Levels and Causes of Maternal Mortality in Southern India

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Most studies of maternal mortality are hospital based. However, in developing countries, where many such deaths take place in the home, hospital statistics do not reflect the true extent of maternal mortality. Furthermore, the socioeconomic and demographic factors and health behavior affecting maternal mortality are rarely known. A study conducted in 1986 in South India demonstrates a new approach to investigating maternal mortality that combines the collection of information from hospital and health-facility records, field surveys, and case -control studies. The findings from this study indicate that there were 7.98 maternal deaths per 1,000 live births. Approximately one-half of the deaths occurred in the home or on the way to the hospital. Maternal deaths accounted for 36 percent of mortality for women of reproductive age. Analysis reveals that many of these deaths were preventable and that significant differentials existed with regard to demographic, social, and behavioral factors between the cases of maternal deaths and the controls. (STUDIES IN FAMILY PLANNING 1993; 24,5:310-318)

The level of maternal mortality is a sensitive index of the prevailing health conditions and general socioeconomic development of a community. According to the International Classification of Diseases, maternal death is:

... the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. (WHO, 1977)

In most developing countries, women of reproductive age (15 to 49 years) constitute a little more than one-fifth of the total population. These women are exposed repeatedly to the risk of pregnancy and childbearing and, under existing socioeconomic conditions and the inadequacy of medical and health facilities, are at great risk of morbidity and mortality from causes related to pregnancy. The death of the woman who, in most developing countries, plays the principal role in the rearing of children and the management of family affairs is a significant social and personal tragedy. The available statistics reveal that maternal

mortality ratios (MMR) for developing countries are many times greater than those for developed countries. The world maternal mortality average is 351 deaths per 100,000 live births, whereas the ratio for North America is 11 per 100,000 live births. The ratio for Asia, the highest in the world, is reported to be 522 deaths per 100,000 live births (Rochat, 1981).

The estimates of maternal mortality in India vary considerably. Estimates based on civil registration systems at the national level were 460 maternal deaths in 1984 and 340 in 1985 per 100,000 live births (Rao, 1985; WHO, 1986). Studies conducted in hospitals in India estimate the maternal mortality ratio to be as low as 80 in Bombay (1980-83) and as high as 1,152 (1983-84) in Baroda (Pandit, 1987; Bhatt, 1989). A Delhi hospital study carried out during 1983-85 reported 800 maternal deaths per 100,000 live births (Anandalakshmy et al., 1991). Community surveys conducted by the Indian Council of Medical Research (ICMR) in the slums of Calcutta, Delhi, and Madras from 1981-85 found maternal mortality ratios of 120 deaths for Calcutta, 460 deaths for Delhi, and 450 deaths for Madras per 100,000 live births (ICMR, 1985). Several estimates of MMR based on community data are available for rural areas in different regions of India. Estimates from these data are also varied: 150 deaths in the Chandigarh area and 550 deaths in the Varanasi district of Uttar Pradesh per 100,000 live births (ICMR, 1985). From the baseline data collected in 1977-78 for an intervention project in Pachod, Maharashtra, the MMR was estimated to be 1,200 deaths, which, after the intervention, was brought down to 440 deaths in 1981-82 and 210 deaths in 1987-88 (Dyal Chand and Khale, 1989). A longitudinal study carried out in Rajasthan during 1974-79 estimated the MMR to be 592 deaths (Datta et al., 1980). Another study carried out in a rural area of Haryana in 1986 estimated that there were 230 maternal deaths per 100,000 live births (Kumar et al., 1989). However, most estimates of MMR in India are based on fragmentary information based on only a small segment of the population.

Even though a registration system for vital statistics is well established in India, births and deaths are severely under registered, and the rates obtained directly from civil registration data do not provide adequate information for estimating the level of maternal mortality. Available evidence is incomplete with regard to population coverage, medical certification of the causes of deaths, and classification procedures. As a result, reported maternal deaths constitute only a fraction of the total (Puffer and Griffin, 1967).

The hospital statistics upon which many estimates are based are not drawn from representative samples of the total population, since an overwhelming majority of deliveries in India, as in many other developing countries, are conducted by

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traditional birth attendants (TBAs) (Bhatia 1982a, 1982b, and 1985). Abortion-related deaths constitute a major proportion of maternal mortality in India (Rao and Malika, 1977). Attempts have been made in the past to determine the prevalence of abortion, both induced and spontaneous (Dandekar, 1959); (United Nations, 1961); (Potter et al., 1965); (Bhatia and Ramaiah, 1971). These studies also show that many abortions are performed in rural areas of India by unqualified medical practitioners, and numerous women have continued to use TBAs even after the enactment of the Medical Termination of Pregnancy Act (MPT), which liberalized the practice of induced abortion (Bhatia and Mehta, 1972); (Bhatia, 1973). A large proportion of these abortion-related deaths are not included in maternal mortality estimates.

In the absence of an adequate registration system and complete medical certification of the causes of deaths, little information can be gathered about the causes of maternal death. The major source of this information is hospital statistics, which do not reflect overall patterns in the community. Information on social, cultural, and behavioral factors that contribute to maternal mortality is scarce. Even in countries where the maternal mortality ratio is very high, a maternal death is a rare event, and a large population sample is required to estimate mortality ratios and to analyze the causes of maternal mortality. Community maternal mortality studies covering such large populations are rare. Innovative approaches must be devised to gather data concerning the extent of maternal mortality and its causes, both medical and non-medical, data which might be used to initiate appropriate remedial measures.

Objectives and Location of the Study

The main objectives of the study were: to estimate levels of maternal mortality in an area of India, based on the occurrence of such deaths in the whole community, whether in hospital or not, over a reference period of one year; to learn the causes of maternal deaths in clinical terms and to discover the socioeconomic, cultural, or behavioral factors that might be altered to prevent maternal death.

The study was carried out in Anantapur district in the state of Andhra Pradesh. According to the 1981 census, the district had a population of about 2.6 million (Census of India, 1981). The selection of the state and district was based on convenience of location and on the anticipated cooperation of the local health department. The district is economically backward. More than four-fifths of the population depend upon agriculture for their livelihood. Industrial development

in the district is just beginning. Medical facilities in the urban areas are available at government hospitals in the district and at *taluk* (subdistrict) headquarters. The primary health centers are responsible for providing medical and health-care services to the rural population. All medical and health-care institutions except the district headquarters hospital are controlled by District Health and Family Welfare Officers (DHFWO). The district hospital, which has 450 beds, is directed by a civil surgeon.

To strengthen health and family planning services, a Model Plan for Creation of Facilities and Provision of Services under Area Programme was developed by the Government of India's Ministry of Health and Family Welfare in 1979. The plan is being implemented in many parts of the country with financial assistance from multilateral and bilateral agencies. In the state of Andhra Pradesh, the World Bank is providing necessary assistance to implement the model plan in three out of the state's 21 districts: Anantapur is one of the three districts covered under the scheme.

The study was divided into three main parts: (1) identification of cases of maternal death; (2) investigation of the causes of maternal death; and (3) a case-control study to determine the characteristics of cases of maternal mortality (that is, how women who die differ from those who do not). The study covered both urban and rural areas of Anantapur district. The reference period used was 12 months, from 1 July 1984 to 30 June 1985.

Materials and Methods

After the cooperation of local officials had been assured, a team of six male interviewers and a male supervisor were recruited. Each of the seven had a bachelor's degree and prior experience conducting health and family-welfare surveys. The interviewers were trained by the principal investigator at Anantapur for seven days. The fieldwork lasted six months; during the first two months, the lead investigator accompanied the team. He later made frequent visits to the study area to oversee the data collection and to discuss and resolve field-related problems.

There are 15 hospitals in the district. The study team visited each one and collected information from hospital records concerning all deaths of women of reproductive age (15-49) during the one-year reference period. A few characteristics of each of the deceased women were collected, including her name, her husband's name, her age, her religion, her husband's occupation, her

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permanent address, the ward to which she was admitted, the cause of her death, the date of her admission, and the date of her death. Case sheets for these women were obtained from hospital records and copied. The medical records and the case sheets were evaluated with the help of medical professionals; the women who died of causes related to maternity were identified.

Information was also obtained from death certificates filed with the civil registration authorities. Each case of death was matched with hospital records and additional deaths were identified. All additional cases where the cause of death could be clearly attributed to complications of pregnancy, childbirth, and the puerperium were considered maternal deaths and included in the study.

Government health services in the rural areas are provided through a network of primary health centers (PHCs). Each PHC serves approximately 100,000 people within an area of 100-200 square miles. In order to make basic services accessible, a subcenter exists for every 5,000 people. There are 22 PHCs in the district, and all were included in the study. The study team visited each PHC and interviewed health personnel to identify deaths of women aged 15 to 49. A random sample of 50 percent of the subcenters for each PHC were visited by the study team. The subcenters maintain records of births and deaths occurring within their jurisdiction. These records were examined and all deaths relating to women of reproductive age during the reference period were noted. Subcenter staff were interviewed to identify additional events. The interviewers then visited the houses of the deceased women and made detailed inquiries about the cause of death, seeking to find out if the woman was pregnant at the time of her death or had delivered a child within 42 days before her death. All villages covered by the subcenters in the sample were visited by the interviewers. Village leaders, schoolteachers, medical practitioners, traditional birth attendants, revenue officials and other civil servants, watchmen, and other knowlegeable people were asked about deaths to women of reproductive age during the reference period. The interviewers visited village schools and asked children about the deaths; children proved to be useful sources of information. For the additional cases of death that were identified through these interviews, the details about the cause of death were collected by interviewing a responsible member of the household. Information about births during the reference period was collected from the civil registration system and from records maintained by health facilities.

An interview schedule was developed for conducting a detailed survey of all the identified maternal deaths and controls. The schedule was pretested on 25 cases in villages outside the sample. The data collected were evaluated, and necessary

modifications and revisions were carried out. The controls were randomly selected for each village from the list of women who gave birth during the reference period and survived. For urban areas, the controls were randomly selected from a list of births obtained from hospital records. The number of controls chosen was equal to the number of maternal deaths identified. To conduct detailed interviews, the field staff visited the deceased women's houses again and spoke with household members, in particular the husbands. For the controls, every possible attempt was made to interview the woman herself; if she was unavailable, another responsible member of her household, preferably her husband, was interviewed.

During the first phase of the study, the interviewers visited 16 hospitals and municipal offices serving a total urban population of 569,500. In the rural areas they visited 22 villages with primary health centers, 181 villages with subcenters, and 1,192 other villages spread over the district, comprising a total rural population of 1,090,640 (47.3 percent of the total rural population of the district). During the second phase of the study, the interviewers again visited all the towns in the urban areas and 10 PHC villages, 65 subcenter villages, and 135 other villages to conduct detailed interviews for maternal death cases and controls.

The completed interview schedules were examined by an experienced and qualified obstetrician-gynecologist from the state to classify obstetric causes and clinical causes of death and to find out if and how the death could have been prevented. The data were processed, coded, and tabulated. The appropriate statistical techniques were used for the analysis of data.

Findings

A total of 1,073 deaths-867 in the rural areas and 206 in the urban areas-were identified. As Table 1 shows, more than one-half (52.5 percent) of the deaths from causes occurred to women 29 years old or younger, women at the peak of their family life. No rural-urban differentials in the age pattern of these deaths are discernible from the data.

Table 1: Percentage distribution of deaths from all causes, deaths from maternity-related causes, and proportion of female deaths that are maternal deaths, among women aged 15-49, according to age group and residence, Anantapur district, India, 1984-85

	Deaths from all causes			Maternal deaths			Proportion of female deaths that are maternal deaths		
Age	Rural	Urban	Combined	Rural	Urban	Combined	Rural	Urban	Combined
15-19	11.9	10.6	11.6	14.7	19.0	15.3	47.6	50.0	48.0
20-24	22.7	20.9	22.4	31.6	32.7	31.7	53.3	44.2	51.7
25-29	19.2	15.5	18.5	24.6	13.8	23.0	49.4	25.0	45.3
30-34	15.3	17.0	15.6	16.5	20.7	17.1	41.4	34.3	39.9
35-39	11.4	13.1	11.7	10.5	8.6	10.2	35.4	18.5	31.7
40-44	8.8	8.3	8.7	1.8	5.2	2.3	7.9	17.6	9.7
45-49	10.7	114.6	11.5	0.3	0.0	0.3	1.1	0.0	0.8
(N)	(867)	(206)	(1,073)	(333)	(58)	(391)			

On the basis of the evaluation of data on causes of deaths collected through hospital case sheets and inquiries from the families of the deceased women, a total of 391 deaths-333 in rural areas and 58 in urban areas could be attributed to complications of pregnancy, childbirth, and the puerperium. The age distribution of these deaths reveals that 70 percent occurred to women younger than 30. Furthermore, about one-third (31.7 percent) of the total maternal deaths were reported to be among women aged 20 to 24.

The percentage of all deaths that can be attributed to maternal causes in the age group 15-49 has been calculated. The analysis shows that the contribution of maternal deaths to total female mortality in the reproductive age group is very high (36.4 percent) in this study, with significant rural-urban differentials. While in the urban areas 28.2 percent of the total number of deaths among women of reproductive age can be attributed to maternal causes, the corresponding percentage for the rural areas is 38.4. Rural-urban differentials for the various age groups are also apparent. While no clear pattern is discernible for the urban areas, in the rural areas, about one-half of the deaths in the 15-29 age range is consistently attributable to complications of pregnancy and childbirth. Thus, the leading causes of death for women of reproductive age are related to maternity.

The probability of dying from complications of pregnancy is not only high for every age group, it is spread over a long period of reproductive life.

Recorded Deaths

Rural subcenters are staffed by one male and one female worker. The workers are required to maintain a complete record of all births and deaths in their area. Fewer than one-half (44.6 percent) of all the deaths of women in the reproductive age group identified by the study were found in these records. Although sub-centers serve small populations (5,000 each), and health workers are supposed to make regular domiciliary visits, nevertheless a majority of the deaths under study were not recorded. Health workers are expected to reside in the PHC and sub-center villages and, presumably, should be aware of such events in the villages where they live. The analysis shows, however, that there are no statistically significant differentials in the registration of deaths according to type of village, whether they are PHC villages, sub-center villages, or villages where no such facilities are located.

Only one-third (34.5 percent) of the maternal deaths identified were found in the health records maintained by sub-centers. An analysis by type of village again reveals no significant differentials. Health centers are required to maintain complete records of eligible couples and pregnant women in order to provide them with family planning and MCH services. Obviously, when such a substantial proportion of pregnant women are not recorded, health-service coverage remains low.

Levels of Maternal Mortality

The levels of maternal mortality in this study have been studied using two different measures: maternal deaths per 1,000 live births (the maternal mortality ratio), as shown in Table 2, and maternal deaths per 10,000 women of reproductive age (the maternal mortality rate). In the population covered by the study, 58 maternal deaths were identified in the urban and 333 in the rural areas. Based on these data, the total maternal deaths have been projected for the 1985 urban and rural population of the district. The information about the number of births collected from civil registration systems and records maintained by the health facilities was found to be grossly underreported. A detailed sample survey was conducted in the district in 1981 by the World Bank--assisted India Population Project. The births have been estimated from these data and used as a denominator (Population Centre, 1985). The maternal mortality ratio for the

entire district is 7.98; it is 5.45 for the urban and 8.30 for the rural areas. Project officials believe that there has been a decline in fertility during the last couple of years as a result of intensive family planning activities undertaken by the project. If current estimates of births, for which reliable data are not available, are used as the denominator, the ratio is likely to be higher than the one reported here. Therefore, the levels of maternal mortality shown here are likely to underestimate the extent of maternal mortality in the district.

Table 2: Estimated population, number of live births and maternal deaths, and maternal mortality ratios, by residence, Anantapur district, India, 1984-85

Residence	Estimated population (N)	Estimated live births (N)	Estimated maternal deaths (N)	Maternal mortality ratio[a]
Urban	(569,500)	(10,650)	(58)	5.45
Rural	(2,307,746)	(84,924)	(705)	8.30
Combined	(2,877,246)	(95,574)	(7630	7.98

[a] Number of maternal deaths per 1,000 live births.

In order to determine the effect of rural development on maternal mortality, a village-development index was worked out based on the following variables: (1) location of the village; (2) condition of the road to the subcenter; (3) condition of the road to the PHC; (4) condition of the road to the nearest town; (5) distance to the nearest town; (6) distance to the nearest railway station; (7) distance to the nearest bus station; (8) existence of educational institutions in the village; (9) electricity in the village; and (10) existence of a post office in the village. Each village was assigned a score (maximum 45). All villages covered by the study were divided into four categories: Poorly developed (score: 0-10), somewhat developed (score: 11-20), adequately developed (score: 21-30), and highly developed (score: >30). The maternal mortality ratios and rates were calculated for each category of village (see Table 3), and the analysis reveals a consistent relationship between the level of maternal mortality and the level of village development. The rates of maternal death for poorly developed villages are more than four times those of highly developed villages.

Table 3: Percentage distribution of villages of Anantapur district, India, by village development status, according to population and maternal morality rates and ratios, 1984-85

Village development status	Percent of total villages	Number of villages	Percent of total population	Estimated population (N)	Maternal mortality rate[a]	Maternal mortality ratio[b]
Poorly developed	4.3	(600	1.3	(13,860)	39.19	21.66
Somewhat developed	33.3	(465)	17.2	(187,792)	26.09	15.23
Adequately developed	43.3	(604)	42.3	(461,355)	13.74	8.03
Highly developed	19.1	(266)	39.2	(427,633)	8.83	5.16
Total	100.0	(1,395)	100.0	(1,090,640)	14.25	8.30

[a] Number of maternal deaths per 10,000women aged 15-49

[b] Number of maternal deaths per 1,000 live births.

An attempt also has been made to determine the variations in the level of maternal mortality according to the distance of a village from rural health facilities. As shown in Table 4, the available information reveals that maternal mortality is lowest in the villages where PHCs are located. The villages with sub-centers also have rates lower than villages that have no such facilities. However, there are no significant differences in the levels of maternal mortality between villages that are nearer or farther than five kilometers from primary health-care facilities.

Table 4: Percentage distribution of villages in the rural areas in Anantapur district, India, by distance of village from government health facilities, according to estimated population, and maternal morality rates and ratios, 1984-85

Type of village	Percent of	(Number of	Percent of total	Estimated Populatio	Maternal Mortality	Maternal

Maternal mortality rate[a]	total villages	villages)	population	n (N)	Rate[a]	Mortality Ratio[b]
PHC headquarters	1.6	(22)	11.9	(129,945)	8.25	8.30
Subcenter headquaters	13.0	(181)	36.8	(401,607)	13.00	7.60
< 5 kms from PHC	8.2	(115)	4.4	(47,760)	16.60	9.70
> 5 kms from PHC	77.2	(1,077)	46.9	(511,328)	16.50	9.64
Total	100.0	(1,395)	100.0	(1,090,640)	14.25	8.30

[a] Number of maternal deaths per 10,000women aged 15-49

[b] Number of maternal deaths per 1,000 live births.

Pregnancy Outcome and Causes of Maternal Deaths

Of the pregnancies of 284 women for which detailed information was collected, 62.3 percent resulted in live births, 14.1 percent in stillbirths, 10.9 percent in abortions, and the remaining 12.7 percent had not yet been delivered (shown in Table 5). The proportions of abortions and undelivered cases are higher in the urban than in the rural areas, but there are more stillbirths in the rural areas. In approximately one-fifth of the cases, labour was prolonged. The proportion of women who experienced prolonged labour was found to be higher in rural than in urban areas.

Table 5: Percentage distribution of maternal deaths in Anantapur district, India, by residence, according to outcome of pregnancy, 1984-85

	Rural		Urban		Combined	
Outcome of pregnancy	Percent	(N)	Percent	(N)	Percent	(N)

Live births	63.0	(165)	54.5	(12)	62.3	(177)
Still births	14.5	(38)	9.1	(2)	14.1	(40)
Abortion	10.3	(27)	18.2	(4)	10.9	(31)
Undelivered	12.2	(32)	18.2	(4)	12.7	(36)
Total	100.0	(262)	100.0	(22)	100.0	(284)

As Table 6 shows, approximately two-fifths (40.9 percent) of maternal deaths occurred at home and about one-twelfth (8.5 percent) happened while the woman was on her way to the hospital. Of the deaths that took place in hospitals, an overwhelming majority occurred in government health institutions.

Table 6: Percentage distribution of maternal deaths in Anantapur district, India, by residence, according to place where death occurred

	Maternal deaths					
	Rural		**Urban**		**Combined**	
Place where death occurred	**Percent**	**(N)**	**Percent**	**(N)**	**Percent**	**(N)**
Home	42.7	(112)	18.2	(40)	40.9	(116)
PHC	3.8	(10)	0.0	(0)	3.5	(10)
Government hospital	37.0	(97)	77.3	(17)	40.1	(114)
Private hospital	7.3	(199)	4.5	(1)	7.0	(20)
On the way to the hospital	9.2	(24)	0.0	(0)	8.5	(24)
Total	100.0	(262)	100.0	(22)	100.0	(284)

Family members of the deceased women were asked if they had been aware of the seriousness of the woman's condition and what they did to save her life. As Table 7 indicates, more than one-fifth (22.2 percent) of the respondents indicated

that they had not realized the seriousness of the woman's condition. Of those who did comprehend it, a small proportion did nothing, while a large majority either called the health worker or doctor to their home or took the woman to the hospital.

Table 7: Percentage distribution of maternal deaths in Anantapur district, India, by residence, according to family's awareness of seriousness of the women's condition before her death, and action initiated, 1984-85

Family's awareness and action	Rural		Urban		Combined	
	Percent of total cases	(N)	Percent of total cases	(N)	Percent of total cases	(N)
Aware	76.7	(201)	90.9	(20)	77.8	(221)
Health worker/ doctor called	6.1	(16)	4.5	(1)	6.0	(17)
Women taken to hospital	56.8	(149)	86.4	(19)	59.2	(168)
No action taken	4.6	(12)	0.0	(0)	4.2	(12)
Women died on the way to hospital	9.2	(24)	0.0	(0)	8.4	(24)
Not aware	23.3	(61)	9.1	(2)	22.2	(63)
Total	100.0	(262)	100.0	(22)	100.0	(284)

Time Interval Between Delivery and Death

Table 8 shows that a little less than one-half (45.1 percent) of the women died on the day they delivered, while about one-eighth (13.0 percent) died more than 15 days after delivery. The mean interval between delivery and death is 6.9 days, with significant rural-urban differentials. While the average time-lapse for rural women is 7.3 days, it is only 2.5 days for the women in the urban sample.

Table 8: Percentage distribution of maternal deaths in Anantapur district, India, by residence, according to time lapse between delivery and death, 1984-85

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	Rural		Urban		Combined	
Time lapse	Percent	(N)	Percent	(N)	Percent	(N)
Same day	43.5	(114)	63.6	(14)	45.1	(128)
1-5days	14.5	(38)	13.6	(30	14.4	(41)
6-10 days	20.2	(53)	18.2	(4)	20.1	(57)
11-15 days	7.6	(20)	4.6	(1)	7.4	(21)
16-20 days	4.2	(11)	0.0	(0)	3.9	(11)
>20 days	9.9	(26)	0.0	(0)	9.1	(26)
Total	100.0	(262)	100.0	(22)	100.0	(284)
Mean days	7.3		2.5		6.9	

The percentage of antepartum, intrapartum, and postpartum deaths is 19.0, 11.6, and 69.4. respectively. While there are no significant rural-urban differentials in postpartum deaths, antepartum deaths are much higher in urban than in rural areas.

Obstetric Causes of Maternal Deaths

As shown in Table 9, about two-thirds (66.9 percent) of maternal deaths studied were due to direct obstetric causes and the remaining one-third (33.1 percent) to indirect causes, with substantial rural-urban differences. While in the rural areas 64.9 percent of maternal deaths are due to direct obstetric causes, the corresponding percentage for urban areas is 90.9.

Table 9: Percentage distribution of clinical causes of maternal deaths in Anantapur district, India, by residence, according to cause, 1984-85

	Rural		Urban		Combined	
Causes	Percent of total cases	(N)	Percent of total cases	(N)	Percent of total cases	(N)

Direct					
Sepsis	30.5	(80)	36.4	(8)	31.0	(88)
Puerperal	22.5	(59)	18.2	(4)	22.2	(63)
Abortion	5.7	(15)	9.1	(2)	6.0	(17)
Postpartum tetanus	2.3	(6)	9.1	(2)	2.8	(80)
Hemorrage	11.4	(30)	22.7	(5)	12.3	(35)
Antepartum	1.1	(3)	0.0	(0)	1.1	(3)
Postpartum	5.7	(15)	13.6	(3)	6.3	(18)
Abortion	4.6	(12)	9.1	(2)	4.9	(14)
Eclampsia	8.0	(21)	22.7	(5)	9.2	(26)
Retention of placenta	8.4	(22)	0.0	(0)	7.7	(22)
Ruptured uterus	4.9	(13)	9.1	(2)	5.3	(15)
Postoperative infection	1.5	(4)	0.0	(0)	1.4	(4)
Indirect					
Infectious hepatitis	10.7	(28)	0.0	(0)	9.8	(28)
Severe anemia from pregnancy	9.2	(24)	9.1	(2)	9.2	(26)
Gastroenteritis and dehydration	5.0	(13)	0.0	(0)	4.6	(13)
Enteric fever	3.1	(8)	0.0	(0)	2.8	(8)
Respiratory and pulmonary diseases	2.3	(6)	0.0	(0)	2.1	(6)
Encephalitis	1.5	(4)	0.0	(0)	1.4	(4)

Hypertension	0.8	(2)	0.0	(0)	0.7	(2)
Miscellaneous / unknown	2.7	(7)	0.0	(0)	2.5	(7)
Total	100.0	(262)	100.0	(22)	100.0	(284)

The principal direct causes of maternal mortality are sepsis (31.0 percent), hemorrhage (12.3 percent), eclampsia (9.2 percent), and retention of placenta (7.7 percent). The main indirect causes are infectious hepatitis (9.8 percent) and severe anemia from pregnancy (9.2 percent).

Comparison with Control Cases

The maternal death cases and controls have been compared in terms of demographic, social, economic, and health-behavior characteristics, including religion; caste; family type (whether nuclear or joint/extended); family size; socioeconomic status; literacy; occupation of the woman and her husband; family contact with the outside world; the woman's age at marriage; age at first pregnancy; number of pregnancies and live births; number of stillbirths and prior abortions; birth intervals; knowledge of, attitudes about, and use of health facilities; and predisposing health conditions.

The results of the analysis reveal that a significantly higher proportion of women of relatively high socioeconomic status survived childbirth, compared with the women who died of maternity-related causes. Similarly, the number of literate women among the surviving mothers is twice that of the women who died. The husbands of the women who survived also had attained a significantly higher level of education than did those of the women who died. The families of women who survived were found to have better contacts with the outside world, compared with the families of those who died. A significantly higher proportion of women who died had experienced prior abortions, compared with those who survived. The number of prior stillbirths was also found to be significantly higher among the deceased women. Knowledge of, attitudes about, and use of health facilities were found to be significantly higher among the families of survivors. A much greater proportion of surviving women registered and sought antenatal care than did the women who died. A significantly higher proportion of women who died were in the younger (15-19) and older (35-44) age groups, compared with those who survived. Similarly, the proportions of women who had no earlier pregnancies and those who had had seven or more earlier

pregnancies were significantly higher among the maternal mortality cases than among the controls.

Preventable Maternal Deaths

After examining the information collected for each maternal death during the detailed survey, the obstetrician gynecologist came to the conclusion that 40.8 percent of the deaths were preventable, 37.0 percent may have been preventable, and the remaining 22.2 percent were not preventable. Her opinion, based on available information, was that the deaths, could have been prevented by taking the steps shown in Table 10.

Table 10: Percentage distribution of 221 cases of maternal death in Anantapur district, India, which were preventable, by measures required to prevent them, 1984-1985

Measures	Percent of cases	(N)
Proper early antenatal care	8.1	(18)
Tetanus immunization	2.7	(6)
Treatment of anemia during pregnancy	11.8	(26)
Prevention of hepatitis	3.2	(7)
Hospital/clinic delivery	8.1	(18)
Blood transfusion	8.1	(18)
Control of infection through blood-spectrum antibiotics	19.9	(44)
Early admission of patient to hospital and proper treatment	19.0	(42)
Avoidance of high risk pregnancy	3.2	(7)
Abortion performed by qualified doctor	8.1	(18)
Early cesarian section	3.2	(7)
Control of dehydration	4.5	(10)

Total	100.0	(221)

Conclusions

Most of the earlier estimates of maternal mortality are based on hospital statistics, but according to this study, more than half of maternal deaths, particularly in rural areas, occur at home or on the way to the hospital. Therefore, any study conducted in India that is based solely on hospital records is likely to give a distorted account of the extent of maternal mortality. Furthermore, socioeconomic and cultural/behavioral factors and accessibility to health services differ for women who die in the hospital and those who die at home. Records of vital statistics maintained by rural health institutions are not complete. Of the events identified in this study, only 44.6 percent of deaths among women of reproductive age and 34.5 percent of maternal deaths were to be found in institutional records. Detailed and widespread community surveys are, therefore, essential both to determine the extent of maternal mortality and to gather enough data for meaningful estimates and statistical analysis of causes of maternal mortality as they relate to demographic, socioeconomic, cultural, behavioral, and health-service-accessibility factors. Such studies can generate a wealth of information useful to health planners and administrators for initiating steps necessary to reduce maternal mortality.

Knowledge about the extent of maternal mortality can help planners to allocate national funds to various appropriate health programs. In addition, the information obtained through such studies can also help program managers to identify high-risk pregnancies and make suitable arrangements for proper antenatal monitoring and institutional service delivery. As this study has demonstrated, such research can be conducted at a cost that developing countries can afford. The contribution of maternal death to total mortality for women of reproductive age has been shown here to be very high (36.4 percent). Beyond the clear rural-urban variations in maternal mortality, differentials among villagers are also apparent. This study revealed that more than one-half (55.4 percent) of the deaths among women of reproductive age and two-thirds (65.5 percent) of maternal deaths were not recorded by health workers. To improve the recording of vital statistics, primary health workers should be trained to gather and maintain complete records of births and deaths in their respective areas. More than three-fourths (77.8 percent) of deaths could have been prevented by early antenatal care, treatment of existing health conditions, and timely availability of medical care and hospitalization. The singular importance of accessibility of transportation is made evident in this study: Of 140

women in serious condition who were taken to the hospital, 96 (68.5 percent) were transported by public bus, 27 (19.2 percent) by bullock cart, five (3.5 percent) by rickshaw, and only 12 (8.6 percent) in motor-driven vehicles or ambulances. Consequently, 24 women died en route and 54 died when they reached the hospital.

The significance of registering all pregnant women and providing them with adequate antenatal services is also made clear. Fewer than one-half (45.5 percent) of the women who died of maternal causes were registered; they made an average of only 0.33 visits to the subcenter or primary health center for antenatal care (they are supposed to have four antenatal checkups; controls had only an average of 0.63 visits). Currently, the female health worker at a subcenter covers a population of 5,000 and is required to provide services to only about 150 pregnant women a year. To provide adequate service, education should be offered to women and their families, and health workers should receive proper training, guidance, and supervision. Many of the women who died experienced danger signals during pregnancy from existing health conditions that predisposed them to difficulties. Their lives might have been saved had proper referral systems and feedback mechanisms been in place. In fact, 28 women had received hospital or PHC treatment for various problems, but died as a result of their not following the prescribed regimen of care. Many women had histories of repeated stillbirths and abortions. These women were at higher risk of dying from maternal causes; had they been identified and provided for appropriately, their risk might have been lessened.

Twenty-seven women died from complications of abortion, most of which were induced because the pregnancies were unwanted. Many of these lives could have been saved if the abortions had been performed by qualified medical personnel. Although abortion law has been liberalized in India, many rural women do not know the law or where they can go to obtain legal abortions. A rigorous health-education campaign is therefore needed to make people aware of the relevant legislation and the facilities it makes available.

Slightly more than one-third (34.3 percent) of the women studied died during their first pregnancy and another one-tenth of them (9.9 percent) had had seven or more pregnancies. A first pregnancy, particularly one occurring to a young girl, is always hazardous. Its risks might be minimized by motivating young, newly married women to delay pregnancy, and also by providing adequate antenatal care. Women of high parity and women pregnancy-complicating conditions should also be encouraged to practice contraception.

Clearly, literacy is important in the prevention of maternal mortality. Long-term improvements in formal education, particularly for girls, will help bring about a decline in maternal mortality, as will improvements in the socioeconomic status of families. In the short term, however, women of low economic status should be identified and provided with necessary health care.

Although primary health centers have existed for more than 40 years, many rural people are not aware of them. Furthermore, they are not much used by the communities they serve. The efficiency and effectiveness of these centers should be improved through careful management and their availability made clear.

Acknowledgments

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