Proximate Correlates of Infant Mortality in Maharashtra: Experience of a developed State in India

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Introduction

Infant mortality is the probability of dying before the first birthday. In discussions on mortality transition, Infant Mortality Rate (IMR) is always used as a proxy for mortality conditions. IMR represents the core area that should be given special attention. Infant deaths account for about 23 % of the total deaths, while the population of infants is only about two to three % of total population.

In India, some success has been attained in bringing down the Crude Death Rate (CDR), but for lowering IMR it still has a long way to go. As per the estimates of the Sample Registration System (SRS) for 1997, CDR is only about 9 per 1000 persons, whereas IMR is still quite high at 71 per 1000 live births. This has led to many health policies and programs being directed towards the reduction of IMR. The Indian State of Maharashtra is number two - ranked only behind the State of Kerala for low mortality statistics. In 1997, CDR for Kerala was 6 and IMR 12, whereas corresponding figures for Maharashtra were 7 and 47. There is a large difference of 35 infant deaths per 1000 births between these two states. In this regard, it was thought worthwhile to examine the proximate correlates of infant mortality in Maharashtra. Knowledge of factors that really matter in bringing about reduction in IMR would help in taking up action programs to reduce the same.

Maharashtra is located on the western coast of India and is considered one of the more developed States in India. According to the latest available census figures of 1991, the population of the state was 78.9 million. This represents about 9 % of the country's population. Maharashtra is also the most urbanized State with 39 % of its population living in urban areas. About 65 % population of the State is literate. For the period, 1992-93, the indicators of fertility, mortality and family planning for Maharashtra were as follows:

Crude Birth Rate (CBR)- 25
Total Fertility Rate (TFR) - three
Life expectancy at birth - 62 and 63 years for males and females respectively
Contraceptive Prevalence Rate (CPR) of the State - 55 %.
Comparable figures for India show Maharashtra has enviable indicators.

Statement of the problem

Infant mortality has two broad components, one, neonatal mortality and the other, post-neonatal mortality. Neonatal mortality is defined as the probability of dying within a month of birth, while post-neonatal mortality is the probability of dying between one and 12 months of age. It is necessary to make this distinction since the causes of mortality in these two periods differ in some respects. The causes of infant mortality are multiple and are broadly classified as the following:

(1) Child's health and / or biological factors
(2) Social characteristics
(3) Maternal and child health care
(4) Environmental conditions.

The first group of causes relate to mother's age, number of children born, birth weight of the child, sex of the child, etc. These factors are purely biological and indicate the resistance of the child to the different health hazards faced.

Social characteristics would broadly be represented by place of residence, religion, caste, mother's education, and work participation. Religion and caste of the respondent could reflect on the specific practices of child rearing, if

any, which would affect the health of the child. Education of the mother, as has been shown in number of studies (Caldwell, 1979; Jain, 1985; Barbieri, 1991), is related to child/infant mortality. As Caldwell (1979) has argued, "...there are three factors of importance in this regard. In ascending order they are, one, a reduction in fatalism in the face of children's ill-health, two, a greater capability in manipulating the world (e.g. in knowing where facilities are and securing the attention of doctors and nurses) and three, a change in the traditional balance of family relationships that shifts the focus of power away from the patriarchy and the mother-in-law and ensures that a greater share of available resources is devoted to children." Educational level of the mother may affect both, neonatal and post-neonatal mortality. Higher education may lead to inclination towards institutional delivery, better antenatal care, etc., i.e., factors which affect neonatal mortality more closely, and it could also lead to progressive attitudes towards nutrition, child care, etc., i.e., to factors closely associated with post-neonatal mortality.

As far as women's participation in economic activity and its relation to infant mortality is concerned, it is observed that at least in rural areas, non-working women can be better care-takers of children (e.g. breastfeeding can be better managed by housewives). Similarly, women who work on family farms or who are self-employed, could bring along their children. But for those women who work at places where children cannot be carried, breastfeeding or other childcare becomes unmanageable, unless they have convenient working hours and/or have some elderly person to look after the child. As Helen Ware (1984) says

"... both, level of nutrition and standards of care may be significantly affected by the nature of mother's employment, but the problem lies in separating the effects of poverty or ignorance from those of the mother's work per se. Ideally, one would wish to divide mothers who work outside the house into two groups, first, those who work because of the driving pressure of poverty, and second, whose work is more a source of interest and higher standard of living. In demographic literature the discussion of the relationship between women's work and child mortality has almost focused on paid employment outside the home - which is believed to be a possible cause of child neglect and child malnutrition due to the abandonment of breastfeeding."

Although, one could grant the above presumptions to be true, it should be kept in mind, that at least in urban areas, women working outside may have benefit of increased purchasing power and better awareness about health. Therefore to an extent, they compensate for the inability to breastfeed and or provide childcare. In short the effect of women's work participation would be of a mixed nature, with no definite direction. As far as the effect of economic conditions is considered, it is expected to be in the direction of better awareness, increased capacity to purchase health care, and finally, to reduce infant mortality.

Causes relating to health care are mainly those relating to antenatal care and attendance at delivery. Proper antenatal care during pregnancy keeps the pregnant mother and the growing fetus in good health, which provides the child better resistance to infections and hence reduces infant mortality. Similarly, if there are any complications at the time of childbirth and if qualified medical or para-medical persons do not attend the delivery, it can create some deficiency in the child and hence increase the probability of dying.

Lastly, the causes relating to environmental factors are included here to assess the level of infections to which the child has to develop resistance. Source of drinking water could be examined to see the possibility of water-borne infections. Some indicator of air pollution also could be taken into consideration. The choice of the indicators would depend upon the availability of data.

Objective of the study

The objective of the present study is to identify the determinants of infant mortality in Maharashtra on the basis of the data on individual births collected by the National Family Health Survey (NFHS) for the year 1992-93.

Methodology

Data

The data used for this study are from National Family Health Survey, Maharashtra conducted in 1992-93. Three different schedules were administered in this survey:

(1) Village schedule
(2) Household schedule
(3) Individual woman's schedule.

Village schedule gives information about the village while the Household schedule gives details about the age, sex, education, occupation, and some illnesses for each member of the household. It also gives the background information about the household and births and deaths that took place in the household in the past two years. The woman's schedule is filled for ever-married women in the age group 13-49 years. It contains detailed information about her background, reproduction, knowledge and practice of family planning, maternal and child health, and fertility preferences. Within the woman's schedule, the section on reproduction gives complete birth history of the woman and also information about the survival status of the child and age at death, if the child is not alive.
The sample design adopted for the NFHS is a systematic, two-stage stratified sample of households. All urban and rural areas of the State comprised the universe for this sample. This methodology is designed to provide State level estimates as well as estimates for urban and rural areas. Considering the need for separate urban and rural estimates, the size of the state, and the time and resources available for survey, the target sample size was set at 4000 completed interviews of ever-married women in the ages 13 to 49. In order to allow for non-response the target sample was increased to 4480 women. Since the sampling fraction is the same in urban and rural areas, this sample is completely self-weighted (I.I.P.S., 1994).

The 1981 Census list of villages served as a sampling frame in the rural areas. A two-stage sample design was adopted with the selection of villages in the first stage and households in the selected villages in the second stage. In urban areas, the list of Census Enumeration Blocks provided by Registrar General of India for 1991 Census, served as a sampling frame. At the first level of stratification, all cities and towns in Maharashtra were sub-divided into three strata, namely, self-selecting cities, district headquarters and other towns. Self-selecting cities are those having probability of selection of unity or the cities for which population in 1991 is bigger than the sampling interval. Probability Proportional to Size (PPS) methodology was then used to select households in these cities. For district headquarters and other non-self selecting towns, a three-stage sample was used for selection of towns with PPS, followed by selection of two Census blocks per selected town with equal probabilities, and finally the selection of households from the selected block.

Data collection in Maharashtra was conducted during November to February 1993. There were 4063 households surveyed in all the 30 districts of Maharashtra with representation of rural and urban areas. From these 4,063 households, 4,106 eligible women were interviewed providing information on 11,941 births. Information about the maternal and child health (MCH) indicators was available only for children born during the reference period of five years, i.e. 1988-93. Thus it was decided to use the data on births only during January 1988 to February 1992 in the final analysis. In this manner we were able to accommodate information on MCH, which is important in the case of infant mortality and also to avoid errors due to lapse in recall. Children who had not completed one year at the time of survey are excluded from the analysis to give one-year exposure to estimate infant mortality. Analysis was conducted on the births that occurred five years preceding the survey, after excluding children who were below one year at the time of the survey. There were 2135 such births during this five year window. The estimated IMR from NFHS, Maharashtra for the period 1988-92 is 50.5, NMR is 36.4, and PNMR is 14. These figures are calculated on the basis of births 0 to 5 years preceding the survey. For this period the corresponding estimate of IMR given by Sample Registration System (SRS) is 61. Survey estimates are seen to be lower than that of SRS estimates, since survey estimates of infant mortality are always affected by under reporting. Further, the estimate has a standard error of 4.9. This means that the SRS estimate of 61 lies within the 95 % confidence interval.

Specification of Variables

To study the determinants of infant mortality, four different sets of variables are used in this study. The choice of variables is made on the basis of the identification of causes mentioned earlier and the availability of data.

Analysis is carried out separately on the four sets because the number of independent variables is more for only 2135 births in the reference period to bring out the exact relationship of these variables with child survival.

(1) Index child related variables
As discussed earlier, these are mainly the characteristics of mother and child. Thus age of the mother at the time of birth, birth order, single/multiple birth, prematurity, and sex and weight of the baby at birth are the chosen indicators. Prematurity in this analysis is the perception of the mother regarding the timing of the birth. It is not based on weight of the child at the time of birth and/or duration of gestation. It is a response to the direct question whether the child is born on time or prematurely. In the Indian situation, childbirth is considered as a normal biological process and many deliveries are conducted at home. In these cases, babies are not weighed at the time of the birth, but mothers can report their size. Thus respondent's perception about the size of the baby is taken as a proxy for the weight.

(2) Social variables
Under this set, variables like place of residence, religion, caste, and education of the mother are taken which represent the social status of the household. Occupation of the mother is not included in the final analysis because it gives mixed results as far as infant mortality is concerned. In the absence of data, no reliable indicator of economic condition of the household could be taken.

(3) Maternal and child healthcare variables
Availing of antenatal care and type of care at the time of delivery and complications at the time of delivery are selected as the indicators of this group of causes. About the complications of pregnancy, respondents were asked whether there were any complications at the time of delivery. If she responds positively, it is expected that she may tell one or more of the problems such as, Caesarean section, use of forceps, excessive bleeding, long period of labor, delayed delivery of placenta or some other complication specifically mentioned.

(4) Environmental indicators
Source of drinking water is used as a variable indicating the possibility of water pollution. To get an indicator of air pollution, indirect information on fuel used for cooking can be used. Similarly, availability of a separate kitchen can also be used to know whether the air in the house is filled with smoke.

Methods

Infant mortality definitely has shown some relationship with different sets of variables discussed above. The NFHS report directly provides information on IMR, NMR, and PNMR based on births 10 years preceding the survey so as to get the correct estimates, as more births and deaths are included in the calculations. These figures are still presented in this paper to get an idea about the mortality status of the population and its sub-groups. Social variables, maternal and child heath-care variables, and environmental indicators have individually exhibited impact on IMR at the aggregate level. Examination of the relationship of IMR with different indicators at the aggregate level presumes that IMR represents the health conditions of the group concerned and not necessarily the mortality risk of the individual child. Similarly, the identified correlates at group level may not turn out to be the real determinants at the individual level. Further, from the action-oriented policy implication point of view, it is important to identify the factors that determine the mortality risk of the individual child. Therefore, in the present paper, an attempt has been made to identify the determinants with a single infant as a unit of analysis. Thus, the probability of dying before completing one year of each individual infant is expressed as a result of different factors determining its survival. It is expected that the most proximate real factors would turn up with significant correlation and hence it would be possible to reach conclusions that have policy implications.

The main interest is to determine in any given circumstances, the factors that increase the probability of a child dying before one year of age. The binary dependent variable in this study is whether the child is still alive or has died as an infant. Independent variables, except for numeric responses like age of the mother at the time of birth and birth order, are defined in the form of dummy variables. This makes interpretation of the results simpler. Age and birth order are not converted to dummy variables because in doing so, minute details of the information

collected are lost. Taking them as it is in the analysis gives more accurate estimates. It was theorized that interactions between variables would shed more light on the relationship of the variables with infant mortality. Thus, some interaction variables are created using dummy variables. Interaction terms in this model are products of single terms. In case of categorical variables, they are products of the values of new variables. The category of the variable, which may contribute more towards infant mortality, is taken as reference category while creating these variables.

For this study, the technique of logistic regression is used to test the effects of different variables on infant mortality. Logistic regression is used to predict a binary dependent variable, whether the infant is dead or not, from the set of independent variables. Under logistic regression, the probability of an event occurring can be directly estimated. Here model parameters are estimated using the maximum likelihood method.
Logistic model is written as,

$$Prob(event) = \frac{\exp(B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k)}{1 + \exp(B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k)} = \frac{1}{1 + \exp-(B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k)}$$

where, $X_1, X_2, \ldots, X_K$ are independent variables and $B_0, B_1, B_2, \ldots, B_K$ are regression coefficients.
To understand the interpretation of logistic coefficients better, it can be rewritten in terms of the odds of an event occurring. The odds ratio is the ratio of probability that event will occur to probability that it will not.

$$\frac{Prob(event)}{Prob(noevent)} = \exp(B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k) = \exp(B_0)\exp(B_1X_1)\ldots\exp(B_kX_k)$$

Then e raised to the power B_i is the factor by which the odds ratio changes when the i^{th} independent variable increases by one unit. If B_i is positive, this factor will be greater than 1, which means that the odds ratio is increased. If B_i is negative, the factor will be less than 1, which means that the odds ratio is decreased. When B_i is 0, the factor equals 1, which leaves it unchanged.

Results and Discussions

Let us examine the effect of each and every set of variables described above on infant mortality from various angles. We study the distribution of births by those characteristics, various mortality rates, and finally the results of multivariate analysis. Tables 4, 7, 10, and 12 give the B values and the odds ratios for index child related variables, social variables, maternal and child health care variables and environmental variables, respectively.

(1) Index child related variables
To begin with, the distribution of births by different variables related to an individual child is given in Table 1. Table 1 shows the characteristics of the child, its survival status, and age of the mother at the time of delivery. As expected, it indicates that most of the children have normal conditions at the time of the birth. This means that most of the births are single births, on time, and without complications at the time of the birth. Under adverse conditions, the probability of dying would definitely be more. In view of the fact that the neonatal mortality is a major contributor to IMR, examining some factors that may elevate risk of infant mortality, especially neonatal mortality, would be relevant. As stated in the NFHS report, the categories which have such an elevated risk of infant mortality are age of mother at the time of birth less than 18 years and greater than 34 years, birth order greater than three, and birth interval less than two years. Ages 18 and 34 presented in Table 2 are the boundaries below and above which the risk of infant death is higher.

Table 2 shows percentages of high-risk births for the State and its rural and urban areas. As expected, percentage of very young mothers is considerably greater for rural areas (16 %), even now than for urban areas (6 %). This risk factor can be controlled, if age at marriage is increased, especially in rural Maharashtra. Another important risk factor is higher order births. Small family norm is thus conducive to decline in IMR. Higher order births are observed in both rural and urban areas. Similarly, if births were spaced sufficiently, IMR would come down.

Table 3 gives neonatal, post-neonatal, and infant mortality rates for all children, 10 years preceding the survey. They are presented here to get an idea of variations in various mortality rates by child-related characteristics. Neonatal mortality for girls is much less than for boys, whereas, post-neonatal mortality is more for girls than for boys. Infant mortality, in general is lower for girls because of the larger share of lessened neonatal mortality. Neonatal mortality is higher for the children of very young mothers, less birth intervals, and small size of baby at the time of birth. The age groups in Table 3 are 10 years age groups conveniently made for presentation. They do not relate to high-risk ages as presented in Table 2. Differentials continue even in post-neonatal mortality for small size babies and those with small birth interval, which has a clear reflection in IMR.

When logistic regression is run on index child related set of variables, it is found that age of the mother, single/multiple birth, prematurity, and the size of the baby (as an indicator of the weight of the baby) are significant variables at five % level of significance. The variables, which did not turn out to be statistically significant, are sex of the child and birth order.

There are reasonable grounds for these findings. IMR could be significantly different between the sexes in a region where sex bias is of remarkable order. As it is said that the female fetus is biologically stronger than the male; the neonatal mortality for boys is higher than that of girls (Table 3), while the post-neonatal mortality for girls is higher. Even with these counter-balancing factors the mortality rate for boys is higher than that of girls. But in the analysis based on individual children, the difference is not significant. It means that the post-neonatal mortality, which is mainly dependent on infections and resistance to them, which could be generated through better nutrition and breastfeeding, should be much higher for girls than for boys than is shown in Table 3. It implies that gender bias, which obviously could not be reflected in neonatal mortality since it mainly depends upon prenatal care, has reflected in the post-neonatal difference in treating boys and girls. However, since neonatal mortality forms the major component of IMR, sex of the child is not reflected in differentials in overall IMR.

It is also observed that IMR does not seem to be differing much by the birth order. There could be two reasons for such an occurrence. First, there is no linear relationship between the birth order and IMR. Secondly, only the births during past five years are taken into consideration, for this study. Proportion of higher order (four or more) births, which are expected to have higher mortality, is less in recent births in this study. Only 23 % of the births are of order four and more. Furthermore, it is found that related variables such as antenatal care and immunization do not differ much between birth order one, two, or three, but they have much lower values for births of order four and more.

Age of the mother does not have a linear relationship with IMR; hence in the analysis squared term of age is used. Age of mother is obviously directly related to IMR. From both the ends, very young and old, it has emerged as a significant variable. Prematurity or weight of the baby at the time of birth also has an impact on IMR. If the child is born before time, the chances of survival are less compared to a baby born on time. Similarly low birth weight babies have to struggle more for survival than normal babies. Analogously, on the same lines, single/multiple births can be explained. Thus prematurity, size of the baby at the time of birth (proxy for birth weight), and single/multiple births are thus significant. In this regression, the role of these three variables in explaining IMR is the most significant.

(2) Social variables

Distribution of births by social characteristics is presented in Table 5. Three variables are incorporated in this group, viz., religion, caste, and education of mother. Differentials are presented by place of residence.

Let us examine the differentials in IMR at aggregate level according to some of the factors mentioned. National Family Health Survey (1993), Maharashtra has information on the differentials in infant mortality based on births

during 1983-93 and is presented in Table 6. It should be noted that the IMR for this period was 56 per 1000 live births and neonatal mortality was higher, i.e., about 38 and post-neonatal mortality was 18. This, once again, clearly indicates the prominence of neonatal mortality. This should be borne in mind while interpreting the contribution of different factors affecting IMR. Further, it is observed that it differs according to residence, i.e., rural versus urban areas. The difference appears to be sizeable. Similarly, it differs remarkably among different religions. IMR for Muslims is lower than that of Hindus. In reality, most of the Muslims in Maharashtra are engaged in low level occupations and reside in environment with poor sanitation. Hence it was surprising to find a low IMR for them. One reason favorable for this lower IMR lies in the fact that most of the Muslims have urban residence. Thus, awareness created in the urban areas seems to be helping the Muslim community in reducing their IMR. Another reason could be given in terms of prominence of neonatal mortality, which is mainly due to the factors related to mother's reproductive health and, to a limited extent, due to environmental factors. Further, it has been observed that Muslims have better practices of child nutrition in terms of a longer duration of breastfeeding. However, Hindu-Muslim difference in post-neonatal mortality is also quite substantial. There may be some other factors which could be favorable for a lower IMR among Muslims.

As far as the role of mother's education is concerned, the effect is clearly visible. Movement from illiteracy to even the very next category of educational level reduces the risk of infant death substantially. The difference is more in case of neonatal mortality. This means that education of the mother brings about favorable changes in the factors that are closely associated with neonatal mortality. As described previously, higher education implies modern attitudes, awareness regarding importance of antenatal care, institutional delivery, and better childcare. Among the social variables, place of residence (rural/urban), caste, religion, and mother's education are taken as determinants of infant mortality. Various mortality rates show that except for education of the woman, the differentials are not observed in other characteristics. Occupation of the mother has mixed effect on infant mortality, so the selection of appropriate reference category is not possible. Hence this variable is not included in the analysis.

When logistic regression is undertaken, rural/urban residence has not turned out to be significant, though urban areas of the state are much more developed than the rural areas. So there may be other factors associated with residence, which truly explain infant mortality and not just the residence per se. For instance, antenatal, natal, and post-natal care is provided well in rural areas with the help of an effective network of health personnel and differs slightly from that in urban areas. The proportion of births with ANC was 90 % in urban areas and 77 % in rural areas.

No significant difference in infant mortality is observed between Hindus and Muslims. Similar is the case with Scheduled Castes and Scheduled Tribes. They are not significantly different from other castes as far as infant mortality is considered.

Education of the mother plays an important role in explaining infant mortality. Education is classified into four categories - illiterate, primary complete, middle school complete, and high school and above. Education of the mother - primary level- has turned out to be a statistically significant variable. There is a significant increase in infant mortality as shown in Table 6 from the category of illiterate mothers to the category of mothers educated at least up to primary level. Illiterate and literate mothers are significantly different in their behavior as far as childcare is concerned. As mentioned earlier, Caldwell (1979) has pointed out 3 important factors related to inverse relationship of education of mother and infant mortality.

(3) Maternal and child healthcare variables
In this group of variables only the mother's variables are included. They are -

1. Whether the mother had received ANC or not, and
2. Assistance at the time of delivery.

Assistance at time of delivery is important regarding an injury of any kind to the child at the time of birth.
It is seen from Table 8 that for most of the births (about 82 %), mothers have received ANC and 72 % of births are attended either by a doctor or by a nurse/TBA/Dai. In urban areas only 10 % of women received neither ANC

nor medical assistance at the time of delivery, whereas about 25 % of rural women were deprived of ANC and about 40 % did not get any medical assistance at the time of birth. Table 9 presents various mortality rates by medical maternity care which brings out the remarkable differentials. Wherever the services are available to women, period-specific mortality rates of the infants are considerably lower than for those whose mothers could not take the full advantage of the services.

Logistic regression results show that as far as antenatal care and maternal and child health are concerned, antenatal care is highly significant statistically. Proper care of mother during pregnancy helps the child to be healthy at the time of birth. Antenatal care also reduces complications at the time of delivery. Size of the baby at the time of birth, which also can be interpreted as an outcome of antenatal care, has earlier shown a significant relationship with infant mortality.

Complications at the time of delivery is also an important variable, having a direct relationship with infant mortality. This is an expected result, since delay in the process of childbirth may lead to suffocation of the child or some other health problem which may subsequently result in death. Complications at the time of delivery are also directly related to antenatal care. A woman having a problem during pregnancy is likely to go for an antenatal check-up or inversely she may get the knowledge that her delivery may be a difficult one if she has sought antenatal care before term.

Assistance at the time of delivery has not turned out to be significant for all the levels namely, doctor, nurse or birth attendant, and relatives, though regression coefficients and hence the odds ratios are on the higher side. This explains the common saying that childbirth is a natural process - that no medical intervention is necessary at any stage, in general, and no assistance to conduct the delivery, in particular. The child can/cannot die irrespective of who has conducted the delivery.

(4) Environmental indicators
Environmental indicators used in this study relate to source of drinking water and availability of smoke-free atmosphere.

Table 11 gives some idea about the environment in which the respondent lives. Almost seventy-five % of children got the benefit of piped water and about 55 % stay in houses with a separate kitchen. Percentage of separate kitchen is considerably more (60 %) in case of rural areas than in urban areas (49 %). Another important fact is that for 88 % of rural children, the cooking fuel used in the house is wood. It may happen that kitchen may be separate; but if the child is always with the mother, then it may not be able to take the advantage of this favorable factor.

Logistic regression analysis indicates that the environmental variables such as source of drinking water and availability of a separate kitchen turned out to be statistically not significant. Maybe the role of drinking water is more significant only later in the child's life and the post-neonatal mortality has a smaller share in the IMR. Availability of separate kitchen also has been insignificant, though it serves as an indicator of economic status and availability of space, which may be considered conducive to child survival.

The only environmental indicator which turned out to be significant is type of fuel used for cooking. This variable is split into three levels. The first is the reference category, which is taken as wood or cow dung cakes. These 'cakes' create maximum smoke in the house and could be harmful. The second category is charcoal, coal, or kerosene representing moderate level. The third category is almost smokeless and it includes liquified petroleum gas, biogas, or electricity. These three levels also represent the economic status of the household. The infants who are generally with their mothers and are constantly exposed to smoke are very likely to develop respiratory ailments, which may in some cases lead to death.

(5) Interactions
At times it is observed that some variables per se, do not have a direct impact on dependent variables. However, its effect may be reflected when combined with some other variable. Hence such interaction variables explain

more of the relationship with the dependent variable. Some interaction variables are created with the help of dummy variables already constructed for further study.

It is generally seen that there is a difference in infant mortality of Scheduled Castes/Scheduled Tribes and other castes. However, it did not appear to be significant. When the interaction between caste and rural/urban residence is studied it turned out to be significant. This means that the caste differentials exhibit their impact on IMR, when analyzed separately for rural and urban areas. Similarly, it is found that the interaction of caste with availability of separate kitchen and type of fuel used are also significant. Scheduled caste/tribe people may be having no separate kitchen or may be using a fuel creating more smoke in the atmosphere, which is explained by this interaction. Again, it could be said that caste alone does not show differential effects on IMR, but it reflects through indicators such as availability of separate kitchen or type of fuel used. When combined with caste, assistance at the time of delivery by doctor/nurse, birth attendant, or by relatives all turned out to be significant. This means that for different castes, assistance at the time of delivery makes the difference as far as child survival is concerned.
The other important variable, which did not turn out to be significant on its own, is assistance at the time of delivery. It turned out to be significant when combined with caste as seen above. When its interactions with the rural/urban residence and also the complications at the time of delivery are studied, it is seen that the interaction term involving the doctor and nurse or birth attendant turns out to be significant in both the cases. This means that the medical and para-medical help at the time of delivery affects the infant mortality in case of complications. It is thus likely that rural/urban differentials in infant mortality get explained with the help of type of assistance woman gets at the time of delivery.

Conclusions

Infant mortality is a crucial indicator of the health conditions in any region. Especially when the mortality in other ages is fairly controlled or in other words when the region has achieved appreciable progress in bringing down the mortality of adult ages, child mortality or infant mortality becomes a topic of concern. In this connection, study of its proximate correlates was considered essential and hence an attempt is made in the present paper.

There is literature available on IMR but the majority of studies are based on areas as units of analysis and hence hides the real relationship of variables. The NFHS, with its fairly large sample provides valuable information on infant mortality and associated variables. The same has been used in the present paper. There was information collected on 2,135 births during 1988-92, for which the analysis has been attempted. Naturally, a single birth is the unit of analysis. A large sample has helped to disaggregate the information at various levels and hence has enabled to reach the genuine determinants of infant mortality. Further, the technique of logistic regression makes it possible to study the interaction of variables. This exercise was done through four sets of variables:

Child related variables - sex of the child, birth order, age of the mother, single/multiple birth, prematurity, and size of the baby
Social variables - residence, religion, caste, and education of the mother
Maternal health and health care variables - antenatal care, complications during delivery, and assistance at delivery
Environmental variables - source of drinking water, availability of separate kitchen, and type of fuel used.
This list of variables covers almost all variables closely related to infant mortality.

The logistic regression analysis came up with the following results. Among the child related variables, except for sex of the child and birth order, all others, namely, age of the mother, single/multiple birth, prematurity, and size of the baby have turned up as significant variables. In fact, IMR when divided into neonatal and post-neonatal, the sex differentials become visible. As far as the birth order is concerned, it has not turned out to be significant because of a recent and small reference period (four years). Among the social indicators, only education of the mother has come up as a significant variable. It again implies that the factors related to individuals like education and not the community such as caste, religion, and residence are important. Among the variables indicating the antenatal care and natal care and those indicating complications at delivery, only the assistance at delivery has not turned out to be significant. Recent medical research findings of Barker (1999) also mention that the health of a

baby in the long run, depends on the health of a mother in pregnancy in general and during the first 11 weeks in particular. The role of ANC is thus important in explaining IMR.

Among the environmental variables, source of drinking water and availability of separate kitchen (as an indicator of facility to be smokefree) have not been significant in explaining the IMR differentials. Though type of fuel used, which directly indicates the presence of smoke, has come out as a significant variable. It was further observed that some variables like caste or assistance at delivery which were not significant as independent variables have acted through residence, availability of separate kitchen, type of fuel used, complications at the time of delivery, etc. These interactions help us to know the complexity of the relationships. For instance, attendance at delivery per se, may not be important; but when there are complications during delivery, attendance of a qualified person improves the chances of survival. Or caste may not be important per se; but when coupled with indicators of residence or environmental variables such as type of fuel used show, there is an impact.
In brief, the present study, based on a child as a unit of analysis, comes out with following important findings: Infant mortality is related to various characteristics of the individual child and mother. However, sometimes, differentials in IMR are explained for different groups like, caste, religion, and place of residence really does not matter. It purely relates to the practices of the woman and individual characteristics of the child at the time of birth.

As expected, neonatal mortality is a prominent component. All variables determining the health of the child at birth have turned out to be important, including the weight of the baby, the age of the mother, and prematurity. The most important finding relates to the close association of ANC with IMR.

It may be said from this analysis that, though the data set is small, the effect of related variables on infant mortality is reflected through individual characteristics or micro-level variables rather than macro-level variables.

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