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ORIGINAL ARTICLE

Method for Estimating Infant Mortality Rate for Chhattisgarh State in India

[1]Sachin Pandey, [2]Hemlata Thakur, [3]Sakuntala Jitpure, [4]Arun Singh

ABSTRACT

Measurement is a fundamental aspect of research in the area of infant mortality. The National Population Policy, 2000 aims at a reduction of Infant mortality rate (IMR) to less than 30 by 2010. The estimates on infant and child mortality at the national level and for major states of India are provided by the sample registration system (SRS) annually. The National Family Health Survey (NFHS) also provides the estimates by mother's educational level, standard of living of the households as well as the other socio economic characteristics of the households. Thus, at the state level we have good information on these estimates. Estimates of IMR can be derived directly as well as indirectly. The direct estimates are usually based on the number of infant deaths reported during the last one year per 1000 live births. The civil registration system as well as the SRS adopts this technique for providing the estimates.

Keywords: Child mortality rate, Family health survey, Infant mortality rate, National sample registration, Under five mortality rate.

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INTRODUCTION

The infant mortality rate (IMR) (the probability of not surviving by age 1) is one of the sensitive indicators of development. It is one of the key indicators from the program point of view. Infant mortality rate is an important indicator of social development of a nation as well as state. It is widely used for assessing socio-economic and health situation in developing countries (Chandra Sekhar[2], Jain and Visara[4]). Measurement is a fundamental aspect of research in the area of infant mortality. If the vital registration is complete, IMR for each year can be calculated in the conventional manner directly from the system's data. Hill[3] Trussell,[7] Palloni and Helligram[6] have been used for estimating IMR for Nepal using the census or survey data. The National Population Policy, 2000 aims at a reduction of IMR to less than 30 by 2010. The Millennium Declaration aims to reduce infant mortality by two-thirds from its current level. A reduction in the IMR depends on both exogenous and endogenous factors, such as medical assistance at delivery, nutritional level, and health of mother as well as care during and after delivery. The estimates on infant and child mortality at the national level and for major states of India are provided by the SRS annually. The National Family Health Survey (NFHS) also provides the estimates by mother's educational level, standard of living of the households as well as the other socioeconomic characteristics of the households. Thus, at the state level, we have good information on these estimates. Estimates of IMR can be derived directly as well as indirectly. The direct estimates are usually based on the number of infant deaths reported during the last 1 year per 1,000 live births. The civil registration system as well as the SRS adopts this technique for providing the estimates. Besides, the following indirect methods are used in providing the estimates of IMR:

- Estimation of infant mortality from information on children ever born and children surviving
- Estimation of IMR based on regression methods
- Estimation of IMR from the birth history of women

The second model is applied to obtain the estimates of IMRs for Chhattisgarh and computing relevant t test between presented IMR data and estimated data.

[1]Assistant Professor (Biostatistics), [2]Professor and Head [3]Associate Professor, [4]Professor

[1-3]Department of Community Medicine, Chhattisgarh Institute of Medical Sciences, Bilaspur, Chhattisgarh, India

[4]Department of Community Medicine, Rohilkhand Medical College, Bareilly, Uttar Pradesh, India

Corresponding Author: Sachin Pandey, Assistant Professor (Biostatistics), Department of Community Medicine, Chhattisgarh Institute of Medical Sciences, Bilaspur, Chhattisgarh, India e-mail: sachinpandey9@rediffmail.com

OBJECTIVE

- To estimate IMR (per 1,000 live births) for three different components, such as total, urban, rural with the help of child mortality rate (under five mortality rate).
- To compare between estimated IMR and presented IMR data with respect to years.

MATERIALS AND METHODS

The proposed methodology of estimation is based on simple regression approach described Kumar,[5] Aryal and

Gautam.[1] The methodology of estimation developed here follows the usual path of establishing the relationships between the dependent variable, which in this case is the IMR, and the independent variable, such as CMR. Several empirical studies show a linear relationship between IMR and CMR. Therefore, it is decided to fit a regression model of type:

$$Y = a + bX + e \quad (1)$$

where Y = IMR (per 1,000 live births); X = CMR (per 1,000 population); e is a random error term; and a and b are parameters to be estimated.

The next step is to determine the value of the parameters. For this purpose, the regression model is fitted in by the following set of data extracted from the NFHS fact sheets (2011–12), census (2011), and NFHS fact sheet of Chhattisgarh (2015–16).

RESULTS

Table 1 gives the following values of constants needed for estimating the parameters.

Intercept (a) for Total = 61.120; Intercept (a) for Urban = 51.736; Intercept (a) for Rural = 62.338.

Slope (b) for Total = –0.137; Slope (b) for Urban = –0.226; Slope (b) for Rural = –0.109

Using these data (Table 2), simple regression approach gives the following estimated regression model for computing IMR for Chhattisgarh as for Total and according to residences by Statistical Package for the Social Sciences (SPSS) 11.5 version.

The results are given below:

$$Y\ (\text{Total}) = 61.12 - 0.137X \quad (2)$$

$$Y\ (\text{Urban}) = 51.736 - 0.226X \quad (3)$$

$$Y\ (\text{Rural}) = 62.338 - 0.109X \quad (4)$$

$n = 8, R^2 = 49.1\%$, $n = 8, R^2 = 62.9\%$, $n = 8, R^2 = 40.8\%$

where Y = Estimated IMR (per 1,000 live births), X = Child (under 5) mortality rate (per 1,000 live births).

Where n is denoted no of year wise presented data of IMR and child mortality rate (CMR). The coefficient of determination (R^2) is computed for goodness of fit. The value of coefficient of determination for Urban = 62.9% is very high which indicates goodness of fit as 63% approximately of the variation in IMR among the periods and appears to be explained by the variation in the CMR. Similarly, the smaller value of computed SE(Y) for Urban = 0.78 indicates the higher reliable of the model. The goodness of fit of a regression model is mostly affected by the estimated values of the parameters. Similarly, the estimated parameters may be considered significant as they satisfied the *t*-test. For the Urban IMR prediction, the parameter b is to be considered significant as the *t*-test = 2.93, which has $p < 0.05$, statistically significant. This is also true for the constant parameter in all three different situations, such as Total, Urban, and Rural prediction of IMR. The calculated F ratio is statistically significant only in prediction of Urban area of Chhattisgarh. Finally, we can say the regression model for IMR is the best model for prediction of IMR in Urban area.

The presence of autocorrelation is a serious problem, and therefore, Durbin–Watson (D-W) test is computed for detection of autocorrelation. The results of D-W test clearly show the absence of autocorrelation in the residuals because the first-order autocorrelation coefficient is very small and the condition $d_u < d < 4 - d_u$ is well satisfied for Urban area (Table 3).

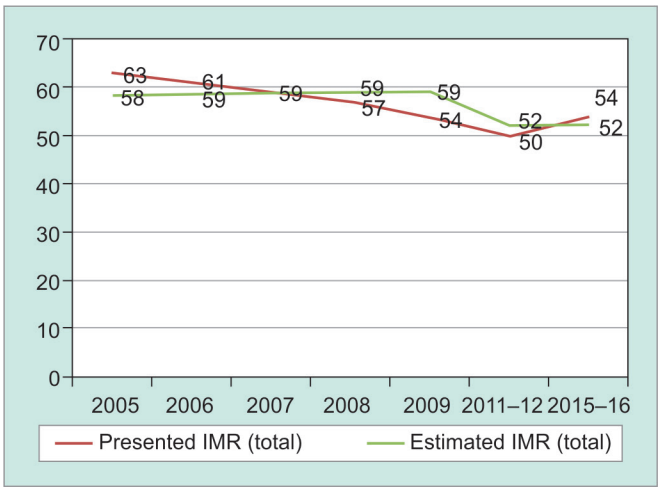
Graph 1 shows comparisons between estimated IMR (Total) and presented IMR (Total) year-wise data. It shows that both lines are gradually decreasing, but after year

Table 1: Estimates of CMR and IMR for Chhattisgarh used for fitting equation (1)

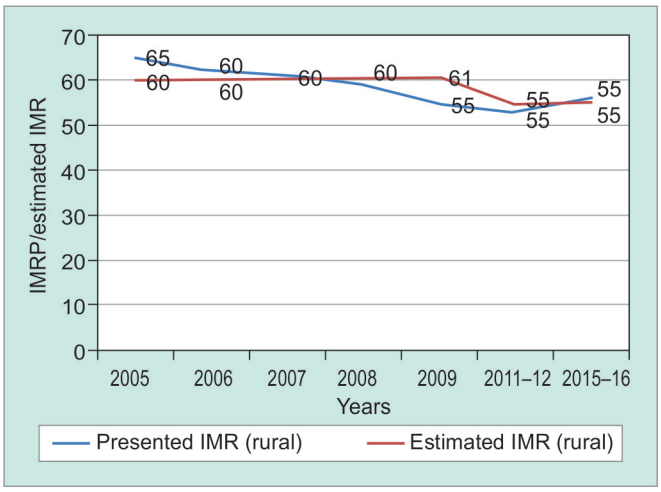
Years	*CMR (Total)*	*IMR (Total)*	*CMR (Urban)*	*IMR (Urban)*	*CMR (Rural)*	*IMR (Rural)*
2005	20.2	63	13	52	21.1	65
2006	18.4	61	12.5	50	19.5	62
2007	16.9	59	11.9	49	17.9	61
2008	17.1	57	11.7	48	18.1	59
2009	15.5	54	11.4	47	16.2	55
2011–12	66	50	44	37	71	53
2015–16	64	54	51	44	68	56

Table 2: Representing current and estimated infant mortality rate (IMR) for total, Urban and rural for Chhattisgarh

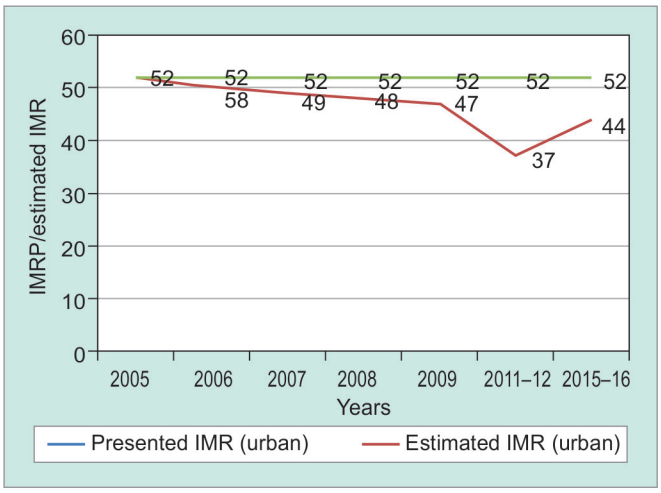
Years	*Y(IMR) Total*	*Est. IMR (Total)*	*Y(IMR) Rural*	*Est. IMR (Rural)*	*Y(IMR) Urban*	*Est. IMR(U)*
2005	63	52	65	60	52	58
2006	61	52	62	60	50	59
2007	59	52	61	60	49	59
2008	57	52	59	60	48	59
2009	54	52	55	61	47	59
2011–12	50	52	53	55	37	52
2015–16	54	52	56	55	44	52



Graph 1: Comparison of presented IMR (Total) and estimated IMR (Total) according to years



Graph 2: Comparison between estimated IMR and presented IMR for rural of Chhattisgarh according to years



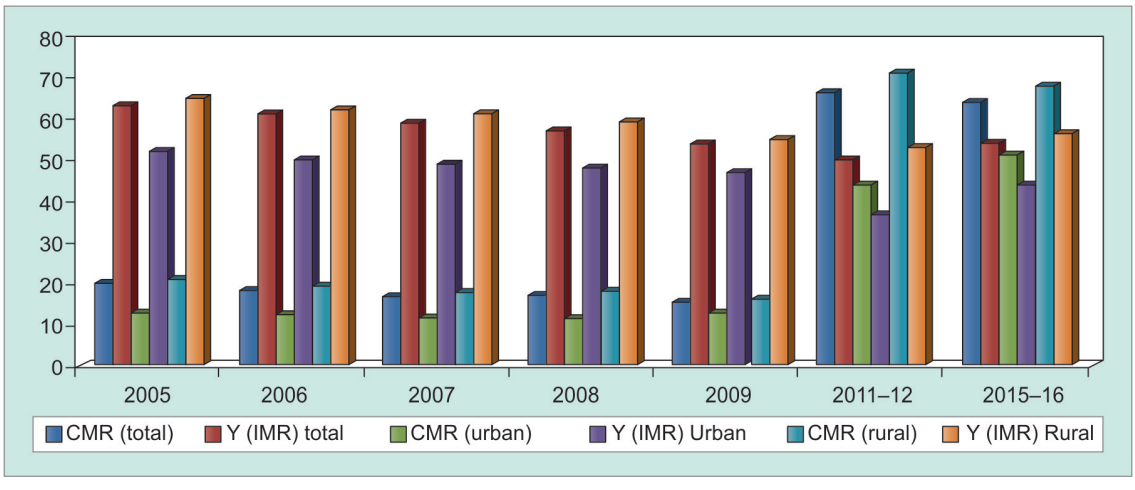
Graph 3: Comparison between estimated IMR and presented IMR for urban of Chhattisgarh according to years

Table 3: Representing all statistical analysis which are done by SPSS 21.0 version

Test for model adequacy	*Results*
Tests for goodness of fit:	For Total = 49.1%, Urban = 62.9%, Rural = 40.8%
1 Based on coefficient of determination R^2 (%), n = 8	t_{Total} (for CMR) = –0.137 (p > 0.05 not significant), t_{rural} = –1.855 (p > 0.05 not significant), t_{Urban} = –2.913 (p < 0.05 significant)
Test of significance	
1 Based on *t*-test	F_{Total} = 4.819 (p > 0.05 not significant), F_{Rural} = 3.442 (p > 0.05 not significant), F_{Urban} = 8.495 (p < 0.05 significant)
2 Based on analysis of variance and F ratio	D*** = 1.621, D** = 0.821, D* = 0.743
3 p value	
4 D-W test for auto correlation	
D statistic	
*for Total,**for Rural,***for Urban	

2011 to 2012 both are increased, which is shown in year 2015 to 2016 recently.

Graph 2 shows comparisons between estimated IMR (Rural) and presented IMR (Rural) year-wise data. It shows that both lines are gradually decreasing but after year 2009 presented data of IMR are less than estimated IMR data, which is a good sign at that time. But in recent year 2015 to 2016, both lines (Estimated IMR and presented IMR for Rural are collapsed or touch each other) increase, which is shown in year 2015 to 2016 recently.



Graph 4: Representing bar chart child mortality rate and infant mortality rate for total, urban and rural of Chhattisgarh according to years

Graph 3 shows comparisons between estimated IMR (Urban) and presented IMR (Urban) year-wise data. It shows that both lines are gradually decreasing overall, but in year 2011 to 2012 presented data of IMR showed big graph than estimated IMR data, which was a good sign at that time. But in recent scenario 2015 to 2016, both lines of presented IMR for Urban are growing and try to touch each other.

Graph 4 shows year-wise child mortality rate under 5 years and IMR in three types, such as Total, Urban, and Rural.

CONCLUSION

The advantages of the indirect techniques in mortality estimates cannot be overemphasized in developing states, such as Chhattisgarh. The proposed model is very simple and easy to apply; it does not need census or survey data and model life tables for estimation of IMR; and it gives approximately reliable estimates of Chhattisgarh state. The results indicate that the model is fit in Urban area, which means that we can predict the best estimation of IMR in Urban area with respect to CMR in last 8 years. The model seems to provide comparatively better estimates for more recent periods than for the distant past. However, the model seems to be affected by accuracy of data and age structure of the population under study.

Conclusively, the model may be considered suitable for estimating IMR for Chhattisgarh for few more decades.

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