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Estimation of Birth Rates from Age Distribution of Population for India and its Major States 1971-81

Introduction

THE age distribution of population at any point of time is the cumulative effect of mortality, fertility and migration. If migration is assumed to be nil and mortality known, fertility can be estimated indirectly from age distribution. The history of estimation of fertility from age distribution is probably as old as population science itself. We have moved from crude and simplest procedures (like the method by Pichat (1957), differencing method, reverse survival method (RSM) etc.) to the most complicated and theoretically sounder technique by Preston (1983). While more and more new techniques are likely to be evolved, the scope and availability of reasonably good quality data have also increased for countries for which these procedures are generally utilised. But the different procedures provide different estimates of fertility. A suitable method needs to be selected which provides the most reliable estimate of fertility in all situations and which requires minimal data.

In the present paper, an attempt is made to estimate the birth rate for India and its states using different methods. The selected methods are those which are generally used at the national and sub-national levels.

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Methodology

Preston (1983) suggested an approach for using age-specific growth rates of population, age distribution, estimate of child mortality (l_5) and standard life table to estimate birth rate. In the present paper this procedure has been used taking smoothed age from the 1971 and 1981 censuses and l_5 estimate from Trussell procedure with the data of Children Ever born (CEB) and Children Surviving (CS) from 1981.

Rele (1987) has proposed a refinement of his earlier procedure (Rele 1967) for estimating birth rate and gross reproduction rate on a 'Prior' knowledge of the expectation of life at birth (e_0^0) and the knowledge of child-woman ratio defined by the ratios of children aged 0-4 to women aged 15-19 and children aged 5-9 to women aged 20-54.

Coale (1981) suggested a procedure to estimate birth rate of the given population in the 15 years before the census/survey using the model-stable population corresponding to the observed proportion of population below age 15 and l_5 (probability of survival from birth to age 5). But Venkatacharya and Teklu (1987) have shown that the adjusted birth rate obtained by using Coale's method is equivalent to the estimate obtained by using reverse survival method (RSM). They have improved upon RSM dispensing with the use of model life table and using the relation :

$${}_{15}L_0 = u + v l_5$$

They found that the values of u and v derived for Coale-Demeny West family of life tables gave a minimum percentage of error in the estimated birth rates. Therefore, they suggested that the robust estimate of birth rate may be obtained as below :

$$b_0 = \frac{C(15) \exp(7.5r)}{(.365 + 14.6 l_5)}$$

where $C(15)$ is the proportion of child population below age 15, r is the rate of growth of the population and l_5 is assumed to be based on West model life table. This method, while retaining the robustness of the original Coale estimate, does not require the use of any model life table.

We have further suggested a modification in this procedure to estimate birth rate without using any standard life table. The estimating equation is as follows :

$$b_i = \frac{C(x) \exp(x \cdot r)}{x \cdot S_i}$$

where $i : 1, 2, 3$ and corresponding x 's are 15, 10 and 5. S_1, S_2 and S_3 are the

proportion of children surviving to the mothers of age group 30-34, 25-29 and 20-24 respectively. $C(x)$ is the proportion of child population below age x . x times of S_1 is analogous to person years lived (L_x column of life table) from birth to age x . It means that when we take $C(15)$, $15 * S_1$ is equal to ${}_{15}L_0$ and when we take $C(10)$, $10 * S_2$ is equal to ${}_{10}L_0$. Further, S_1 , S_2 and S_3 are the actual mortality experience of the cohort, hence take care of mortality decline which may not be possible when we take Lx from one-point life table.

The time series estimate of birth rate may help us in studying the trend or in evaluating the age distribution of children. The main advantage of the proposed procedure over the usual RSM is that it does not require the use of any life table and S_1 , S_2 and S_3 as mentioned earlier being the actual cohort estimates take care of the mortality decline.

Application and Discussions

The estimates of birth rate for India and its major states are given in Table 1. These estimates have reference period of about 7.5 years before the census.

TABLE 1-ESTIMATES OF CRUDE BIRTH RATE BY DIFFERENT INDIRECT PROCEDURES INDIA AND ITS STATES

Country/State	Integrated	RSM		Rule's Method		
	1971-81	1971-81	1976-81	1971-76	1976-81	1971-76
India	34.5	36.4	33.6	39.1	34.4	39.3
Andhra Pradesh	30.8	36.4	30.9	42.3	33.2	38.5
Bihar	36.5	43.6	37.9	49.5	40.8	44.8
Gujarat	35.1	37.1	34.5	39.7	34.4	38.4
Haryana	35.1	38.6	36.0	41.2	35.7	40.4
Karnataka	34.6	36.6	34.0	39.2	33.3	38.0
Kerala	26.3	28.5	26.7	30.4	26.6	30.8
Madhya Pradesh	35.5	40.7	37.1	44.3	35.7	42.1
Maharashtra	31.0	34.1	31.0	37.3	30.8	36.1
Orissa	36.3	39.4	35.3	43.5	32.1	40.2
Punjab	30.4	32.0	30.2	33.9	31.5	33.1
Rajasthan	41.9	43.1	40.3	45.8	32.9	41.9
Tamil Nadu	28.8	31.0	28.7	33.4	28.1	32.6
Uttar Pradesh	37.6	44.8	41.5	47.9	38.3	43.3
West Bengal	32.9	36.1	32.4	39.8	31.8	38.9

i.e. for 1973-74. For some of the estimates the reference period is not the same and hence they cannot be directly compared.

TABLE 1 (Contd.)

<i>Country/State</i>	<i>Robust</i>	<i>Venkatacharya</i>	<i>Proposed Method</i>			<i>SRS</i>	
<i>1973-74</i>		<i>1973-74</i>	<i>1973-74</i>	<i>1971-81</i>	<i>76-81</i>	<i>1971-75</i>	<i>76-80</i>
India	36.5	36.4	36.3	35.4	33.8	35.6	33.4
Andhra Pradesh	35.1	34.9	35.1	33.9	29.5	34.3	32.5
Bihar	37.9	37.6	37.9	37.7	34.5	—	—
Gujarat	35.4	35.2	35.3	33.8	32.4	38.2	35.9
Haryana	38.9	38.7	38.9	36.7	35.1	39.9	35.6
Karnataka	36.5	36.3	36.6	35.2	31.2	29.6	28.1
Kerala	28.9	28.8	28.8	27.3	25.8	29.3	26.3
Madhya Pradesh	40.0	39.8	40.5	38.7	36.4	38.5	38.0
Maharashtra	35.2	35.0	35.1	32.7	30.4	30.4	27.8
Orissa	36.8	36.5	36.9	36.3	33.8	34.2	32.0
Punjab	31.9	31.7	32.3	31.1	30.0	33.2	32.0
Rajasthan	42.6	42.8	42.5	41.5	39.8	38.4**	35.4
Tamil Nadu	30.2	30.1	30.2	28.8	27.2	30.7	29.2
Uttar Pradesh	40.2	39.9	40.6	49.9	39.3	43.0	39.9
West Bengal	34.2	34.1	34.2	32.9	30.5	—	—

*SOURCE : *Sample Registration System, 1979-80*, Ministry of Home Affairs, New Delhi.

**Relate* to 1972-75.

It is seen from Table 1 that the estimates of birth rate using Coale's, Venkatacharya's and our procedure are quite close to each other. The estimate obtained from the Coale procedure is generally between the estimates obtained from Venkatacharya's procedure and our procedure, but the differences are negligible. Hence we may use any one of these procedures. Our selection will therefore depend upon data requirements and availability of data.

In all the three procedures $C(15)$: proportion of population up to age 15 is used. Estimate of I_5 is obtained from the CEB and CS data to women aged 30-34. Coale's procedure requires, in addition, stable population. Venkata-

charya's procedure does not, but requires the model life table. All procedures except Rele's method, in fact, require it. In our procedure, one does not have to select a model life table as such; ${}_{16}L_0$ can be estimated by using ${}_5$ with the regression line given in the procedure. The regression lines are based on the model life table and one has to test whether ${}_5$ and ${}_{15}L_0$ for the given population have as strong a relation as observed in the model life table.

In our procedure we require only S_1 , S_2 and S_3 . There is no need to estimate exact life table function.

The estimates based on 0-4 and 0-9 age groups can be compared with the estimates obtained by using the usual RSM and Rele's method. The estimates from RSM may be higher because S_1 , S_2 and S_3 in the proposed procedure are actual cohort estimates of survival whereas in Rele's method period life table corresponding to the middle period is used. Nevertheless, there seems to be quite good agreement in the two estimates with few exceptions. The difference increases with increase in the duration of estimation of estimating period. It would be unfair to say which estimate is more reasonable but it may be observed that the decline in CBR with RSM estimate and Rele's method is much faster than that observed from the proposed method. For example, using Rele's method, birth rate for U.P. declined from 43 during 1971-76 to 38 by 1976-81, i.e. five units decline in five years. Almost the same extent of decline is observed with reverse survival estimates. In the case of Rajasthan, the decline is much steeper, from 41.9 to 33.0. The estimates obtained by using the present method indicate a decline of less than two units in three to four years for both U.P. and Rajasthan. They are not the exceptional states. This brief account of the trends may indicate the suitability of the procedure. We may only say that the proposed method provides reasonable estimate of both the level as well as the trend in fertility.

Comparison of the estimates obtained by using RSM and Rele's method reveals that for 1976-81, Rele's estimates are invariably lower than the RSM estimates, except for India, A.P. and Bihar. The difference is unacceptably large for U.P. and Rajasthan. If we exclude these two states, the difference in estimates by the two methods is around one unit. It indicates probably the fact that RSM can be used as effectively as Rele's method. When we are using unsmoothed age distributions of more than one census, the adjustment suggested by Rele can also be used for the estimates of RSM. With few exceptions, the weights of 7 and 3 as suggested by Rele are applicable for all the states.

Lastly, we compare the estimates obtained by using the integrated approach proposed by Prestoa. This procedure is theoretically very sound but it has certain practical limitation :

1. It requires age distribution from the two censuses.
2. It is directly affected by intercensal migration which may be quite large.
3. It requires model life table.

The estimates of birth rate from this procedure can be compared with birth rate obtained from RSM based on 0-9 age group. It may be observed that Preston's procedure provides invariably lower estimate than that obtained from using RSM. The birth rate for U.P. is unacceptably low. In view of the data requirements and complications of calculation, this procedure may not be preferred for wide application. Further, it fails to provide reasonable estimate at the state level. It has also been shown that this procedure, when limited age range is considered i.e. below 15, is similar to RSM (see Venkatacharya and Teklu 1987).

Concluding Remarks

In the present procedure, an attempt is made to examine the estimates of birth rates from the age distribution of India and its states using different procedures. It has been observed that three procedures based on $C(15)$ and mortality indicators like $1/5$ or S_1 provide almost similar estimates. In terms of simplicity and less data requirement, the present procedure has certain advantages over the others.

The modified Rele's method does provide reasonable estimates of birth rate. The estimates based on the 0-4 age group i.e. 1976-81, are however, unreasonably lower than those based on the 5-9 age group especially for states like U.P. and Rajasthan. There is a risk involved in estimating birth rate on the basis of past trend, and extrapolation of such rates beyond observed trends is not advisable.

The integrated approach, though theoretically sound, fails to provide reliable estimates of birth rate at state level. Since age-specific growth rates are used in this procedure, there is greater chance of error due to migration, differential coverage and different patterns of age misreporting in the two censuses.

From the discussion it is clear that RSM with the modifications suggested has various advantages and can be used to get reliable estimate of birth rate. In case unsmoothed age distribution from the two censuses or more is used, adjusted birth rate can be obtained by following the procedure suggested by Rele (1987).

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