A METHOD FOR ESTIMATING INFANT MORTALITY RATE FOR NEPAL

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Introduction

Infant mortality rate (IMR) is an important indicator of social development of a nation. It is widely used for assessing socio-economic and health situation in developing countries (Chandra Sekhar 1972: 77; Jain and Visaria 1988). Measurement is a fundamental aspect of research in the area of infant mortality. If vital registration is complete, IMR for each year can be calculated in the conventional manner directly from the system's data (Hill 1991:369). Unfortunately, complete vital registration system is practically non-existent in Nepal (Karki 1989). In the absence of complete vital registration system, indirect techniques proposed by Brass (1964), Trussell (1975), Feeney (1980), and Palloni and Heligman (1986) have been used for estimating IMR for Nepal using the census or survey data.

The estimation of IMR by these techniques needs accurate birth history data to be collected from census or survey; reliable and adequate age patterns of child mortality for selecting an appropriate method and model life table; and lastly, many assumptions to be satisfied by the population under study. But the irony is that the birth and death data collected from the censuses or surveys of Nepal are highly inaccurate (Radhakrishna 1992:6-9; Pant 1996:1-8). Further, many assumptions underlying the models are unjustifiable in the population under study (Hill and Yazbek 1993:7). Moreover, there is no reliable age distribution of mortality for Nepal to use in deciding the right family that fits (CBS 1995:101). Apart from this, Nepal is a poor country where 42 percent of people still live below the poverty line, and almost half of the total population are unable to read or write (UNDP 2002:2).

Keeping in view the socio-economic and demographic realities of our own country, this paper presents a simple regression model for estimating IMR from the minimum relevant parameter. Crude death rate (CDR) has

Contributions to Nepalese Studies, Vol. 31, No. 2 (July 2004), 257-264

been selected as the minimum relevant parameter needed for estimating IMR because it represents the 'end result' of development; can be easily obtained from either suitable models or various publications; and more importantly, it is strongly correlated with the level of IMR (Arriaga 1994). The model is applied to obtain the estimates of IMR for Nepal, and its validity is ascertained by comparing the estimated IMRs for Nepal with the other estimates available in the country; and by computing relevant tests for diagnostic checking for model adequacy.

Materials and Methods

The proposed methodology of estimation is based on simple regression approach described elsewhere (Kumar 1981; Aryal and Gautam 2001; Singh 2003). 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, herein identified as CDR. Several empirical studies show almost a linear relationship between IMR and CDR. Therefore, it was decided to fit a regression model of type:

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

Where Y = IMR (per 1000 live births); X = CDR (per 1000 population); e is a random error term; and a and b are parameters to be estimated.

The next step is to estimate the value of the parameters. For this purpose, the regression model is fitted in by using the following set of data extracted from the United Nations (1999).

Table 1 : Estimates of CDR and IMR for Nepal used for Fitting the Equation (1)

Years	X (= CDR)	Y (= IMR)
1950-1955	27.9	210
1955-1960	26.7	200
1960-1965	25.0	189
1965-1970	22.8	175
1970-1975	21.1	160
1975-1980	18.4	142
1980-1985	16.2	125
1985-1990	14.1	109
1990-1995	12.8	96
1995-2000	10.9	83

Source: United Nations (1999), p. 305.

The table gives the following values of constants needed for estimating the parameters:

$\Sigma X = 195.90$ $\Sigma Y = 1849.00$ $\Sigma XY = 31598.20$

$\Sigma X^2 = 4163.81$ $\Sigma Y^2 = 239821$ $n = 10$

Using these data, simple regression approach gives the following estimated regression model for computing IMR for Nepal:

$\hat{Y} = 3.01 + 7.4470\, X$ .... (2)

$n = 10$, $R2 = 99.8763\%$, S.E. ($\hat{Y}$)= 1.7009

Where $\hat{Y}$ = Estimated IMR (per 1000 live births);

X = CDR (per 1000 population).

Diagnostic Checking for Model Adequacy And Discussions

A model that fails in diagnostic checking for model adequacy will always remain suspect and little faith can be put in the results (Kerlinger 1998). Therefore, it is essential that the model fitted for estimation purposes should satisfy the important tests of model adequacy. In this study, diagnostic checking for model adequacy is done by applying the model in Nepal's context; comparing the estimated IMRs for Nepal with the other estimates available for the country from different sources (Singh 1979; CBS 1987a, 1995; UNICEF 2001); and by computing relevant tests for model adequacy described elsewhere. The comparison of the estimated IMRs for Nepal with the other estimates available for the country is presented by the figures in the following table and figure:

Table 2 : Comparison of the Estimated IMRs for Nepal with other Estimates

Estimates of other sources			Present Study
Years	CDR	IMR	IMR*
1954[i]	36.70	255.00	276.05
1961[ii]	25.72	171.23	194.55
1976[iii]	22.20	134.00	168.33
1981[ii]	17.35	131.00	132.21
1991[iv]	13.30	97.00	102.02
1999[v]	10.00	75.00	77.48

Notes: i Refers to the estimates of Baidyanathan and Gaige (1973), PP. 278-290.

ii Refers to the estimates of Singh, M.L. (1979, P. 172.

iii Refers to the estimates of CBS (1987a), P. 99.

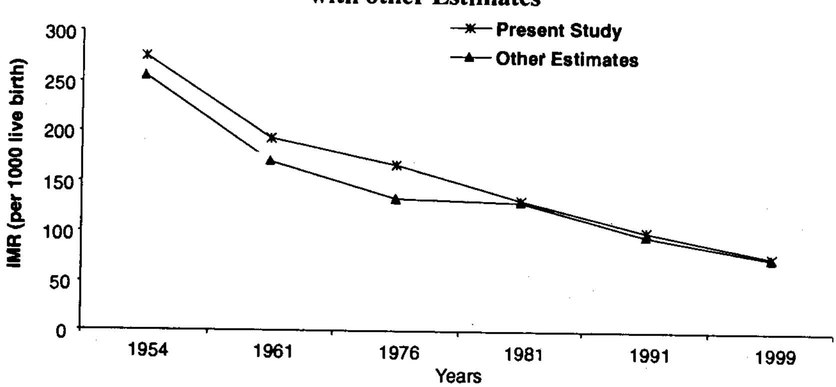
iv Refers to the estimates of CBS (1995), P. 96.

v Refers to the estimates of UNICEF (2001), P. 80

* Refers to the estimates of the present study.

Source: CBS (1987a, 1995); Singh, M.L. (1979); UNICEF (2001).

Figure 1 : Comparison of the Estimated IMRs for Nepal with other Estimates



This figure clearly shows declining trends of IMRs over the periods as is usually expected. More importantly, it shows close agreement between the estimated IMRs and the other estimates available for the country from different sources over a wide range of periods. However, it also shows a weak agreement between the estimated IMRs and other estimates especially, before 1981. This may be attributed to the limitations of data sources. In summary, the model seems to provide better estimates for more recent periods than the distant past. Diagnostic checking for model adequacy can also be done by computing major relevant tests described elsewhere.

The following table presents the results of major relevant tests computed for diagnostic checking for model adequacy:

Table 3: Tests Computed for Diagnostic Checking for Model Adequacy

Tests for Model Adequacy		Results[@]
1. Tests for Goodness of fit:		
i. Based on coefficient of determination:	R^2(%)	99.6900
	r	-0.9984
	n	8
2. S.E. of Estimates:	S.E. ($\hat{Y}$)	3.0188
	S.E. ($\hat{a}$)	4.4288
	S.E. ($\hat{b}$)	0.0817
3. Tests of significance:		
i. Based on 't' test:	For $\hat{a}$: |t|	205.843
	For $\hat{b}$: |t|	5808.738
	For r: |t|	43.249
	Tabulated t*	2.447
	Tabulated t**	1.943
ii. Based on ANOVA and 'F' Ratio :	TSS	22801.968750
	SSR	22731.509070
	SSE	70.459680
	Calculated 'F Ratio'	1935.70
	Tabulated F*	5.99
	Tabulated F**	13.70
iii. Based on P.E. (r):	P.E. (r)	0.0011

4. D-W test for Autocorrelation:	d statistic	1.191
	ρ	0.392
	d_u*	1.332
	d_L*	0.763
	d_u**	1.003
	d_L**	0.497

Notes: * Refers to 5% level of significance.
** Refers to 1% level of significance.
@ Refers to the results of tests computed for the proposed model (2).

The coefficient of determination (R^2) is computed for testing the goodness of fit. For the given set of data, the computed value of coefficient of determination R^2 (= 98.88%) is very high which indicates goodness of fit as 99.88% of the variation in IMR among the periods appears to be explained by the variation in the CDRs. Similarly, the smaller value of computed S.E. ($\hat{Y}$) [= 1.70] indicates the higher reliability of the model. The goodness of fit of a regression model is mostly affected by the estimated values of parameters. Similarly, the estimated parameters may be considered significant as they satisfied the 't' test. For instance, the parameter $\hat{b}$ may be considered significant as the calculated value of $|t|$ statistic for $\hat{b}$ is 103.358 which is greater than the tabulated values t* (=1.306) and t** (= 1.860) for n – 2 (= 8) degrees of freedom..This is also true for the other remaining parameters except for $\hat{a}$ at 5 percent level of significance. Another way to test the significance of the regression model is to compute the 'F' test. The calculated value of 'F ratio' (= 6060.69) is evidently greater than the tabulated values F* (= 5.32) and F** (= 11.30) for (1, 8) degrees of freedom and therefore, the regression model may be considered significant.

The presence of autocorrelation is a serious problem and therefore, D-W test is computed for detection of autocorrelation. The results of D-W test clearly show absence of autocorrelation in the residuals because the first order autocorrelation coefficient ρ (= 0.233) is very small, and the condition: $d_u < d < 4 - d_u$ is well satisfied. For instance, d_{u*} (= 1.32) < d (= 1.44) < 4 – d_{u*} (= 2.68); and d_{u**} (= 1.001) < d (= 1.44) < 4 – d_{u**} (= 2.999) are satisfied.

Conclusions

The advantages of the indirect techniques in mortality estimation cannot be overemphasized in developing countries like Nepal. The proposed model is very simple and easy to apply; does not need census or survey data and model life tables for estimation of IMR; and gives approximately reliable estimates for Nepal. The results indicate that the model is effective in providing approximately reliable estimates of IMR for Nepal during the last few decades. 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 Nepal for few more decades.

Acknowledgement

The author wishes to thank Dr. Mrigendra Lal Singh, the Professor of Statistics at Central Department of Statistics, Tribhuvan University, Kirtipur, Kathmandu, Nepal for his valuable suggestions while planning the study. Any remaining errors are entirely the responsibility of the author.

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