The Child Health Scenario in India: An Application of Bayesian Approach

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Abstract:

Background: The child mortality rate of a place is an indication of the basic health facility prevalent there. A place with better medical facility records low child mortality. The child mortality rate reduction is not as expected in many developing countries. In last two decades the child death rate has not been reduced significantly in India. The aim of this work is to explore the child death rate in different Indian states.

Materials and Methods: The Bayesian approach has been applied to control the over dispersion due to presence of zero (i.e. no-death count) in the data set. The Zero Inflated Poisson (ZIP) has been applied to control the presence of over the Zero Inflation Distribution. The data set has been considered from Indian National Health and Family Survey (NFHS-3) conducted during 2005-2006. The women having at least one living child of age less than five years has been selected as study subjects.

Results: The state of Goa has attained the best position recording the lowest child death rate (0.03) and followed by Kerala (0.08). The Arunachal Pradesh (0.75) has attained the last rank among all states in India. In case of child death for women who have at least one living male children Tamilnadu has the lowest child death.

Conclusion: In India it has been observed that married couples accept family planning only after having sufficient number of children. This is mainly because as the child mortality rate is higher so only few of their children would survive to adulthood. Reduction in infant mortality over time and the awareness of such improvements among the people in the community may ultimately lead to lesser number of children per couple due to the removal of the fear of death to their children. It is, therefore, necessary, from the policy point of view, to estimate the actual levels of child mortality of an area under study at different period of time. Attempt shall also be made to explore the extent of changes in the levels of child mortality and its causes over time.

Keywords: NFHS 3, Infant Mortality, Child Mortality, Public Health.

BACKGROUND

Infant mortality refers to the death of a child born alive before its first birthday and child mortality is the death of a child aged between one to five years [1]. The declining trends in infant and child mortality in several developing countries like Sri Lanka, Costa Rica, India is attributed to the introduction of medical technology and corresponding socio economic development [2]. Demographers have for a long time been interested in the study of mortality which is one of the components of population change. The rapid growth of public health and medical services coupled with some improvement in socio-economic condition did result in some decline in overall mortality in the country, though the level of mortality in India is still higher than even some of the developing countries. The high level of mortality in India is because of its high infant mortality [3]. The infant and child mortality are among the best indicators of socio-economic development because a society's life expectancy at birth is determined by the survival chances of infants and children [1]. In the Indian context, the safe delivery of a healthy child and survival of both mother and child cannot be taken for granted [4]. Survival of the child and mother is an indicator of the health of the medical system. It is a reflection of the country's normative framework, its institutional framework, its power balances and priorities. Death rates in India are considerably higher as compared with those of developed countries, even much higher than some developing ones. In order to reduce the overall death rates, more emphasis is needed on the reduction of infant and child mortality. It is known that the deaths of children before their fifth birthday account for 47% of all deaths and almost one third of all deaths are those of infants before their first birthday [5]. It is to be pointed that the reduction of infant and child mortality is one of the necessary pre-conditions for acceptance of the idea of a small family, particularly in societies which for many reasons continue to attach major importance to male offspring and their survival to parents' old age [6].

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In 1998, India faced the highest number of under-5-year-olds child death [7]. The progress of reducing the child death rates is relatively slow in many developing countries. In India, between 1991-95 and 2001-05 the child death rates have declined 40% and 45% respectively in urban and rural areas. However, childhood mortality rates in India are still at elevated levels and the observed reduction in the decline is not readily explainable. The sliding trend in mortality appeared to be a worldwide phenomenon and little interest was shown in critically defining the specific factors responsible for it. It is the usual tendency that the younger children of women's get less health care, food care in presence of the oldest child of age less than five years. In this paper, the state wise child mortality comparison has been carried out of women's who have at least one living child of age five years or less.

Health inequity is an emerging issue all over the India. It is argued that survival of children would be an incentive for the practice of family planning in order to avoid heavier economic burden with the increased number of children. On the contrary, the prevailing high infant mortality fosters a feeling of insecurity of life at early age in which more births are favored to make up the loss [8].

It has been discussed that the continuing high infant mortality rate in India is naturally a cause for general concern [9]. The concern for population policy makers is all the more serious because of the assumptions that unless infant mortality rate is reduced drastically, fertility and population growth cannot be reduced. The high infant mortality leads to shorter birth intervals [10, 11]. The infants born after short intervals are subject to comparatively higher mortality risks [11]. The reason for this is that the previous child in the household claims some of the care that mother could otherwise devote to the new born infant. Different methods of measuring child mortality were discussed and compared recently [12].

In 1999, the total under five-year child mortality among under developed countries comes down to 10 million. In the same time, India alone shares about 20% of child deaths [13]. There is a large body of empirical studies which focus on analyzing determinant of child mortality in India [7]. Several recent studies conclude that safe water, sanitation facilities has an impact on mother's health which in turn has an impact on the health of newborns [14]. The different studies have shown that as compare to boys, girl children exposed with health care in more complex stage of illness, are taken to less qualified doctors when they are ill [15]. Das Gupta (1987) showed that in Punjab the average time spent off parents are 2.3 times higher for son compared to daughter [16]. In contrast, Kerala has an expensive track record of child health in Comparison to the rest of India [23]. However, in brief the lack of national care has generated severe child health issue specially states like Rajasthan [24]. Recently, National Rural Health Mission plan is playing important to control the child death to some extent. The mid day meal plan for school going children is another appreciated model to improve nutrition levels of children.

The purpose of this work is to compare the child death count per women in different states of India. The women with presence of at least one living child are considered for this comparison. The living children are again stratified into two non-over lapping groups. One group comprises of those with at least one living male child and the other with one living female child. In both the cases the oldest living child has been considered. The Bayesian computation technique has been used to deal with over dispersion of no-death count distribution of women sampled in NHFS-3 sample survey. The comparison among states has been done on average child death count per women generated from the posterior distribution.

MATERIAL AND METHODS

Data Source

Secondary data is used for the study. The source of data being the 2005-2006 National Family Health Survey (NFHS-3) conducted in 2005-2006. The survey conducted under the Ministry of Health, Government of India presents information on population and health of 29 states of India.

Sampling Design

The NFHS-3 has been conducted from a sample of households as a representative of national and state levels. In this survey, all women of age 15-49 years of age provide a complete account of the health of their off-springs including for each live birth, their sex, month and year of birth, survival status, and age at the time of the survey or age at death. In this work, all women who have at least one living child in NHFS-3 were considered. The women were then stratified by either one living boy or girl child.

Methodology of Statistical Analysis

In real life situation, the problem of the presence of over dispersion and excess zero to handle the count data is often faced. Zero-inflated distribution is used to model the count data that have many zero counts. The zero inflated Poisson distribution can be useful to model count data when the proportion of zero counts is very high that expected on the basis of the mean non-zero count. This model assumes that the data are a mixture of two separate data generation processes: one generates only zeros, and the other is either a Poisson or a negative binomial data-generating process. The ZIP model with the help of Bayesian approach has been considered to compare the state wise child mortality count per women with living children.

The Statistical Model

The zero inflated models are the particular case of the discrete mixture model used for count data and to deal with cases where there is extensive zero. Of all the different zero inflated models, the widely used inflated model is the Zero Inflated Poisson (ZIP) model. In this work, the Bayesian approach is used [17, 18]. If *y* represent the response variable (the number of child

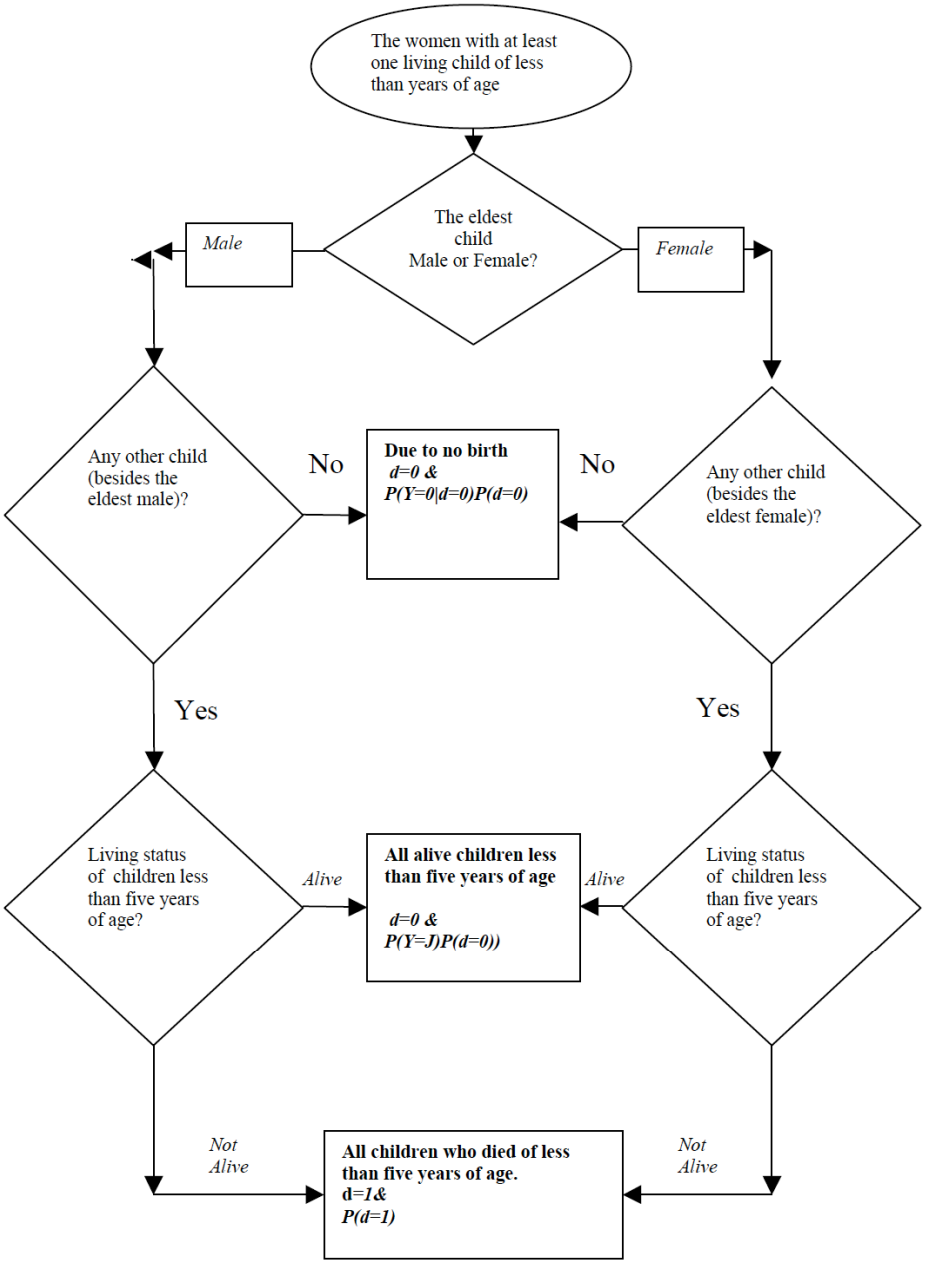

Figure 1: Flow chart of the model.

death) in count data with two associated probability density *P(y=0)* and *P(y =j| j>0)*.

P(*y* =0) stands for probability that a woman whose number of present child count is zero. The component P(*y =0)* has been further classified in two components, viz.

(i) women have zero number of child ever born or child born in still birth condition and (ii) women have experiences her child death and presently the number of surviving child is zero,

$$P(y=0)=P(y=0\mid d=0)P(d=0)+P(d=1) \quad \ldots(1)$$

$$P(y=j\mid j>0)=P(y=j)P(d=0) \quad \ldots(2)$$

In equation (1), *d*=0 represents the woman have zero number of child ever born or she has given birth to a still baby and *d* =1 represents that the woman's child died after taking a live birth. The perceptive of the model can be better explained by a flow diagram that follows in Figure **1** above.

To deal with inflated zero the ZIP model by P(*y*|μ) for mean μ and P(*y*) has been considered from the equation (1) and (2) by,

$$P(y=0)=\omega+(1-\omega)e^{-\mu} \quad \ldots (3)$$

$$P(y=j\mid j>0)=\frac{(1-\omega)e^{-\mu}\mu^{y}}{(y)!} \text{ for } j = 1, 2,\ldots \quad \ldots(4)$$

where ω represents proportion childless mother due to no-birth.

Let t_0 be the total number of true zeroes among the *n* sample obtained such that t_0 ~ Binomial (*n,*θ). The prior distribution of θ has been obtained from ω/(ω+(1-ω)$e^{-\mu}$). It has been assumed that μ follows Gamma(a_1,a_2) and ω follows, Beta(b_1,b_2) priors. In case of b_1 and b_2 the initial value has been used by 33 and 1000 given in the child mortality rate (NHFS-3 report). In place of a_1 and a_2 the total number of child and the total number of women sampled has been used to build the prior information. Here, the term *d* has been used as an indicator variable for women's child status (true zero, *d=1* for women who have experienced child death and *d=0* who have not experienced child death) [17]. The explanation to generate likelihood from posterior distribution in ZIP model by [18],

$$L(\mu,\omega\mid y,d)=L(\mu,\omega\mid y)\prod^{n}\theta^{d}(1-\theta)^{1-d} \quad \ldots(5)$$

Out of the n_1 women who have at least one living child (boy or girl), n_2 has not experienced any child death. So, the proportion of n_2 women's who have not experienced any child death is a high portion of the total women surveyed i.e., n_1. In the ZIP model the estimated parameter of ω and μ were generated from 1000 iteration from a two-chain in WinBUGS.

RESULTS

Table **1** shows the distribution of deaths among the children ages 0-5 years generated from the NFHS-2 report. In the report, an estimated less than five years child mortality was 74.3 for India. The highest death rate was in Uttar Pradesh (96.4) and minimum was in Kerala (16.3). In this study, the state wise an average number of child deaths in women who have at least one living male child have been presented and compared.

Table **2** shows that the minimum mean count of child death per women who have at least one living boy child observed in Goa followed by Kerala and Tamilnadu. The maximum mean count observed is in Arunachal Pradesh followed by Meghalaya and Sikkim. The death counts for Goa was estimated at 0.034 (95% CI [0.007,0.022]) with a standard deviation of 0.10 (95% CI [0.003,0.636]). The child death count in the Northeastern states like Arunachal Pradesh and Meghalaya was found to be as high as 0.758 (95% CI [0.576, 0.954]) and 0.710 (95% CI [0.49, 0.90]) respectively.

Table **3**, shows that the minimum mean count of child death per women who have at least one living girl child observed in Goa followed by Jammu and Kashmir and Sikkim. The maximum mean count observes in Maharashtra followed by Tamil Nadu and Madhya Pradesh. The death counts for was estimated at 0.049 (95% CI [0.028, 0.089]) with a standard deviation of 0.76. The child death count in states like Maharastha and Tamilnadu was high 0.70 (95% CI [0.130, 0.821]) and 0.687 (95% CI [0.08, 0.85]) respectively. The lowest child death rate experienced in Goa (0.03) and Jammu and Kashmir (0.10) and the highest by Maharashtra (0.70) followed by Tamil Nadu (0.8), Madhya Pradesh (0.57) and Haryana (0.56).

DISCUSSION

The infant mortality rate is an important indicator of health conditions in population [19]. Recently, several contributing factor are explored as determinants of

Table 1: Early Childhood Mortality Rates by State

State	Infant Mortality (per 1000)	Child Mortality (per 1000)	0 to 5 year mortality
India	57	18.4	74.3
Delhi	39.8	7.3	46.7
Haryana	41.7	11.1	52.3
Himachal Pradesh	36.1	5.6	41.5
Jammu Kashmir	44.7	6.8	51.2
Punjab	41.7	10.8	52
Rajasthan	65.3	21.5	85.4
Uttaranchal	41.9	15.5	56.8
Chhattisgrah	70.8	21	90.3
Madhya Pradesh	69.5	26.5	94.2
Uttar Pradesh	72.7	25.6	96.4
Bihar	6.17	24.7	84.8
Jharkhand	68.7	26.1	93
Orissa	64.7	27.6	90.6
West Bengal	48	12.2	59.6
Arunachal Pradesh	60.7	28.8	87.7
Assam	66.1	20.2	85
Manipur	29.7	12.6	41.9
Meghalaya	44.6	27.1	70.5
Mizoram	34.1	19.5	52.9
Nagaland	38.3	27.5	64.7
Sikkim	33.7	6.7	40.1
Tripura	51.5	8.2	59.2
Goa	15.3	5	20.2
Gujrat	49.7	11.9	60.9
Maharasthra	37.5	9.5	46.7
Andhra Pradesh	53.2	10.2	63.2
Karnataka	43.2	12.1	54.7
Kerala	15.3	1	16.3
Tamil Nadu	30.4	5.3	35.5

Table 2: Estimated Mean Child Mortality Count in Different States to a Woman who has at Least One Living Boy Child

States	Mean	Sd	Highest Posterior Density		Rank
			2.5%	97.5%	
Goa	0.034	0.014	0.007	0.022	1
Kerala	0.08	0.072	0.05	0.028	2
Tamil Nadu	0.13	0.035	0.205	0.205	3
Gujrat	0.186	0.034	0.099	0.134	4
Manipur	0.187	0.051	0.106	0.286	5
Andrapradesh	0.205	0.072	0.117	0.336	6

(Table 2). Continued.

States	Mean	Sd	Highest Posterior Density		Rank
			2.5%	97.5%	
Karnataka	0.229	0.051	0.007	0.636	7
Himachal	0.289	0.104	0.98	0.502	8
Haryana	0.291	0.064	0.16	0.421	9
West Bengal	0.298	0.058	0.159	0.407	10
Jammu	0.299	0.061	0.152	0.438	11
Maharasthra	0.33	0.094	0.082	0.467	12
Mizoram	0.348	0.127	0.108	0.599	13
Nagaland	0.386	0.058	0.21	0.489	14
Tripura	0.392	0.099	0.229	0.616	15
Delhi	0.407	0.1	0.154	0.599	16
Jharkhand	0.441	0.053	0.292	0.532	17
Punjab	0.441	0.139	0.107	0.653	18
Uttaranchal	0.449	0.098	0.275	0.068	19
Orrisa	0.457	0.685	0.248	0.582	20
Bihar	0.463	0.067	0.244	0.571	21
Assam	0.493	0.44	0.064	0.279	22
M.P.	0.496	0.04	0.365	0.251	23
U.P.	0.506	0.056	0.299	0.568	24
Rajasthan	0.587	0.073	0.408	0.711	26
Chatisgrah	0.532	0.06	0.426	0.642	25
Sikkim	0.651	0.199	0.202	0.048	27
Meghalaya	0.71	0.11	0.493	0.9	28
Arunachal	0.758	0.099	0.576	0.954	29

Table 3: Estimated Mean Child Mortality Count in Different States to a Woman who has at Least One Living Girl Child

States	Mean	Sd	Highest Posterior Density		Rank
			2.5%	97.5%	
Goa	0.049	0.015	0.028	0.089	1
Jammu	0.102	0.018	0.079	0.142	2
Sikkim	0.129	0.061	0.171	0.291	3
Kerala	0.151	0.12	0.026	0.636	4
West Bengal	0.21	0.048	0.364	0.457	5
Mizoram	0.222	0.076	0.116	0.41	6
Delhi	0.231	0.069	0.106	0.383	7
Tripura	0.237	0.077	0.128	0.441	8
Andrapradesh	0.254	0.077	0.086	0.418	9
Himachal	0.276	0.115	0.107	0.35	10
Orrisa	0.282	0.054	0.227	0.636	11
Karnataka	0.292	0.067	0.126	0.414	12
Gujrat	0.303	0.061	0.162	0.398	13

(Table 3). Continued.

States	Mean	Sd	Highest Posterior Density		Rank
			2.5%	97.5%	
Chatisgrah	0.337	0.053	0.497	0.443	14
Assam	0.339	0.054	0.205	0.707	15
Uttaranchal	0.346	0.077	0.19	0.499	16
Punjab	0.356	0.106	0.107	0.565	17
Rajasthan	0.376	0.049	0.271	0.475	18
Manipur	0.4	0.097	0.113	0.57	19
Nagaland	0.401	0.077	0.171	0.41	20
Bihar	0.429	0.047	0.061	0.501	21
Meghalaya	0.497	0.109	0.205	0.707	22
Arunachal	0.501	0.077	0.077	0.664	23
U.P.	0.513	0.053	0.271	0.571	24
Haryana	0.565	0.069	0.341	0.743	26
Jharkhand	0.55	0.078	0.169	0.689	25
Madhya Pradesh	0.577	0.042	0.162	0.668	27
Tamil Nadu	0.687	0.211	0.081	0.856	28
Maharasthra	0.7	0.172	0.13	0.821	29

child survival [20-22]. Further, it has been noticed about couples who accept family planning, that they do so after having sufficient number of children. One of the main reasons for this may be that under the Indian socio-cultural setting when the chances of survival of the children are slender, couples opt for the large families in the hope that at least few would survive to adulthood. Reduction in infant mortality over time and the awareness of such improvements among the people in the community may ultimately lead to the growing preference for lower fertility, due to the removal of the fear of death to their children. It is, therefore, necessary, from the policy point of view, to know the true levels of infant mortality of an area under study at different periods of time and explore the extent of changes in the levels of infant mortality and its causes over time.

Here, analysis has been done where the data comprises of several families with the number of death count as zero. The presence of a high amount of zero can produce over dispersion while working with the data. It is interesting to note that Tamil Nadu, which has a higher human development index, higher literacy rate, and even less number of child mortality rate stratified for at least one living boy child, yet, the child mortality rate stratified for at least one living girl child is the worst compared to several other states. At the same time Arunachal, Meghalaya and Sikkim ranked bottom due to high amount of child mortality stratified for at least one living boy child. Among all the states Goa and Kerala are better positioned with reference to child survival for this survey population.

The potential roles includes planning, supervision of health and family planning monitoring by health workers can be beneficial to improve child health condition in India. Village levels workers can be helpful for decision about reproductive health and family planning decision. Policies are required to be placed to be involved the Panchayat level workers for Child health in India.

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