the context of Madhya Pradesh Population Policy 2000, district Indore with a maternal mortality ratio of 208 maternal deaths for every 100,000 live births appears to have already achieved the goal of the maternal mortality ratio of 222 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, there is little hope unless efforts directed towards reducing the risk of maternal death are planned and implemented in a sustained manner. In any case, reducing inter-district disparity in maternal mortality is a major challenge in achieving the maternal mortality goals of Madhya Pradesh Population Policy 2000.

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 sequela 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 undivided Madhya Pradesh 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 the State. In

Figure 3
Causes of maternal death in Undivided Madhya Pradesh
(Including Chhattisgarh)



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 childbirth. Since direct obstetric complications cannot be accurately predicted in advance and are highly fatal, not attended timely and appropriately, 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 Madhya Pradesh 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 which is based on the concept of 'high risk' may not be sufficient enough 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 timely and effective management and treatment of 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 Obstetric Risk

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 comprehensive obstetric care services - essential as well as emergency - constitutes another dimension of the determinants of the obstetric risk. Majority of the health problems of women in general and problems related to pregnancy and childbirth in particular continue to persist primarily due to the lack of appropriate comprehensive obstetric care services either in terms of availability or in terms of access or in terms of appropriateness and quality. 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, especially the emergency obstetric care has to travel long distances in arduous travelling conditions to receive required reproductive health care. This seriously limits the access of women to even the basic reproductive health care services.

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 event, the risk of death associated with complications of pregnancy and childbirth cannot be estimated through conventional approaches of demographic estimation either direct or indirect. The way

out therefore is to develop alternative approaches to estimate this risk. In this chapter, we have developed a simple method of estimating maternal mortality ratio and life time risk of a maternal death on the basis of the empirical relationship between the maternal mortality ration, infant mortality rate and proportion of births attended by professionally trained persons based on the experience of 86 countries of the world. 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 approach developed in this chapter to States constituting central India, especially, Madhya Pradesh indicates that the risk of death due to complications of pregnancy and childbirth as well as the life time risk of a maternal death to a woman is unacceptably high in most of the central India and is a cause of serious concern. The evidence from Madhya Pradesh suggests that special efforts will be needed to ensure that the goal of a maternal mortality ratio of 222 maternal death per 100,000 live births as stipulated in Madhya Pradesh Population Policy 2000 are achieved. These efforts should focus on, among others, universal availability and access to emergency obstetric services as majority of the maternal deaths in the State are found to be due to direct obstetric causes.

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Table 1: Population and development in Central India						
Country/State	Population 2001	Population (0-6 years)	Sex Ratio	Child Sex Ratio	Scheduled Castes	Scheduled Tribe
	million	*per cent*	*1000F*	*1000F*	*per cent*	*per cent*
India	1028.61	15.93	1072	1078	16.20	8.20
Bihar	83.00	20.25	1037	1061	15.72	0.91
Chhattisgarh	20.83	17.06	1011	1026	11.61	31.76
Jharkhand	26.95	18.40	1063	1036	11.84	26.30
Madhya Pradesh	60.35	17.87	1088	1073	15.17	20.27
Orissa	36.80	14.56	1028	1050	16.53	22.13
Rajasthan	56.51	18.85	1086	1100	17.16	12.56
Uttar Pradesh	166.20	19.03	1114	1092	21.15	0.06
Uttaranchal	8.49	16.02	996	1102	17.87	3.02
Central India	459.13	18.53	1076	1076	17.48	9.21
Rest of India	569.48	13.82	1069	1081	15.17	7.38

Source: Calculated from the information available from the 2001 population census - final population totals.

Remarks: Population and population (0-6 years) as enumerated at 0.00 hours of 1 March 2001.

Population sex ratio and child sex ratio are measured in terms of males per 1000 females.

Scheduled castes and scheduled tribes are presented as proportion to the total enumerated population.

Table 2: Population and development in Central India.

Country/State	Literacy rate			Work participation rate		
	Total	Male	Female	Total	Male	Female
India	64.84	75.26	53.67	30.43	45.13	14.68
Bihar	47.00	61.46	32.10	25.37	41.45	8.69
Chhattisgarh	64.66	77.38	51.85	33.86	45.28	22.31
Jharkhand	53.56	67.30	38.87	23.92	36.98	10.05
Madhya Pradesh	63.74	76.06	50.29	31.65	44.70	17.46
Orissa	63.08	75.35	50.51	26.05	42.90	8.73
Rajasthan	60.41	75.70	43.85	30.86	43.65	16.97
Uttar Pradesh	56.27	68.82	42.22	23.67	39.21	6.36
Uttaranchal	71.62	85.41	58.14	27.36	38.70	16.06
Central India	57.22	70.49	42.95	26.65	41.30	10.88
Rest of India	70.64	78.91	61.81	33.48	48.22	17.72

Source: Calculated from the information available through the 2001 population census.

Remarks Literacy rate is defined as the number of persons who can read and write with understanding for every 100 people with at least 7 years of age.

Work participation rate has been defined as the number of main workers for every 100 population. Main workers mean those workers who have worked for at least 6 months during the reference year.

Table 3: Estimates of maternal mortality ratio in central India, 1999

State	Maternal deaths for every 100,000 live births		
	Level	Lower bound	Upper bound
Bihar	448	220	914
Chhattisgarh	548	247	1210
Jharkhand	517	247	1077
Madhya Pradesh	605	252	1448
Orissa	621	243	1581
Rajasthan	503	205	1230
Uttar Pradesh	604	270	1344
Uttaranchal	343	169	695
Central India	524	232	1187
India	396	159	987

Source: Ranjan (2004)

Remarks: Estimates of infant mortality rate have been taken from the sample registration system (Government of India, 2002).

Estimates of proportion of births attended by professionally trained persons have been taken from the rapid household survey carried out under the Reproductive and Child Health Programme (International Institute for Population Sciences *no date*). Estimates for Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Uttar Pradesh and Uttaranchal are unweighted average of district level proportions.

Table 4: Estimates of maternal mortality ration and life time risk of a maternal death in Madhya Pradesh

Year	Maternal deaths for every 100,000 lie births			Life time risk of maternal death
	Estimate	Lower bound	Upper bound	
Madhya Pradesh 2003 Rural population	627	277	1410	na
Madhya Pradesh 1999 Total Population	597	246	1443	na
Madhya Pradesh 1998-99 Total population	610	247	1495	41
Geo-political regions of Madhya Pradesh 1998-99				
Vindhya region	829	364	1876	26
Central region	582	228	1478	41
Malwa region	451	179	1133	55
Southwest region	516	222	1193	45
Southeast region	747	309	1791	36

Source Ranjan (2004)

Remarks The districts included in different geo-political regions of Madhya Pradesh are

Vindhya Region	Tikamgarh, Chhatarpur, Panna, Satna, Rewa, Sidhi, Umaria, Shahdol, Anooppur
Central Region	Vidisha, Sagar, Damoh, Sehore, Bhopal, Raisen
Malwa Region	Neemuch, Mandsaur, Ratlam, Rajgarh, Shajapur, Ujjain, Dewas, Indore, Jhabua
Southwest Region	Barwani, Khargone (West Nimar), Khandwa (East Nimar), Burhanpur, Harda, Hoshangabad, Betul
Southeast Region	Katni, Jabalpur, Narsimhapur, Dindori, Seoni, Mandla, Chhindwara, Balaghat
Northern Region	Sheopur, Morena, Bhind, Gwalior, Datia, Shivpuri, Guna, Ashoknagar

Table 5: Differentials in maternal mortality ratio and life time risk of maternal death in undivided Madhya Pradesh: 1998-99

Year	Maternal deaths per 100000 live births			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Residence				
Urban	261	91	742	122
Rural	747	318	1746	31
Education				
Illiterate	775	336	1779	28
Literate<8	459	180	1168	57
8	321	111	928	111
10+	97	33	285	448
Religion				
Hindu	636	261	1542	39
Muslim	381	132	1094	64
Caste				
Scheduled Caste	708	289	1721	30
Scheduled Tribe	786	348	1761	29
Backward Castes	588	233	1476	42
Upper Castes	371	136	1004	90
Status of living				
Low	816	354	1872	25
Medium	646	265	1568	40
High	204	71	581	180

Source: Ranjan (2004)

Table 6 Inter-district variations in maternal mortality ratio and life time risk of maternal death in undivided Madhya Pradesh

Year	Maternal deaths per 100000 live births			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
Balaghat	480	232	993	60
Bastar	727	315	1669	36
Betul	514	218	1205	40
Bhind	515	254	1044	43
Bhopal	351	123	998	56
Bilaspur	498	236	1051	60
Chhatarpur	932	370	2331	20
Chindwara	474	213	1052	43
Damoh	598	288	1239	43
Datia	709	286	1750	25
Dewas	399	161	989	57
Dhar	588	261	1317	37
Durg	416	172	1000	56
East Nimar	568	234	1372	40
Guna	612	234	1592	40
Gwalior	464	161	1331	34
Hoshangabad	395	165	941	73
Indore	208	74	582	152
Jabalpur	600	231	1549	38
Jhabua	8956	367	2163	25
Mandla	724	343	1520	36
Mandsaur	276	121	629	93
Morena	414	182	939	48
Narsimhapur	619	268	1422	38
Panna	644	310	1333	40
Raigarh	573	271	1207	52
Rajgarh	457	200	1042	59
Raipur	588	258	1334	42
Raisen	757	316	1800	27
Ratlam	564	213	1489	48
Rewa	609	278	1330	42
Rajnandgaon	635	283	1415	40
Sagar	622	257	1495	35
Satna	804	347	1848	24
Sehore	541	229	1271	39
Seoni	552	254	1195	39
Shahdol	750	302	1852	29
Shivpuri	580	249	1346	35
Shajapur	315	135	733	72
Sidhi	1044	459	2361	19
Surguja	560	260	1200	46
Tikamgarh	842	324	2167	26
Ujjain	367	139	966	87
Vidisha	652	273	1548	33

Year	Maternal deaths per 100000 live births			Life time risk of maternal death
	Estimate	95% confidence interval		
		Lower bound	Upper bound	
West Nimar	584	268	1264	37

Remarks

Estimates of maternal mortality ratio are based on the estimates of infant mortality rate obtained through the Madhya Pradesh Target Couple Survey 1996 (Chaurasia, 1999) and estimates of the proportion of safe deliveries obtained through the rapid household survey under the Reproductive and Child Health Programme (International Institute for Population Sciences, *no date*).

The table include districts that now constitute the State of Chhattisgarh also.