Estimation Of Infant Mortality Rate At A District Level Study Of India Based On 2011 Census.

Barnali Thakuria

Abstract: Infant mortality is considered to be one of the indispensable demographic indicators that reflect the quality of life in a community. India has attained spectacular achievements in the child survival over the last century. Although the levels of infant mortality revealed a perceptible decline over the years, but the pace of reduction in the infant mortality rates is not evenly distributed across the genders, socioeconomic groups and geographical regions. So, monitoring the progress of any nation only at the national and state level could be an ambiguous particularly in the countries with great diversities. Thus the present study has made an attempt to estimate the mortality rates at the district level which will help the policy makers to assess the quality improvements related to the health services and will also assist in evaluating the programs and policy implications.

Keywords: Brass method, district, Infant mortality rates, India.

1. INTRODUCTION:
The significance of infant mortality as the foremost yardstick of a nation’s state of health and well-being has been well documented in social and biomedical research [1]. Generally, infant mortality is considered to be one of the indispensable demographic indicators that reflect the quality of life in a community and the social and human state development of any environment around the world [2]. Globally, the infant mortality rate (IMR) has been significantly shrunk from 113.7 to 17.3 per 1000 live births between 1960 and 2011 [3]. The developing country like India has also attained spectacular achievements in the child survival over the last century [4]. Prior to 1970, the IMR in the country was 130 per 1000 live births and then began to decline steadily after the mid 1970’s, with the greatest reduction in the 1980’s and 1990’s [5]. During the last two decades (1990-2010), with the fastest improvement in socio-economic dimensions like rise in the literacy rates, decline in the rates of poverty, the infant mortality that plays a crucial role in the health planning has fallen sharply from 80 per 1000 live births in 1990 to 47 in 2010 [6]. Although the levels of infant mortality revealed a perceptible decline over the years, but the pace of reduction in the infant mortality rates is not evenly distributed across the genders, socioeconomic groups and geographical regions [7]. For instance, the SRS (Sample Registration System) bulletins for the year 2012 highlighted that IMR was highest in Madhya Pradesh (56 per 1000 live births) and the lowest is concentrated in the states viz., Goa and Manipur (10 per 1000 live births) amongst all the states of the country. However in India, all the mortality estimates are readily available from the famous demographic source like Sample Registration System. But the source provides the information only at the national and sub-national level. Many studies pertaining to infant and child mortality estimates at the national and state level are existed in the literature while studies at the district level are very limited.

countries with great diversities. India experienced notable mortality variation in all the age groups by the place of residence [8]. So, it is imperative to estimate the mortality rates at the district level which will help the policy makers to assess the quality improvements related to the health services and will also assist in evaluating the programs and policy implications. In developing countries like India accurate estimation of infant mortality rate at the sub-state level is a difficult task due to lack of comprehensive vital registration system. In such circumstances, researchers have to rely only on the indirect methods. One of the famous widely such methods is the Brass method pioneered by Brass (1964) [9], which is based on the information related to children ever born (CEB), child survival (CS) and total married woman reported in the age group of 15-49 years. Brass converted proportions of dead children that were ever born as reported by their mothers classified by various age groups of the reproductive period into the estimates of death probabilities before attaining definite childhood ages [10]. He noticed that the link between the proportions of dead children with respect to mother’s age group (D(i)) where i takes the values 1, 2, 3, 4, 5, 6, 15 and 20 for the corresponding mother’s age group 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 and the life table measure is basically influenced by the age pattern of fertility. Brass also found a series of correspondence between the ages of the mothers and their children as shown in Table 1. But however, these matches are not exact and they rely upon the reproduction stories of those females who report about their births [11]. In addition to this, Brass established a series of multipliers in order to adjust the specific reproductive stories for the mothers and also to convert the values of the proportion of children died into the estimates of the death probabilities before age x [12]. The multipliers adopted by Brass have been further modified by Sullivan (1972) and Trussell (1975) [13, 14]. However, Brass method is subjected to some fallacies. Such errors mainly derive from misreporting on the number of babies born and children dead; incorporation of stillbirths as births, and exclusion of living children who have moved away from their mother’s house, changes in the levels of fertility and also selective mortality amongst the mothers [9]. Another drawback of this method it ignores the estimate of the death probabilities before reaching age 1 (q(1)) which is based on the mother age group 15-19. Regardless of these limitations, the method has found to have several
interesting features and has been observed to estimate the levels of the childhood mortality over the period of 10 years in a very well manner [15]. The estimation given by Brass has led to a revolution in the estimates of infant mortality particularly in least developing countries. But sometimes it has been observed that the death probability that has been estimated by using the Trusell’s variant of Brass method failed to increase monotonically [9]. So, in such cases, it is a prerequisite to utilize some sort of smoothing so that the estimates become genuine. Such type of smoothing can be easily done by logit smoothing technique using the logit of the Brass standard life table.

2. OBJECTIVE:
In the present study an attempt has been made to estimate the infant mortality rate at the district level of the six selected states representing various zones of India namely Assam from the North-East, Gujarat from the West, Kerala from the South, Rajasthan from the North, Uttar Pradesh from the Central and West Bengal from the East respectively based on 2011 census.

3. DATA:
The necessary data for the present study were utilized from the Census of India on the number of children that were born by sex , sex-wise surviving children and total number of women for the age groups 15-34 classified by five year age intervals for the districts of the six selected states mentioned above. Instead of taking the entire reproductive period of women i.e., 15-49 years, we have considered the age groups from 15-19 to 30-34 since Brass method is mainly used to calculate infant and child mortality.

4. METHODOLOGY:
To estimate the IMR using the Brass method, first we need to calculate the average parity per woman P(i) and the proportion of dead children D(i) for each age group by using the equation (1) and (2).

\[ P(i) = \frac{CEB(i)}{W(i)} \quad \text{for } i = 1, 2, 3, 4 \quad (1) \]

\[ D(i) = \frac{CEB(i) - CS(i)}{CEB(i)} \quad (2) \]

Then the multipliers \( K(i) \) for each age group are estimated by using the following equation

\[ K(i) = a(i) + b(i) \frac{P(i)}{P(i + 1)} + c(i) \frac{P(i + 1)}{P(i + 2)} \quad (3) \]

The values of the coefficient \( a(i) \), \( b(i) \) and \( c(i) \) are furnished in United Nations Manual X, 1983 [16].

Thereafter, the death probabilities \( q(x) \) and survival probabilities \( l(x) \) can be easily obtained by the equation (4) and (5) as given below

\[ q(x) = K(i) \cdot D(i) \quad (4) \]

\[ l(x) = 1 - q(x) \quad (5) \]

Next to make the \( l(x) \) for \( x = 2, 3, 5 \) monotonically decrease, logit smoothing is applied.

The logit transformation of \( l(x) \) for \( x = 2, 3, 5 \) (ignoring \( l(1) \)) since \( q(1) \) is disregarded are obtained by

\[ y(x) = 0.5 \ln \left( \frac{1 - l(x)}{l(x)} \right) \quad (6) \]

Then, the smoothed values of \( \hat{y}(x) \) are obtained as

\[ \hat{y}(x) = y_x(x) + \frac{1}{3} \sum_{x=2,3,5} [y_x(x) - y_5(x)] \quad \text{for } x = 2, 3, 5. \quad (7) \]

The values of \( y_x(x) \) are given in the United Nations Manual X, 1983.

Next, the \( l(x) \) values are obtained by the following equation:

\[ \hat{l}(x) = \frac{1}{1 + \exp \left( 2 \cdot (\hat{y}(x)) \right)} \]

for \( x = 2, 3, 5 \) (8)

Choe (1981) [17] stated that Weibull model has two parameters so a pair of \( l(x) \) values are sufficient to estimate them. But in our case we have three smoothed \( l(x) \) values, so decision has to be made about which pair is to be used in estimating the parameters. Out of three combinations, \( l(2) \) and \( l(3) \); \( l(3) \) and \( l(5) \); \( l(2) \) and \( l(5) \), it was found that the combination of \( l(2) \) and \( l(3) \); \( l(2) \) and \( l(5) \) gives almost the same estimate of \( l(1) \). Since the estimate of \( l(1) \) obtained by taking \( l(2) \) and \( l(5) \) is smaller than the one by taking \( l(2) \) and \( l(3) \), so it is chosen to use \( l(2) \) and \( l(5) \) (Sarma and Choudhury, 2014).
\[ \hat{y} = \ln \left[ \frac{\ln \left( \frac{1}{\hat{i}(2)} \right) - \ln \left( \frac{1}{\hat{i}(5)} \right)}{\ln(2) - \ln(5)} \right] \]  

(9)

Then using the value of \( \hat{y} \), \( \hat{\lambda} \) is estimated by

\[ \hat{\lambda} = \exp \left[ \ln \left( \frac{1}{\hat{i}(2)} \right) \right] - \hat{y} \ln(2) \]  

(10)

Finally,

\[ l(x) = \exp \left( - \hat{\lambda} x^\hat{y} \right) \text{ for } x=1, 2, 3, 5 \]  

(11)

\[ \hat{q}(x) = 1 - l(x) \]  

(12)

5. RESULTS AND DISCUSSION:

Table 1: The correspondence related to age group, age group index \( i \) and age \( x \) as given by Brass:

<table>
<thead>
<tr>
<th>Age group</th>
<th>15-19</th>
<th>20-24</th>
<th>25-29</th>
<th>30-34</th>
<th>35-39</th>
<th>40-44</th>
<th>45-49</th>
</tr>
</thead>
<tbody>
<tr>
<td>( i )</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>( x )</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

The above table (Table 2) shows the infant mortality rates estimated by using the Brass method at the district level based on the recent census year. Due to space limitation, we tried to give only the districts with highest and lowest values. The table showed that in Assam out of 27 districts, the infant mortality rates vary from 48 per 1000 live births in Tinsukia to 84 per 1000 live births in Halakandi amongst the males. For females, IMR is the highest in Kokrajhar district with 88 per 1000 live births while the lowest is seen in Kamrup Metropolitan with 41 per 1000 live births. In Gujarat, for males, Valsad district in the lowest position with 47 per 1000 live births and the highest is concentrated in the Dohad district (77 per 1000 live births). On the contrary, for females, Surendranagar occupies the lowest rank and Dohad is in the highest position. In Kerala, Pathanamthitta district occupied the lowest position for both the sexes while Thiruvananthapuram is in the highest position for males and Kasaragod for females respectively. Again in Rajasthan, out of 33 districts, IMR values ranged from a minimum of 45 to 108 per 1000 live births amongst the males. In case of females, the estimates vary from 45 to 97 per 1000 live births. In Uttar Pradesh, IMR values amongst the males stood at 43 per 1000 live births in Lalitpur district to 97 per 1000 live births in Farrukhabad district while for females, the values are 59 in Jalaun district to 99 in Badaun district. Finally in West Bengal, Bankura stood the lowest position and Maldah is in the highest position while the corresponding districts for females are Bankura district and Kolkata. A wide inter-district variation is also observed in almost all the selected states.

### Table 2: Districts with highest and lowest IMR (q1) for all the selected states of India based on 2011 census for both sexes

<table>
<thead>
<tr>
<th>States</th>
<th>Number of districts</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest IMR</td>
<td>Highest IMR</td>
<td>Lowest IMR</td>
</tr>
<tr>
<td>Assam</td>
<td>Tinsukia (0.048)</td>
<td>Halakandi (0.084)</td>
<td>Kamrup Metropolitan (0.041)</td>
</tr>
<tr>
<td>Gujarat</td>
<td>Valsad (0.047)</td>
<td>Dohad (0.077)</td>
<td>Surendranagar (0.044)</td>
</tr>
<tr>
<td>Kerala</td>
<td>Pathanamthitha (0.022)</td>
<td>Thiruvananthapuram (0.035)</td>
<td>Pathanamthitha (0.022)</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>Jaipur (0.045)</td>
<td>Banswara (0.108)</td>
<td>Jaipur (0.045)</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>Lalitpur (0.042)</td>
<td>Farrukhabad (0.097)</td>
<td>Jalaun (0.059)</td>
</tr>
<tr>
<td>West Bengal</td>
<td>Bankura (0.036)</td>
<td>Maldah (0.059)</td>
<td>Bankura (0.035)</td>
</tr>
<tr>
<td>Total</td>
<td>Pathanamthitha (0.002)</td>
<td>Banswara (0.108)</td>
<td>Pathanamthitha (0.002)</td>
</tr>
</tbody>
</table>

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Table 3 presents the frequency distribution of IMR at the district-level of the selected states amongst the male children. It is observed that the highest number of districts from the selected states falls under the range of 60-80 deaths per 1000 live births. Out of all the selected states, more than half of the districts from Uttar Pradesh belong to this IMR interval. It is also observed that many districts of Rajasthan and Uttar Pradesh performed very poor in terms of the IMR indicator as they values have fallen in the category of above 80 deaths per 1000 live births.

Table 4 provides the frequency distribution of IMR amongst the female children. From the table, it is noticed that except the state Kerala, the districts of the other states did not perform well with respect to the IMR indicator. The maximum percentage of the districts has ranged the IMR values in the interval 60-80 deaths per 1000 live births. A varied rate of IMR is indicating in the states. For instance, fifteen districts from Assam registered an IMR range of 40-60, eleven in 60-80 and one district above 80. A majority of the districts from Uttar Pradesh belonged to the highest range i.e, above 80.

Table 5: Comparison of the districts with the national level in terms of IMR for the year 2011.
IMR values.

(### None** indicates no district scored below)

Table 5 revealed the list of the districts that scored IMR values below the national level. As per the SRS bulletin 2011, IMR at the national level stood at 43 for males against the 46 for females. By comparing the district values with the national estimates, we can find out the regional disparities that are existing in the country. Except Kerala, the districts of the other states showed a worst performance in the levels of IMR (Refer to Table 4). The results also indicated that gender differential in terms of IMR values.

6. CONCLUSION:
In order to track the progress of any nation in a better way, micro-level estimates are necessary as districts are the important units of an administration. It is strongly believed that the study will furnish an evidence and guidance in addressing the mortality estimates particularly at the infant level. Proper interventions and steps should be made by the governments so that the mortality rates get reduced. The results also showed that more intensive programs should be focused mostly in the demographically backward districts.

7. REFERENCES:
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