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ESTIMATES OF VITAL RATES FOR THE DECADE 1971-81

ANALYSIS OF THE 1981 CENSUS 5 PER CENT SAMPLE DATA

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FOREWORD

In the absence of reliable registration data on births and deaths, it has been the practice in India to examine the age returns of the census to infer about the likely levels of fertility and mortality during the decade preceding the census. The 1981 census is unique in the sense that in addition to age data, data was also collected from each ever-married woman on number of children ever-born and the number surviving. Further, a question on births during last one year was also canvassed for each currently married woman. In addition, during the decade 1971-81, the Office of the Registrar General, India, has also regularly released data on fertility and mortality based on SRS. The census data have been subjected to thorough investigation using a battery of recently developed techniques of analysis. This report presents the results of the analysis undertaken keeping in view the SRS data.

Shri P. Padmanabha, former Registrar General and Census Commissioner, India, under whose able guidance the entire operations were carried out deserves all credit for the successful completion of the 1981 Census operations. He had to leave the organisation for taking up another assignment before this volume could be made ready for the press.

The report has been prepared by the Demography Division of my Office. In particular, I wish to acknowledge the services of Shri K. S. Natarajan, Assistant Registrar General, Shri K Narayanan Unni, Senior Research Officer, Shri A. K. Biswas and Shri Phool Singh, Deputy Directors, Shri S. S. Bawa and Shri Subash Garg, Assistant Directors of Census Operations and Shri N. Y. Gore, Research Officer who are associated with this report.

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CHAPTER 1

INTRODUCTION

With the release of the data of 1981 census based on 5% sample for the 14 major states of India the interest has shifted to estimating the vital rates for the decade 1971-81 based on census age distribution The 1981 census is quite unique in the sense that in addition to the age distribution, data on children ever born and children surviving to ever married women and births during last one year to currently married women were also collected in the census. Thus, the census provides means of estimating various parameters like birth rate, death rate and child mortality. The present report uses the age distribution of 1971 and 1981 censuses and estimates various parameters like expectation of life at various ages, crude birth rate and crude death rate. From the data on children ever born and surviving estimates of child mortality have been derived. Data on children ever born have been combined with data on births during last one year to estimate fertility level in 1981.

Due to disturbed conditions then prevailing in the state, the 1981 census could not be conducted in Assam. In view of this, the analysis presented in this report relate to India excluding Assam. For comparison, 1971 census age distribution has been worked out excluding Assam The age distribution was then pro rata adjusted to the estimated 1 March population of 1971. The age distribution of the 1971 census used in the calculations is presented below.

TABLE 1

Age-wise population of India (excluding Assam) as on 1st March 1971

('000)

Age group	1971		
	Persons	Males	Females
1	2	3	4
All Ages	**532,548**	**275,807**	**256,741**
0—4	76,934	38,891	38,043
5—9	79,442	40,928	38,514
10—14	66,727	35,425	31,302
15—19	46,154	24,536	21,618
20—24	41,929	20,972	20,957
25—29	39,648	19,733	19,915
30—34	35,233	17,803	17,430
35—39	32,011	16,736	15,275
40—44	27,592	14,662	12,930
45—49	22,339	12,138	10,201
50—54	20,048	10,835	9,213
55—59	12,532	6,698	5,834
60—64	14,073	7,311	6,762
65—69	6,845	3,552	3,293
70+	11,041	5,587	5,454

NOTE.—Agewise distribution has been obtained by applying the 1st April, 1971 (Census) age distribution on the estimated total population as on 1st March, 1971.

The present report has been organised in four main chapters, in addition to the introductory chapter.

Chapter 2 discusses method of estimating expectation of life at birth and crude death rate. In this chapter the results of applying the various methods to census data have been discussed. The methods discussed are:—

(a) Forward projection method using age distribution of 1971 and 1981 censuses.

(b) Preston and Bennett method using inter-censal age specific growth rate.

Estimates of the expectation of life at birth are obtained by these two methods. This chapter also presents for comparison, the estimates of expectation of life at birth for the various states based on the Sample Registration System for 1971-81 and for years 1970-72 and 1978-80.

(c) Census Differencing Method.—This method estimates crude death rate for the decade 1971-81.

Chapter 3 presents the estimates of the child mortality i.e., probability of dying before ages 1, 2, 3 and 5. These have been derived from the data on children ever born and children surviving tabulated by age of mother in the 1981 census. The differentials in child mortality have also been presented by religion. Three methods of estimation using Brass, Trussel's and Sullivan's have been made use of in deriving the child mortality. Since the mortality has been declining in the recent period, the mortality level estimated may not apply exactly to the year 1980. The years prior to census to which these estimates may be related have also been presented.

The infant mortality rates and years prior to census to which these relate has also been estimated from the data of children ever born and children surviving by using Feeney's technique. These rates have been compared with the infant mortality rates available from the SRS

Chapter 4 discusses method of estimating fertility. The results obtained by applying P/F ratio method have been presented. These give estimates of fertility for the year 1980. The limitations of this estimate have also been discussed. Estimates of crude birth rates for the decade 1971-81 and for the quinquennial 1971-76 and 1976-81 using the child mortality as estimated from the 1981 census and also using SRS child mortality rates have also been presented. The crude birth rate for these period using Rele's method based on child-woman ratio have also been presented.

Chapter 5 attempts an integration of various estimates. It compares the birth rates and death rates obtained by various methods and recommends the birth

rate and death rate that can be adopted for the decade 1971-81. The following table shows the estimates of crude birth rate by reverse survival method and crude death rate.

TABLE 2

Crude birth rate based on reverse survival method and crude death rate for the decade 1971-80

India/State	Birth rate	Death rate
1	2	3
INDIA*	**37.2**	**15.0**
Andhra Pradesh	35.1	13.8
Bihar	40.9	18.8
Gujarat	37.5	13.5
Haryana	37.7	12.2
Karnataka	35.3	11.6
Kerala	27.5	9.2
Madhya Pradesh	39.8	16.8
Maharashtra	32.7	12.6
Orissa	36.5	18.8
Punjab	32.3	10.8
Rajasthan	43.6	14.9
Tamil Nadu	29.5	13.0
Uttar Pradesh	45.0	21.0
West Bengal	34.5	14.5

TABLE 2—*Concld.*

*India excludes Assam.

CHAPTER 2

METHODS OF ESTIMATING EXPECTATIONS OF LIFE AT BIRTH AND CRUDE DEATH RATE

Methods of estimating mortality

In section 'A' of this chapter measures of mortality based on three methods have been presented. The forward projection method and Preston & Bennett's method provide estimates of expectation of life at birth while the census differencing method is used to estimate crude death rate. In section 'B' of this chapter the expectation of life at birth and the crude death rate derived have been compared with the SRS based values for the decade 1971-80.

A(i) Forward projection method

In this method the age wise population of the 1971 Census have been projected 10 years ahead and compared with the 1981 unadjusted population by age. For the purpose of projecting the 1971 age wise data South Asian model life tables recently brought out by the United Nations have been made use of. These life tables have been developed after careful evaluation, selection and adjustment procedures to the base data. For the South Asian pattern, the mortality data collected in SRS in the years 1970-72 have also been made use of.

The South Asian pattern is typified by high mortality under age 15, and at older ages i.e., approximately age 55 and above. In general high rates of diarrhoeal and parasitic diseases at younger ages and high mortality from diarrhoeal and respiratory diseases at older ages are considered as contributory causes of deaths.

It may be worth pointing out that the approach of using model life tables and census age distributions to estimate the expectation of life at birth results in only certain approximate estimates since the expectations of life at birth indicated at various ages are widely different. This suggests that certain survival rates are over stated and others under stated. In this situation it has been suggested by Coale and Demeny* that the median level of mortality indicated by the proportion surviving among first nine age groups should be used.

The median has been suggested as a most satisfactory rule of thumb in the absence of any indication as to the patterns of age distortions. It does not necessarily follow that one should adopt the median in all the cases. If the age data indicates certain probable guidelines as to over estimation or under estimation at certain ages, these could profitably be used in fixing the level suitably.

It has been the experience both in 1971 census and in 1981 census that substantial number of children in the age group 0—4 have been omitted in the census. This has been confirmed both by the Post Enumeration Check and Census Evaluation Studies conducted after the census. Both indicate that children in the age group 0—4 have been under enumerated. The Census Evaluation Study has given higher omission rate in the age group 0—4 than Post Enumeration Check. If P^{a}_{x+} denotes the population aged x and over in the census year, 'a' then the ratio P^{81}_{10+} of 1981 divided by P^{71}_{0+} would therefore be an over estimate of survival ratio. In view of this the mortality level indicated by first age group should be taken as an upper bound of the mortality level in the Indian context.

Another age group on which one can reasonably fix a bound is the ratio of P^{81}_{15+} divided P^{71}_{5+}. The Census Evaluation Study has indicated that children from the age group 0—4 have been reported in the ages 5, 6 etc. and that there is a net transfer of children from the age group 0—4 and 5—9. Further a comparison of concentrations at the ages 8 and 10 indicate that age 9 is the only age in the age group 5—9 which can contribute at best to the concentration at age 10. In fact in the age group 5—9 there are concentration at ages 5, 6 and 8. In view of these not much transfer may be expected from ages 5—9 to age 10. In other words age group 5—9 seems to be slight over estimate. Similarly an examination of the concentration patterns in the age group 15—19 suggests that this age group in general has been losing population to adjoining age groups. There is no concentration at age 15. Age 15 is the only age which ends in digit 5, but does not show a big heaping, indicating that it does not attract persons from the age group 10/14. The age ratio also indicates that age group 15/19 is an under estimate. In view of these the ratio of population aged 15 and over in 1981 divided by population aged 5 and over in 1971, or the survival ratio which would project the population aged 5 and over in 1971 to population aged 15 and over in 1981 would be an under estimate. Thus from the nature of biases noticed in the age data we can modify the criteria given by Coale and Demeny. We may search for the median from among the values bounded by the above two ratios.

*U.N. Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data.....Page 11 U.N., New York 1967.

TABLE 3

Expectation of life at birth in South Asian Pattern model life table corresponding to census survival ratio from age 'X' and above in 1971 to Age (X+10) and above in 1981—Males

State	10+	15+	20+	25+	30+	35+	40+	45+	50+	MEDIAN UR	MEDIAN R
1	2	3	4	5	6	7	8	9	10	11	12
Andhra Pradesh	52 4	40 8 Below	63 5	67 2	61 9	57 1	55 2	48 4	46 4	53 5	47 4
Bihar	45 4	35 0	46 7	67 8	63 6	56 2	52 7	49 8	52 8	52 7	45 4
Gujarat	63 6	46 6	54 2	62 1	59 3	58 3	54 6	52 7	52 1	54 6	54 6
Haryana	64 5	45 1	50 7	66 8	70 2	71 4	72 2	70 1	69 7	69 7	64 5
Karnataka	61.7	48 2	55 9	65 2	63 4	64 6	60 5	54 2	53 4	54 2	54 2
Kerala	52.7	39 6	37 4	44.2	49 3	59 6	57 8	58 2	58 1	52 7	52 7
Madhya Pradesh	49 4	39 5	53 2	68 6	58 0	52 4	51 0	50 6	53 3	52 4	49 4
Maharashtra	59 0	46 1 Below	54 9	62 6	57 3	55 4	53 1	50 1	51 2	54 9	54 0
Orissa	46 2	35 0	41 5	58 6	53 5	49 5	45 0	41 4	43 6	45 1	42 6
Punjab	66 6	51 4	52 1	65.2	69 2	72 1	73 6	70 8	70 6	69 2	65 2
Rajasthan	64 5	47 0	59 6	74 7	68 7	62 7	62 8	61 1	61 1	62 8	61 1
Tamil Nadu	50 3	41 8 Below	46 0	50 8	47 5	50 9	48 6	44 3	42 0	47 5	47 5
Uttar Pradesh	48 4	35 0	42 4	60 3	60 3	57 2	57 2	54 0	55 5	55 5	48 4
West Bengal	55 9	40 7	46 7	52 4	45 1	40 7	38 2	37 7	36 0	40 7	46 4
INDIA	**54 1**	**40 2**	**49 9**	**62 1**	**58 6**	**56 1**	**54 2**	**51 2**	**51 8**	**54 1**	**51 2**

UR — Median of the first nine values

R — Median of the values lying between the first two values

TABLE 4

Expectation of life at birth in south asian pattern model life table corresponding to census survival ratio from age 'X' and above in 1971 to age (X+10) and above in 1981—Females

State	10+	15+	20+	25+	30+	35+	40+	45+	50+	MEDIAN UR	MEDIAN R
1	2	3	4	5	6	7	8	9	10	11	12
Andhra Pradesh	49 7	41 7 Below	56 1	63 0	52 0	50 8	51 6	50 6	52 6	51 6	49 7
Bihar	39 4	35 0	53 8	59 0	47 6	42 6	41 8	45 1	51 4	45 1	39 4
Gujarat	66 9	56 7	67 4	64 9	58 7	57 8	57 8	57 8	57 5	57 8	57 8
Haryana	54.9	41 6	49 1	60 9	60 8	62 3	64 9	66 3	63 4	60 9	49 1
Karnataka	58 8	45 6	56 5	69 7	59 7	58.7	59 6	61 2	65 8	59 6	57 6
Kerala	65 1	54 3	46 9	46 2	50 3	62 3	60 9	63 4	67 1	62 3	60 9
Madhya Pradesh	46 2	41 8	61 9	65 1	53 8	51 1	53 0	56 0	57 9	53 8	46 2
Maharashtra	58 6	48 4 Below	67 4	74 0	60 1	58 6	58 5	59 1	62 0	59 1	58 5
Orissa	41.8	35 0	40 3	51 5	44 2	40 2	40 2	41 1	45 8	41 1	40 3
Punjab	65 4	52 4	51 9	60 0	65.4	67 2	67 0	66 5	65 0	65 4	65 0
Rajasthan	60 9	49 4	66 8	73 9	61 8	59 7	62.6	65 4	64 0	62 6	59 7
Tamil Nadu	49 7	42 3 Below	44 3	46 1	37 7	39.5	38 1	38 0	39 1	39 5	45 2
Uttar Pradesh	46 6	35 0	56 1	62 4	53 5	50 0	49 8	50 5	50 2	50 2	46 6
West Bengal	54 2	43 2	53 9	59 1	49 1	46 5	47 9	51 1	54 2	51 1	51 1
INDIA	**52 2**	**43 5**	**56 2**	**61 7**	**52 5**	**51 0**	**51 3**	**52 8**	**55 0**	**52 5**	**51 2**

UR — Median of the first nine values

R — Median of the values lying between the first two values

A note of caution has to be added that, if a particular state is known to receive a large number of in-migrants the lower bound may not work, since age group 15-19 may receive a number of persons through migration. Thus states like Maharashtra, West Bengal, Union Territories which receive large in-migrants the upper bound should be used and the lower bound should not be used.

Tables 3 and 4 show the level of mortality at different ages indexed by expectation of life at birth separately for males and females; the median of the first nine values and the median of the values lying between the upper and lower bound as determined in the earlier paragraph. In cases where no value falls between these two bounds; value indicated by $P_{10}^{18} + \div P_{0}^{71} +$ has been used, as most of the other values i.e., this is the minimum of the upper bounds. If even number of values fall between upper and lower bounds the average of the two middle values has been taken. The wide range of the level of mortality indicated by the method is a reflection on the extent of age misreporting in Indian census. It should be recalled that these estimates have been derived after cumulating the age data. Even cumulation does not seem to reduce to range of variation drastically. The following table shows the range of e_{os}^{0} i.e., highest value of e_{o}^{e} – lowest value of e_{o}^{e} indicated by cumulated age data. Only values of e_{o}^{o} corresponding to population aged 10+ to 50+ in 1981 have been considered.

TABLE 5

Maximum, minimum and the range of values of expectation of life at birth indicated census age data by sex, 1971-81

Sl No.	India/State	Males			Females		
		Max. value	Min. value	Diff. (3—4)	Max. value	Min. value	Diff. (6—7)
1	2	3	4	5	6	7	8
1.	Andhra Pradesh	67.2	40.8	26.4	63.0	41.7	21.3
2.	Bihar	67.8	35.0*	32.8*	59.0	35.0*	24.0*
3.	Gujarat	63.6	46.6	17.0	67.4	56.7	10.7
4.	Haryana	72.2	45.1	27.1	66.3	41.6	24.7
5.	Karnataka	65.2	48.2	17.0	69.7	45.6	24.1
6.	Kerala	59.6	37.4	22.2	67.1	46.2	20.9
7.	Madhya Pradesh	68 6	39.5	29.1	65.1	41.8	23.3
8.	Maharashtra	62.6	46.1	16.5	74.0	48.4	25.6
9.	Orissa	58.6	35.0	23.6	51.5	35.0	16.5
10.	Punjab	73.6	51.4	22.2	67.2	51.9	15.3
11.	Rajasthan	74.7	47.0	27.7	73.9	49.4	24.5
12	Tamil Nadu	50.9	41 8	9.1	49.7	37.7	12.0
13.	Uttar Pradesh	60.3	35.0*	25.3*	62.4	35.0*	27.4*
14.	West Bengal	55.9	36.0	19.9	59.1	43.2	15.9
	INDIA	**62.1**	**40.2**	**21.9**	**61.7**	**43.5**	**18.2**

*Minimum values is less than 35 and hence the difference is more than the indicated value.

Note :— Maximum and minimum values are based on the nine values 10+, 15+, 20+, ...50+, ...

While a part of the variation may be explained by inter state migration, it is clear that major part is due to age distortion. This is evident by noting that the range is high in states where lot of in-migration has taken place, like Maharashtra, West Bengal, in the states like Kerala and Uttar Pradesh where lot of out-migration has taken place and in other states where migration has been limited. In other words the range is high irrespective of the quantum of migration, indicating that it is age distortion perse, not migration which causes high variation.

A(ii) Preston and Bennett's method

Recently Preston and Bennett have developed a method of estimating adult mortality from the age distribution of two censuses. The method is in essence an extension of stable population relationship to non stable population. The method uses age specific growth rates to transform the observed population age structure into the equivalent of a stationary—population $5L_x \times$ function. The main advantages of the method are that it is free from the assumption of stability and that it introduces as element of cumulation thus reducing the effects of age mis-statement. If it can be assumed that patterns of age errors are similar in two censuses, then the use of growth rates minimises the effects of age errors.

Table 6 shows the estimated values of life expectancies at various ages.

TABLE

Estimated values of e_x by Preston & Bennett method

India/States	Sex	e_x Ratio	Ages 5	10	15	20	25	30	35	40
1	2	3	4	5	6	7	8	9	10	11
INDIA	**Male**	e_x	**51.45**	**50.43**	**50.39**	**43.98**	**38.25**	33.40	28 34	24.35
		Ratio	**0.9805**	**1.0928**	**1.0178**	**0.9286**	**0.9616**	0.9893	1.0015	1.0295
	Female	e_x	**59.39**	**52.63**	**53.61**	**50.96**	**42.34**	37.49	33.81	29.81
		Ratio	**1.0137**	**1.0708**	**0.9679**	**0.9324**	**1.0204**	1.0373	1.0239	1 0192
1. Andhra Pradesh	Male	e_x	59.83	51.11	52.13	53.15	46.52	39.70	34.22	27.92
		Ratio	1.0005	0.9145	1.0158	1.1359	1.1000	1.0492	1.0233	0.9572
	Female	e_x	58.47	51.29	53.74	52.07	42.78	37.71	34.38	29.49
		Ratio	1.0098	0.9428	1.0750	1.1379	1.0276	1.0065	1.0309	1.0079
2. Bihar	Male	e_x	55.27	51.99	47.63	43.33	39.06	34.85	30.72	26.73
		Ratio	1.0093	1.0085	1.0085	1.0088	1.0090	1.0093	1.0095	1.0098
	Female	e_x	52.34	46.95	52.14	50.41	40.94	34.92	30.79	27.73
		Ratio	0.9862	0.9347	1.1315	1.1943	1.0639	1.0066	0.9955	1.0214
3. Gujarat	Male	e_x	64.23	54.64	52.53	50.33	44.08	38.70	33.28	28.62
		Ratio	..	1.0090	1.0574	1.1125	1.0796	1.0606	1.0332	1.0200
	Female	e_x	66.59	59.20	58.25	52.40	44.04	39.65	35.41	31.15
		Ratio	..	0.9963	1.0639	1.0442	0.9647	0.9640	0.9662	0.9668
4. Haryana	Male	e_x	64.62	54.66	52.47	52.67	48.35	43.90	39.41	34.10
		Ratio	1.0117	0.9183	0.9577	1.0515	1.0645	1.0765	1.0893	1.0764
	Female	e_x	60.96	52.64	51.39	51.01	45.28	41.24	37.61	33.93
		Ratio	..	1.0057	1.0693	1.1593	1.1303	1.1430	1.1706	1.2040
5. Karnataka	Male	e_x	64.22	54.88	53.12	51.90	46.29	41.55	35.56	29.26
		Ratio	1.0055	0.9220	0.9695	1.0361	1.0192	1.0189	0.9829	0.9236
	Female	e_x	63.41	53.99	54.15	53.97	45.32	40.01	36.45	32.12
		Ratio	0.9973	0.9086	0.9890	1.0755	0 9928	0.9728	0.9945	0.9969
6. Kerala	Male	e_x	58.64	50.44	45.41	43.02	41.02	39.12	33.56	29.94
		Ratio	0.9971	0.9168	0.8992	0.9350	0.9870	1.0525	1.0225	1.0465
	Female	e_x	65.00	56.53	48.93	44.06	41.45	40.22	35.51	32.27
		Ratio	1.0597	0.9847	0.9260	0.9105	0.9418	1.0151	1.0065	1.0420
7. Madhya Pradesh	Male	e_x	57.86	51.18	51.97	51.63	43.32	36.64	32.14	28.09
		Ratio	1.0009	0.9452	1.0461	1.1412	1.0609	1.0041	0.9978	1.0011
	Female	e_x	56.58	52.74	56.18	52.14	42.16	37.31	34.17	30.60
		Ratio	0.9975	0.9880	1.1450	1.1615	1.0323	1.0147	1.0437	1.0658
8. Maharashtra	Male	e_x	62.53	53.61	52.00	50.51	43.31	38.00	32.95	28.05
		Ratio	0.9951	0.9150	0.9649	1.0260	0.9711	0.9498	0.9292	0.9045
	Female	e_x	63.15	55.89	58.01	55.86	45.09	39.92	35.93	31.54
		Ratio	0.9931	0.9406	1.0595	1.1132	0.9877	0.9706	0.9804	0.9789
9. Orissa	Male	e_x	56.75	47.41	47.82	50.00	42.22	35.79	30.89	25.88
		Ratio	0.9991	0.8897	0.9787	1.1244	1.0523	0.9992	0.9772	0.9404
	Female	e_x	53.49	45.96	46.82	46.79	39.17	33.84	30.60	26.79
		Ratio	1.0079	0.9150	1.0161	1.1085	1.0179	0.9755	0.9893	0.9867
10. Punjab	Male	e_x	66.49	56.10	52.57	51.21	48.40	45.32	40.90	35.06
		Ratio	1.0410	0.9425	0.9595	1.0224	1.0658	1.1113	1.1305	1.1067
	Female	e_x	65.84	56.64	52.85	50.79	47.42	43.48	38.44	33.88
		Ratio	..	1.0041	1.0185	1.0690	1.0974	1.1180	1.1103	1.1152
11. Rajasthan	Male	e_x	65.56	55.34	54.91	55.51	47.79	40.14	36.02	31.16
		Ratio	1.0097	0.9150	0.9856	1.0888	1.0331	0.9654	0.9751	0.9620
	Female	e_x	64.66	56.64	58.14	55.70	45.78	40.53	37.62	33.46
		Ratio	0.9992	0.9373	1.0434	1.0902	0.9845	0.9668	1.0064	1.0173
12. Tamil Nadu	Male	e_x	57.94	57.38	48.83	45.61	40.17	36.85	32.01	26.78
		Ratio	1.0022	0.9488	0.9829	1.0082	0.9838	1.0099	0.9938	0.9544
	Female	e_x	57.96	52.01	49.15	44.34	36.77	33.61	30.40	25.94
		Ratio	1.0010	0.9561	0.9832	0.9832	0.9690	0.8833	0.8970	0.9115
13. Uttar Pradesh	Male	e_x	56.61	46.23	46.38	49.36	44.53	38.69	34.60	29.21
		Ratio	0.9967	0.8675	0.9492	1.1109	1.1099	1.0793	1.0946	1.0614
	Female	e_x	56.68	50.45	53.49	52.08	42.95	37.71	33.69	29.49
		Ratio	0.9991	0.9451	1.0910	1.1602	1.0517	1.0258	1.0290	1.0272
14. West Bengal	Male	e_x	..	51.97	49.63	47.86	39.26	33.07	29.22	24.87
		Ratio	..	1.0081	1.0508	1.1143	1.0142	0.9577	0.9602	0.9396
	Female	e_x	..	53.89	53.18	50.17	41.13	30.74	33.03	29.61
		Ratio	..	1.0096	1.0846	1.1176	1.0006	0.9892	1.0089	1.0313

Relate to 5—45 age group

6

and the Ratios e^x / e^s_x at various ages 1971 -1981

Ages						e_o for standard used	Mean ratio (5-50)	Adjusted e_o
45	50	55	60	65	70			
12	13	14	15	16	17	18	19	20
20.02	17.59	14.67	10.50	6.54	..	..	..	..
1.0301	1.0601	1.0062	0.9874	..	..	52.00	1.0046	52.50
26.40	22.31	19.83	15.68	11.07	6.61	..	..	..
1.9928	0.9929	0.9262	..	..	..	52.09	1.0085	52.89
23.39	19.11	16.67	14.15	9.68	6.77	..	..	..
0.9326	0.9006	0.9423	0 9772	0.8252	0.7202	52.00	1.0030	52.33
26.16	21.11	18.41	15 25	10.18	6.86	..	..	..
1.0381	0.9930	1.0466	1.0679	0.8914	0.7665	48.00	1.0270	50.79
22.94	19.38	16.15	13.20	10.69	8.58	..	..	..
1.0101	1.0099	1.0093	1.0092	1.0104	1.0094	42.00	1.0093	43.00
25.26	23.36	21 15	15.26	10.18	6.46	..	..	..
1.0818	1.1900	1.3064	1.1631	0 9695	0.7849	40.00	1.0606	45.90
24.35	19.55	17.03	14.43	10.58	6.38	..	..	..
1.0108	0.9597	1.0029	1.0396	0 9413	0.7073	48.00	1.0381	52.10
26.66	22.73	20.61	16.48	11.89	6.70	..	..	..
0.9566	0.9611	1.0473	1.0262	0.9239	0.6634	58.00	0.9871	56.63
29.63	23.25	20.26	16.94	11.56	6.89	..	..	..
1.0838	1.0017	1.0443	1.0634	0 8947	0.6657	60.00	1.0331	63.32
29.24	24.11	21.53	16.92	11.89	6.75	..	..	..
1.2053	1.1807	1.2762	1.2368	1.0868	0.7876	44.00	1.1409	57.80
24.88	20.42	18.39	15.49	11.14	6.75	..	..	..
0.9100	0.8798	0.9479	0.9724	0 8622	0 6522	60 00	0.9668	56.43
29.48	24.44	21.98	17.96	12.23	6.98	..	..	..
1.0578	1.0334	1.1163	1.1183	0 9502	0.6911	58.00	1.0019	58.20
26.20	22.23	20.47	16.28	12.20	6.21	..	..	..
1.0659	1.0693	1.1812	1.1480	1 0627	0.6750	50.00	0.9992	49.91
29.58	25.46	23.45	18.34	13.22	6.35	..	..	..
1.1062	1.1251	1.2487	1.1995	1 0801	0.6621	54.00	1.0118	55.24
24.58	19.87	17.38	14.78	10.59	6.53	..	..	..
1.0203	0.9755	1.0236	1.0648	0.9422	0.7239	48.00	1.0193	50.11
26.83	22.72	20.40	16.34	11.57	6.72	..	..	..
1.0849	1.0907	1.1847	1.1696	1.0349	0.7671	46.00	1.0625	52.35
24.19	20.22	17.44	13.96	10.48	6.16	..	..	..
0.9050	0.8919	0.9208	0.8989	0.8324	0.6111	58.00	0.9453	51.91
27.92	23.47	20.63	16.00	11.23	6.44	..	..	..
1.0018	0.9924	1.0477	0.9963	0.8726	0.6376	58.00	1.0018	58.19
22.72	18.29	15.62	13.14	9.79	6.49	..	..	..
0.9619	0.9163	0.9387	0.9662	0.8892	0.7342	46.00	0.9837	44.20
24.08	20.12	17.72	14.53	10.45	6.62	..	..	..
1.0313	1.0250	1.0945	1.1075	0.9953	0.8044	40.00	1.0073	40.71
30.18	24.24	21.57	17.98	12.63	7.22	..	..	..
1.1039	1.0444	1.1119	1.1294	0.9776	0.6983	60.00	1.0528	65.15
29.21	24.75	22.24	17.71	13.46	7.06	..	..	..
1.1145	1.1174	1.2107	1.1854	1.1273	0.7535	52.00	1.0849	61.51
36.62	20.76	17.08	14.28	9.52	6.56	..	..	..
0.9514	0.8730	0.8583	0.8734	0.7169	0.6171	62.00	0.9759	59.40
29.10	24.03	20.97	16.24	10.94	6.85	..	..	..
1.0218	0.9930	1.0392	0.9854	0 8275	0.6599	60.00	1.0060	60.62
22.33	18.19	16.03	12.90	9.92	6.04	..	..	..
0.9269	0.8930	0.9441	0.9294	0.8826	0.6696	48.00	0.9704	44.69
22.92	18.65	16.46	13.34	9.98	6.09	..	..	..
0.8865	0.9095	0.8772	0.9358	0.9342	0.8739	48.00	0.6804	40.36
25.19	20.41	17.41	14.91	10.22	6.69	..	..	..
1.0665	1.0225	1.0463	1.0963	0.9282	0.7568	46.00	1.0358	49.8
25.53	21.69	19.10	14.96	10.66	6.60	..	..	..
1.0323	140.13	1.1092	1.0732	0.9543	0.7534	46.00	1.0402	50.1
21.31	18.01	16.11	13.44	10.28	6.30	..	..	..
0.9384	0.9385	1.0075	0.9275	0 9707	0.7412	42.00	0.9913	41.0
26.40	21.94	19.13	15.52	11.16	6.56	..	..	..
1.0675	1.0533	1.1109	1.1106	0.9982	0.7489	46.00	1.0421	50.3

To examine the consistency of the expectation of life at various ages, these have been compared with the corresponding expectations from a standard South Model life tables. The standard chosen for comparison is the life table which has e_5 close to the e_5 given by the Preston and Bennett's technique. The ratio e_x/e^s_x for x - 5, 10, 15, 20, ...50 where 's' stands for a standard life table have also been shown

It has been shown by Preston and Bennett that for h given change in e_0 the changes in life expectancy by age are to a close approximation equiproportionate between ages 5 and 50. In other words they show that if the x expected life expectancies are divided by equivalent values of a standard life table, then the age sequence of ratios must be nearly constant, given that estimates are correct, regardless of the underlying pattern of mortality. This property can be used to smooth the derived $e'_{x's}$,

The mean ratios of the life expectancies at various levels of South Asian model life tables system to life expectancy at the standard level are presented in Tables 7 & 8 separately for males & females. These tables were made use of in correcting the expectation of life at birth estimated using Preston and Bennett's methods shown in table. The values so corrected have been shown in the last column of Table 6.

The values of life expectancies at birth derived show that at the national level life expectancy for females is higher than that for males, reversing the trend observed in earlier decades. The table indicates that during the decade female life expectancy was lower than males in Andhra Pradesh, Haryana, Orissa, Punjab, Tamil Nadu and West Bengal and it was higher than male life expectancy in other states.

It should be noted that the method is based on observed growth rate in various age groups and is therefore affected by differential enumeration of various age groups, age selective migration and differential pattern of age reporting in the two censuses. The effect of migration on the estimates is clearly visible in the states of Kerala and West Bengal wherein male life expectancies estimated according to the procedure are very low. This points out to the need for caution in accepting the results of the method.

A(iii) Census differencing method

If the population can be assumed closed for migration, then persons who are aged 10 and above in 1981, are the survivors of the population counted in 1971 census. The difference between the two is the number of deaths that occurred during the decade to persons alive at the time of earlier census. At the mid point of the decade, this population at risk is the population aged five and over, so that the survival rate for the whole population is closely linked to the average death rate for population age above five. The difference $P^{71}_{0+} - P^{81}_{10+}$ is considered approximately as deaths in the ages 5 and above during the decade 1971-81. This is then multiplied by the ratio of deaths in all ages to deaths in ages 5 and over, derived from an external source such as civil registration system

TABLE 7

Mean of the ratioses $e^L_{(x}/e^s_x$, x=5, 10, ... 50) of life expectancy at age X in Level 'L' of the South Asian pattern of the model life tables system to the life expectancy at corresponding standard levels —Males

Standard Level e^s_0	Level e^L_0										
	40	42	44	46	48	50	52	54	56	58	60
1	2	3	4	5	6	7	8	9	10	11	12
40 . .	1.0000	1.0188	1.0377	1.0568	1.0762	1.0958	1.1163	1.1365	1.1576	1.1795	1.2023
42 . .	0.9815	1.0000	1.0186	1.0373	1.0563	1.0756	1.0956	1.1155	1.1362	1.1577	1.1801
44 . .	0.9636	0.9818	1.0000	1.0184	1.0370	1.0560	1.0757	1.0951	1.1155	1.1366	1.1585
46 . .	0.9462	0.9640	0.9819	1.0000	1.0183	1.0369	1.0562	1.0753	1.0954	1.1161	1.1376
48 . .	0.9292	0.9467	0.9643	0.9820	1.0000	1.0183	1.0372	1.0560	1.0757	1.0960	1.1171
50 . .	0.9126	0.9298	0.9470	0.9644	0.9821	1.0000	1.0186	1.0371	1.0564	1.0763	1.0971
52 . .	0.8962	0.9131	0.9300	0.9471	0.9644	0.9820	1.0000	1.0181	1.0370	1.0566	1.0770
54 . .	0.8800	0.8966	0.9132	0.9300	0.9470	0.9643	0.9819	1.0000	1.0186	1.0378	1.0578
56 . .	0.8639	0.8802	0.8965	0.9130	0.9297	0.9467	0.9640	0 9817	1.0000	1.0189	1.0385
58 . .	0.8480	0.8639	0.8799	0.8961	0.9125	0.9291	0.9461	0.9636	0.9815	1.0000	1.0193
60 . .	0.8320	0.8476	0.8633	0.8792	0.8953	0.9116	0.9283	0.9454	0.9629	0.9811	1.0000

e^L_x : Life expectancy at age **X** in South Asian model life table.

e^s_x : Life expectancy at age **X** in Standard Asian model life table.

TABLE 8

Mean of the ratios (e^L_x / e^s_x, x = 5, 10, ...50) of life expectancy at age X in level 'L' of the South Asian pattern of model life tables system to the life expectancy at corresponding age at standard levels—Females

Standard level e^s_0	Level e^L_0										
	40	42	44	46	48	50	52	54	56	58	60
1	2	3	4	5	6	7	8	9	10	11	12
40 . .	1.0000	1.0206	1.0411	1.0616	1.0823	1.1031	1.1242	1.1457	1.1676	1.1900	1.2023
42 . .	0.9799	1.0000	1.0201	1.0402	1.0605	1.0809	1.1016	1.1226	1.1441	1.1661	1.1781
44 . .	0.9606	0.9803	1.0000	1.0197	1.0396	1.0596	1.0799	1.1005	1.1215	1.1431	1.1549
46 . .	0.9420	0.9613	0.9806	1.0000	1.0195	1.0391	1.0590	1.0792	1.0998	1.1210	1.1325
48 . .	0.9240	0.9430	0.9619	0.9809	1.0000	1.0193	1.0388	1.0586	1.0788	1.0996	1.1109
50 . .	0.9065	0.9252	0.9438	0.9624	0.9811	1.0000	1.0191	1.0386	1.0584	1.0788	1.0899
52 . .	0.8895	0.9078	0.9260	0.9443	0.9627	0.9812	1.0000	1.0191	1.0386	1.0585	1.0694
54 . .	0.8729	0.8908	0.9087	0.9266	0.9447	0.9629	0.9813	1.0000	1.0191	1.0387	1.0494
56 . .	0.8565	0.8741	0.8917	0.9093	0.9269	0.9448	0.9629	0.9812	1.0000	1.0192	1.0297
58 . .	0.8403	0.8576	0.8749	0.8921	0.9095	0.9270	0.9447	0.9628	0.9812	1.0000	1.0103
60 . .	0.8325	0 8496	0.9667	0.8838	0.9010	0.9184	0.9359	0.9538	0.9720	0.9906	1.0000

e^L_x : Life expectancy at age 'X' in South Asian model life table.

e^s_x : Life expectancy at age 'X' in Standard Asian model life table.

TABLE 9

Estimation of crude death rate by census differencing Method 1971-81

State	0 + Pop. of 1971 as on Ist March (00)	10+Pop. of 1981 as on Ist March (00)	Difference (00)	Inflation factor $\frac{D_0 +}{D_5 +}$	Mid 1976 population (00)	Estimate death rate		
						Without adj. for Net Mig.	With adj. for Net Mig.	S.R.S. 1971-80 Average
1	2	3	4	5	6	7	8	9
INDIA	**5,325,480**	**4,878,238**	**447,242**	**1.988279**	**5,989,180**	**14.85**	..	**14.68**
Andhra Pradesh . . .	434,321	394,036	40,285	1.707783	481,629	14.28	13.71	14.37
Bihar	562,602	498,123	64,479	1.956560@	624,651	20.20	19.33	14.40
Gujarat	266,392	252,901	13,491	2.180972	302,169	9.74	11.02	14.34
Haryana . . .	100,131	93,435	6,696	2.046393	114,120	12.00	12.11	12.03
Karnataka . . .	292,450	273,030	19,420	1.627364	328,484	9.62	10.10	11.40
Kerala	213,051	197,884	15,167	1.422216	235,368	9.16	8.51	7.92
Madhya Pradesh . .	415,658	374,274	41,384	2.190224	468,665	19.34	18.87	16.55
Maharashtra . . .	503,086	468,306	34,780	1.681822	565,029	10.35	12.71	11.64
Orissa	219,152	194,428	24,724	1.722896	242,703	17.55	18.99	16.28
Punjab	135,284	127,185	8,099	1.794237	150,104	9.68	9.95	10.81
Rajasthan . . .	257,122	242,685	14,437	2.194749	294,590	10.76	10.80	15.00
Tamil Nadu . . .	411,284	372,224	39,060	1.643528	451,743	14.21	14.08	13.69
Uttar Pradesh . .	882,046	789,243	92,803	2.439222	981,246	23.07	20.06	20.00
West Bengal . . .	442,225	409,046	33,179	1.988279	492,180	13.40	15.57	..

@Average of Madhya Pradesh and Orissa inflation factors.

+Using India inflation factor.

or the sample registration system. The deaths, obtained by census differencing are subject to following errors of opposite sign.

(a) Since the deaths to children in the age group 0-4 counted in 1971 census, would be higher, the difference may not exactly relate to ages 5 and above. In fact these deaths may be an over estimate of deaths to persons aged 5 and above during the decade.

(b) In practice, however, in all the censuses, the population aged 0-4 is relatively more under counted then that of the population in other age groups. Thus the difference $P^{71}_{0+} - P^{81}_{10+}$ be an under estimate of the true number of deaths in the age group 5 and over.

One can assume that the two errors which are in opposite direction may counter balance to some extent. Multiplying the estimated deaths in age group 5 and above i.e., $P^{71}_{0+} - P^{81}_{10+}$ by the ratio D_{0+}/D_{5+} derived from SRS one can estimate the death rate during the decade 1971-81. The death rates so estimated are approximate and should be treated as such.

Table 9 shows the various inputs used for estimating death rate by this method. In particular the ratios D_{0+}/D_{5+} were calculated by using the average age structure and death rate based on SRS for the period 1971-78. In case of Bihar wherein the SRS data for the period are not available, average ratios for the states of Orissa and Madhya Pradesh have been made use of. Of the four states adjoining Bihar, West Bengal does not have reliable data based on SRS. Of the remaining three states, the death rate in Uttar Pradesh seems distinctly higher than that of Bihar. This may be seen from the following table, showing death rates for Bihar, Uttar Pradesh, Orissa and Madhya Pradesh for the year 1979 to 1982, for which reasonably reliable data are available for Bihar.

TABLE 10

Crude death rate for Bihar, Uttar Pradesh, Madhya Pradesh and Orissa based on SRS 3 years average

Period	Bihar	Uttar Pradesh	Madhya Pradesh	Orissa	Average of U.P., M.P. & Orissa	Average of M.P. & Orissa
1	2	3	4	5	6	7
1979-81	14.7	16.4	15.7	14.0	15.4	14.8
1980-82	14.3	16.0	15.6	13.5	15.0	14.3

It is seen from the table that the death rate in Bihar lies in between that of Madhya Pradesh and Orissa. In view of this, the average of the ratio of (D_{0+}/D_{5+}) for the states of Madhya Pradesh and Orissa were made use of in the case of Bihar. In case of West Bengal, the death rate is below that of India. A part of this may be attributed to the fact that West Bengal has large number of adult migrants in the age group 15-59, lowering the crude death rate. In view of this the ratios D_{0+}/D_{5+} derived for India was made use of. To that extent the figures may be subject to error.

Impact of migration on the estimates of CDR

The census differencing method assumes that population is closed for migration. In a number of states there has been a significant in-migration/out-migration. In the absence of the age distribution of migrants, it is not possible to adjust for this deficiency. If, however, it is assumed that the age distribution of migrants might not have changed drastically during the 1971-81 decade and would be same as in 1971 census, then the 1971 census age distribution of migrants can be made use of to correct for migration.

Migrants estimated from place of birth data, were split into population aged 0-9 and 10 and above. The population aged 10 and above reported in 1981 census was then adjusted by adding the estimated number of net migrants aged 10 and above. The death rate was re-calculated. The death rates so derived have been termed as death rate adjusted for migration. These have also been shown in the table 9.

B—Comparison with SRS crude death rate

It would be of interest to compare the crude death rate estimated by the above methods with that of SRS. Since the SRS relates to usual residents the relevant birth rate to compare would be the death rate adjusted for migration. The following table classifies the states by the difference between SRS based CDR's and the estimates derived by using census differencing method. Since SRS is known to be not reliable in Bihar and West Bengal, for most part of 1971-80 decade, the comparison is restricted to 12 states and India.

Crude death rates by SRS & Census differencing method compared

Difference in CDR SRS—Census	States
0—1	India, A.P., Haryana, Kerala, Punjab, Tamil Nadu. U.P.
1—2	Karnataka, Maharashtra
2—3	M.P.
3—4	Gujarat, Orissa (—3.71)

For India as a whole and the states of A.P., Haryana, Kerala, Punjab, Tamil Nadu and U.P. the death rates by both the sources are closer. In Maharashtra the SRS estimate falls between adjusted and unadjusted estimates. In M.P. and Orissa SRS death rates seem under estimates. In Gujarat SRS death rate appears to be on higher side when compared with estimates derived by census differencing method.

Comparison with SRS based estimates of expectation of life at birth

During decade 1971-80, this office has been conducting regularly in random sample of villages and urban blocks, a survey to meet the requirement of providing reliable vital rates. In addition to crude birth and death rates, the measures of fertility and mortality like age specific fertility rates, age specific mortality rates have been published annually for India and states. Based on the age specific mortality rates, the life expectancy at birth and at various ages have been estimated for the decade 1971-81 as a whole.

For the purposes of constructing the abridged life table, simple average of the mortality rates at each age group ($_nm'_x \times s$) for the ten years 1971-1980 were worked out. These were then converted into life table death rates ($_nq'_x \times s$) by using Greville's formula.

The SRS system provides death for the open ended age group 70 and over. The $_\infty m_{70}$'s for the age group were converted into $_nq_x$'s by locating the South Asian model life tables with the same $_\infty m_{70}$'s and adopting the $_nq_x$'s for ages 70-74, 75-79, 80-84 and 85 + relating to the chosen life table. This procedure is approximate as it does not take into account the age structure. The effect of this on e^0_0 is likely to be negligible.

TABLE 11

Expectation of life at birth estimated by various methods

	Forward survival Method*		Preston & Bennett's Method		SRS 1971-80	
	M	F	M	F	M	F
INDIA	**51 2**	**51.2**	**52.5**	**52.9**	**50 9**	**50.0**
Andhra Pradesh	47.4	49 7	52 3	50 8	50 0	52.1
Bihar	45.4	39.4	43.0	45.9	..	..
Gujarat	54.6	57 8	52.1	56 6	50.1	50.8
Haryana	64.5	49.1	63.3	57.3	57.6	54.5
Karnataka	54.3	59.2	56 4	58 2	55 6	56 3
Kerala	52.7	62.3	49 9	55 2	62 5	66.3
Madhya Pradesh	49 4	46.2	50.1	52.4	48 5	47.5
Maharashtra	54 0	58.5	51.9	58.2	54.8	56 6
Orissa	42 6	40.3	44 2	40 7	47.5	46 0
Punjab	65 2	65.0	65 2	61 5	59.2	58.0
Rajasthan	61.1	60.9	59 4	60.6	50 5	50.3
Tamil Nadu	47.5	45.2	44.7	40.4	51 9	52.3
Uttar Pradesh	48.4	46.6	50 0	50.1	46 7	41.9
West Bengal	46 4	51.1	41 1	50 3		

*Restricted median

Table 11 shows the expectation of life at birth for the decade 1971-80 estimated by various methods. SRS based age specific mortality rates for the states of Bihar and West Bengal are not available.

It is seen from the table that the estimates of e^0_0 by various methods are very different. In view of this only broad trends have been discussed. It is worth noting that the estimates of life expectancy

at birth based on census data are likely to be affected by inter-state migration. In the states of A.P., Bihar Haryana, Karnataka, M.P., Punjab, Rajasthan and Tamil Nadu wherein impact of net migration on growth rate as judged from place of birth data is negligible, the distortion is likely to be small. In the states of Gujarat, Maharashtra, Orissa, West Bengal, Kerala and U.P. which have experienced considerable net migration, the distortion is likely to be higher. In the former group of states, the impact of migration on annual exponential growth rate is less than 0.05% while in the latter group it is much higher. In the following paragraphs, the broad trends indicated by different estimates are discussed statewise.

Andhra Pradesh : The estimates of expectation of life at birth, e_0^0 range from 47.4 years to 52.3 years for males and 49.7 years and 52.1 years for females. SRS based estimates fall between the two census based estimates for males. Forward survival method and SRS show a higher female e_0^0 compared to males while Preston and Bennett's method indicates a lower female e_0^0

Bihar : While reasonable closeness is seen in e_0^0 for males, for females the difference in e_0^0 estimated by the two method is large. While forward survival method indicates that female e_0^0 lower than males, Preston and Bennett indicates that it is higher.

HARYANA : Estimates of e_0^0's based on SRS particularly for males are lower than those based on census analysis. All the methods indicate higher female mortality. Census based estimates are close for males but not for females.

Karnataka : There is reasonable agreement among all the methods on the levels of e_0^0. All methods indicate that female e_0^0 is higher than males.

Madhya Pradesh : Estimates of e_0^0 by SRS & forward survival method are close with both indicating lower female e_0^0.

Punjab : Despite higher e_0^0 for males/females the male-female differentials persist with female e_0^0 being lower. The estimates of e_0^0 by census based methods are 65.2 for males but differ for females. The census based estimates indicated higher life expectancy compared to SRS.

Rajasthan : There is a very clear difference between census based estimates & SRS based estimates. The census based estimates agree among themselves and indicate that expectation of life at birth should be in the range of 60, for males & females while SRS based estimates are around 50. The male/female differentials are not high by either source.

Tamil Nadu : Census based estimates of e_0^0 are distinctly lower than SRS based estimates. Census based estimates indicate lower female life expectancy at birth while SRS indicates that they are more or less equal.

As pointed out earlier in the states of Gujarat, Maharashtra, Orissa, West Bengal, Kerala & U.P migration plays a significant role. In Gujarat, Maharashtra, Orissa & West Bengal in-migration affects the growth rate. In Kerala & U.P. out-migration affects the growth rate. The effect of migration on estimates derived by forward survival method would be to inflate the estimated life expectancy in the in-migrating states and to reduce the estimated life expectancy in out-migrating states. The effects are clearly noticed in Kerala.

Gujarat : The higher figures of life expectancy by forward survival method may perhaps be attributed to migration. All methods indicate that female life expectancy is higher than that of males.

Maharashtra : All the methods indicate that female life expectancy is higher. The e_0^0 by forward survival is not very different from that of SRS particularly for males.

Orissa : Contrary to earlier expectation, e_0^0 based on forward survival method and Preston and Bennett's method are very low compared to SRS. Probably SRS based mortality rates are under estimates. This is also confirmed by the analysis of crude death rate. Census based estimates are reasonably close particularly for females. All methods indicate lower female life expectancy.

West Bengal : The low figures of e_0^0 particularly for males is hard to explain. Estimates of life expectancy for females are however close.

Kerala : Effect of out-migration on the e_0^0 is clearly visible particularly in case of males. The state Bureau of Economics & Statistics* had estimated in 1978 that there were about 2,08,000 migrants to other countries from Kerala. Assuming that all are males who migrated after 1971 and that all are in the age group 15-34, the expectation of life at birth was recalculated as 60.2 years, making it closer to SRS estimates. No adjustment for inter state migration was done in the above calculation. If this is also taken into account the estimate may be higher. The exercise shows that SRS estimates of e_0^0 may be closer to reality.

All the methods indicate that female life expectancy is higher than males.

*Directorate of Economics & Statistics, Government of Kerala, Survey on Housing & Employment (mimeo) 1980 page 44.

Uttar Pradesh : Forward survival method and SRS indicate that female life expectancy is distinctly lower than males.

To sum up, different methods based on age distribution yield different estimates. This lack of consistancy among estimates derived by different methods makes estimation of life expectancy at state level a difficult job. However, at national level there is reasonable agreement among all methods.

Despite this it can be said that female life expectancy at birth is lower than males life expectancy in Haryana, Orissa and Punjab. In Haryana and Punjab, the sex ratio (females/1000 males) has increased slightly during 1981 compared to 1971, but is still well below 900. Orissa is one of the states where sex ratio is declining. In Rajasthan the differentials are very small. In this state sex ratio has improved during 1981 census. In the states of Gujarat, Karnataka, Kerala, Maharashtra and West Bengal, the female life expectancy at birth is higher than males. In all these states sex ratio has become more balanced in the recent census. In the remaining states of A.P., Bihar, M.P., Tamil Nadu and U.P., no uniform trend is discernible. Two of the three estimates indicate higher female life expectancy in A.P. and lower female life expectancy in M.P., Tamil Nadu and U.P. of these states, in M.P. and Tamil Nadu sex ratio has remained more or less the same during 1971 and 1981. In A.P. and Bihar it has decreased but has increased in U.P. Both in A.P. and Tamil Nadu the sex ratio is well above the National average. In Bihar and M.P., it is closer to National average and in U.P. it is far below the National average.

CHAPTER 3

ESTIMATED OF CHILD MORTALITY

As mentioned in the introductory chapter in 1981 census data on age at marriage children ever born, children surviving and births during last one year were collected. The first three questions were canvassed for all ever married women. The question on births during last one year was canvassed for currently married women only, for operational convenience.

Based on 5% sample tabulation, sex wise data on children ever born and children surviving classified by age of mother have been published separately for each of the major religions viz Hindus, Muslims, Sikhs, Christians, Jains, Buddhists and others. In each state data for three numerically larger religions of the states have also been released. Similar data based on educational level of the females is also available at national level.

From these set of data, the proportion of children who would die before celebrating 1, 2, 3, 5 or 10th birth day i.e. child mortality, q(1), q(2), q(3), q(5) and q(10) have been estimated using Brass and Trussel's coefficients. Estimates of p(2), q(3) and p(5) using Sullivan's regression equation have also been presented for comparison. Only the estimates relating to state as a whole have been presented in this report, as these are the ones relevant for estimation of fertility and mortality levels.

Rationale of Brass method:—Brass[1] suggested a procedure to convert the proportion of children dead, D(i) reported by women in the age group 15-19, 20-24.....into estimates of the probability of dying before attaining certain exact childhood ages. The basic form of estimation equation proposed by Brass is $q(x)=k(i)\ D(i)$ where the multiplier k(i) is meant to adjust for non-mortality factors determining the value of D(i), which is primarily the age pattern of fertility. Under the assumption of constant fertility and mortality in the recent past he developed a set of multipliers to convert observed values of D(i), into estimates of q(x), the multiplier being selected according to the value of P(1)/P(2), where P(i) is the average parity reported by women in age group i.

Sullivan[2] computed another set of multipliers using observed fertility schedule and Coale and Demency model life tables. He estimated the multiplier, Ki by using regression approach, the independent variables being (P_1/P_2) and (P_2/P_3).

Trussel[3] generated a third set of multipliers by using model fertility schedules developed by Coale and Trussel and the regional model life tables developed by Coale and Demency by using regression approach.

In all the methods, underlying assumption was that mortality has been constant in the recent past. However, in many countries mortality has been declining. Subsequently a procedure was developed by Coale and Trussel[4] which assigned the estimated q(x)s, to a period t(x) years prior to census/survey. This procedure can be adopted when mortality is declining.

In this chapter, child mortality estimates have been derived by all the three methods. The number of years prior to the census (YPC) to which these q(x) relate to have also been worked out. In estimating these values coefficients pertaining to South Model Life tables have been made use of, since many demographers have expressed the view that child mortality in India may follow this pattern. It should be recognised that there is divergence in child mortality patterns within the country between Kerala at one end and Uttar Pradesh at the end of the spectrum and use of same model for all states may be opened to question. This would only point out to the need for more studies on the pattern of child mortality in India.

Table 12 presents the estimated values of q(x)s by Brass, Sullivan and Trussel co-efficients together with the YPC sex wise. The YPC indicates that at national level of q(1) applies to a period approximately one year prior to census, while q(2), q(3), q(5) refer respectively to 2.3 years, 4.2 years and 6.5 years prior to census. The exact values of YPC for various states vary around these years. At national level, the estimate of q(x)'s by various methods are reasonably close. At state level, also the methods give close estimates for q(2), q(3) and q(5). It is further seen from the statement that the progression of q(x)'s is uneven in the states of Gujarat (males), Haryana (males), Maharashtra, Punjab, Tamil Nadu (males) and West Bengal (males). At national level also the progression is uneven for male. For example in Haryana q(1), q(2), q(3) and q(5), which represent the probabilty of death (out of 1000 children born) before reaching age 1, 2, 3, 5 respectively are 137.6, 120.2, 114.4, 122.8 which is obviously impossible. This may be largely due to errors in reporting of male child birth. Surprisingly in the same state for females the respective q(i)'s are 106.9, 122.3, 130.4 and 150.2, which seem reasonable. Does it indicate that reporting of male mortality is subjected to more errors than females? This suspicion strengthens as one looks at the data for states. In most of the

[1]William Brass, Methods for estimating Fertility and mortality from limited and defective data (Chapel Hill North Carolina Laboratory for Population studies 1975).

[2]Jeramiah M. Sullivan, 'Models for the estimation of the probability of dying between birth and exact ages of early childhood—Population studies Vol. XXVI No. 1 (March 1972).

[3]J. James Trussel-'A reestimation of the multiplying factors for the Brass technique for determining childhood survivorship rates Population studies Vol. XXIX No. 1 (March 1975.)

[4]Ansley J. Coale & Jame Trussel Estimating the time to which Brass estimates apply annex. 1 to Saumel H. Preston and Alberto Public. Fine tuning Brass type mortality estimates with date on ages of surviving children—Population Bulletin of the United Nations No. 10 1977.

states the trend of the estimated q(i)'s is uneven for males, but is reasonable for females. The reasons for this differentials in mortality exhibit an interesting pattern. Mortality in the first year of life, q(1) is higher for males in all the states and at national level. When q(2), the mortality from birth to age two is considered. Bihar and Uttar Pradesh exhibit higher female mortality. In Haryana, male/female mortality become almost equal. In all other states male mortality is higher when q(3), the mortality from birth to third birth anniversary is considered. Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh exhibit higher female mortality. As the age progresses, more and more states exhibit higher female mortality. By age 10, Kerala is the only state where male mortality q(10) still remains higher than females. In Maharashtra and Karnataka the rates become almost equal. The reasons for the progressively increasing child mortality among females needs further field studies.

TABLE 12

Estimates of child mortality by BRASS ' 'SULLIVAN's and TRUSSEL's Methods and the associated YPC India and States

Sl. No.	India/State	Method	q(1)		q(2)		q(3)		q(5)		q(10)		q(15)	
			M	F	M	F	M	F	M	F	M	F	M	F
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	INDIA	**Brass**	**127.8**	**109.0**	**125.4**	**119.6**	**129.5**	**135.5**	**146.3**	**156.5**	**163.1**	**179.8**	**178.7**	**201.7**
		Sullivan's	..	..	**126.5**	**120.6**	**126.1**	**131.8**	**140.7**	**150.5**	..	..	..	..
		Trussel	**128.0**	**109.1**	**126.7**	**120.8**	**130.2**	**136.1**	**147.2**	**157.5**	**165.3**	**182.2**	**181.3**	**204.8**
		Y.P.C.	**(1.0)**	**(1.0)**	**(2.03)**	**(2.3)**	**(4.2)**	**(4.2)**	**(6.5)**	**(6.5)**	**(9.1)**	**(9.1)**	**(11.9)**	**(11.9)**
1.	Andhra Pradesh	Brass	113.8	91.9	116.3	97.3	122.9	135.7	140.9	141.7	153.6	155.9	172.9	172.3
		Sullivan's	...	..	117.0	98.8	118.6	131.7	134.5	135.9	..	..	..	..
		Trussel	104.6	82.7	114.3	96.0	122.7	136.4	142.2	144.0	157.1	160.5	177.5	178.2
		Y.P.C.	(1.2)	(1.3)	(2.6)	(2.7)	(4.7)	(4.6)	(7.0)	(6.9)	(9.6)	(9.4)	(12.4)	(12.1)
2.	Bihar	Brass	96.9	93.8	110.7	116.0	116.2	132.1	132.2	152.2	143.3	172.2	153.5	191.1
		Sullivan's	..	..	111.6	116.8	112.3	127.9	126.5	145.6	..	..	..	..
		Trussel	92.9	90.3	110.2	115.5	116.4	132.2	133.1	153.2	145.4	175.2	156.8	194.9
		Y.P.C.	(1.1)	(1.1)	(2.5)	(2.5)	(4.4)	(4.4)	(6.8)	(6.8)	(9.4)	(9.4)	(12.2)	(12.2
3.	Gujarat	Brass	112.9	98.0	107.9	100.5	105.3	110.6	121.5	129.1	131.1	145.6	139.4	158.9
		Sullivan's	..	..	105.6	98.6	101.7	106.9	116.6	124.0	..	..	..	..
		Trussel	116.6	101.2	109.4	102.0	104.6	110.1	120.1	127.8	130.1	144.7	137.7	159.5
		Y.P.C.	(0.7)	(0.7)	(1.8)	(1.8)	(3.6)	(3.6)	(6.0)	(6.0)	(8.7)	(8.7)	(11.7)	(11.7)
4.	Haryana	Brass	137.6	106.9	120.2	122.3	114.4	130.4	122.8	150.2	136.3	167.3	152.5	183.7
		Sullivan's	..	..	120.0	123.0	111.0	127.0	118.0	144.0	..	..	..	..
		Trussel	141.7	109.3	121.9	124.2	114.4	130.9	122.6	150.5	136.8	168.6	152.7	185.1
		Y.P.C.	(0.9)	(0.9)	(2.1)	(2.1)	(4.0)	(4.0)	(6.3)	(6.3)	(9.0)	(9.0)	(11.9)	(11.8)

5. Karnataka .	Brass	99 3	83 7	110 8	101 9	123 1	118 3	141 9	137 8	154 3	156 2	170 1	175 1
	Sullivan's	..	..	112 2	103 7	120 0	115 6	136 6	133 0		.		
	Trussel	97 0	80 9	111 5	102 7	124 0	119 6	143 3	139 8	157 3	159 8	173 7	179 5
	Y P C.	(1 1)	(1 1)	(2 3)	(2 4)	(4 2)	(4 2)	(6 5)	(6 4)	(9 1)	(8 9)	(11 9)	(11 7)
6. Kerala	Brass	60 1	39 7	56 4	49 6	66 5	57 1	80 3	74 6	107 9	102 0	129 4	121 0
	Sullivan	.	..	56 6	49 6	65 2	56 0	78 0	72 5				.
	Trussel	60 9	40 2	57 9	50 8	67 3	57 8	80 8	75 1	109 0	102 9	130 1	121 5
	Y P C.	(0 8)	(0 8)	(1 8)	(1 8)	(3 5)	3 5)	(5 7)	(5 7)	(8 2)	(8 2)	(11 0)	(11 0)
7 Madhya Pradesh .	Brass	163 9	141 3	165 1	159 2	170 2	172 9	191 9	201 9	213 1	227 5	232 6	271 8
	Sullivan	.		165 6	159 6	164 5	167 0	183 5	192 9				
	Trussel	160 8	139 0	164 7	158 8	170 0	172 4	192 5	202 4	215 9	230 3	236 3	255 5
	Y P C.	(1 1)	(1 1)	(2 4)	(2 4)	(4 4)	(4 4)	(6 8)	(6 8)	(9 4)	(9 5)	(12 3)	(12 3)
8. Maharashtra	Brass	132 7	109 8	121 6	106 8	123 2	119 3	144 6	143 9	170 0	172 9	191 2	200 8
	Sullivan			121 7	106 9	119 4	115 5	138 6	137 8				
	Trussel	135 7	112.3	122 8	107 8	123 2	119 2	144 5	143 7	171 2	174 2	192 7	202 4
	Y P C.	(0 9)	(0 9)	(2 2)	(2 2)	(4 1)	(4 2)	(6 5)	6 5)	(9 2)	(9 2)	(12 1)	(12 2)
9 Orissa . .	Brass	171 2	143 2	167 8	150 4	169 8	160 6	183 6	179 3	193 3	201 9	211 0	229 0
	Sullivan	..		165 2	148 0	162 7	153 9	174 5	170 4				
	Trussel	179 9	150 5	168 5	151 0	167 5	158 4	181 0	176 8	192 0	200 5	209 7	227 6
	Y P C.	(0 8)	(0 8)	(2 1)	(2 1)	(4 2)	(4 2)	(6 7)	(6 7)	(9 6)	(9 6)	(12 6)	(12 6)
10 Punjab	Brass	147 6	108 1	109 3	105 9	97 2	105 0	103 8	119 9	116 1	136 1	118 2	141 4
	Sullivan			110 1	105 9	96 0	103 2	101 4	116 7				
	Trussel	146 7	108 0	112 5	108 6	99 1	106 5	105 1	120 9	118 0	137 5	119 5	142 2
	Y.P.C.	(0 8)	(0 8)	(1 8)	(1 8)	(3 4)	(3 4)	(5 4)	(5 5)	(7 8)	(8 0)	(10 6)	(10 8)

TABLE 12—*Concld*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	Rajasthan	Brass	147 7	136 2	151 4	145 0	153 4	162 7	166 4	185 5	181 4	210 7	194 4	228 4
		Sullivan			152 8	145 5	149 6	157 9	160 3	178 0				
		Trussel	148 9	138.9	153 4	146 6	154 5	162 9	167 5	185 7	183 8	212 4	197 2	230 5
		Y.P C.	(1 0)	(0 9)	(2 2)	(2 2)	(4 1)	(4 1)	(6 4)	(6 5)	9 0	(9 2)	(11 8	(12 1
12.	Tamil Nadu	Brass	117 1	91 8	110 8	96 0	117 7	114 3	135 2	134 3	153 2	162 8	170 4	193 4
		Sullivan			110 7	95 8	114 4	111 0	130 1	129 2				
		Trussel	120 5	94 6	112 6	97 5	118 0	114 5	135 1	134 2	154 0	163 4	171 0	194 0
		Y P C	(0 8)	(0 8)	(2 0)	(2 0)	3 9)	(3 9)	(6 2)	(6 2)	(8 9)	(8 9)	(11 8	(11 8
13.	Uttar Pradesh	Brass	138 9	131 9	145 5	159 3	156 7	181 5	171 7	205 1	192 8	237 6	207 6	260 9
		Sullivan			146 6	160 4	152 5	176 4	165 1	197 1				
		Trussel	138 9	132 3	146 8	160 8	157 5	182 2	172 7	206 1	195 4	240 6	210 7	264 6
		Y.P C.	(1 0)	(1 0)	(2 3)	(2 3)	(4 2)	(4 2)	(6 5)	(6 5)	(9 1)	(9 1)	(12 0)	(12 0)
14.	West Bengal	Brass	122.7	91 6	108 6	96 3	112 0	110 5	122 3	143 0	135 6	142 2	144 5	155 8
		Sullivan			110 3	97 4	109 1	107 4	117 6	137 3				
		Trussel	118 2	88 1	109 2	96 3	112 8	111 1	123 6	144 4	138 5	145 1	147 8	159 3
		Y.P C.	(1 1)	(1 1)	(2 4)	(2 4)	(4 3)	(4 4)	(6 6)	(6 7)	(9 1)	(9 2)	(11 9)	(12 0)

CHAPTER 4

ESTIMATION OF FERTILITY

In this chapter fertility measured by CBR during the period 1971-80 have been estimated by

(a) Reverse survival method using smoothed age distribution;

(b) Rele's method using child women ratio derived from smoothed age distribution;

(c) Census differencing method by adding growth rate adjusted for migration to the crude death rate estimated in Chapter 2;

(d) by cohort parity increment method, (for India only).

The chapter also presents the results of applying Brass P/F ratio technique to the data on children ever born and births during last one year collected in the census. The estimated birth rate may be related to the close of the decade. The limitation of this procedure has also been discussed.

Both for reverse survival method and Rele's method, smoothed age data in the age group 0-4 and 5-9 have been made use of. The procedure adopted for smoothing the age data has been described in detail in the report on the 'Age tables based on 5% sample data'. The main difference worth noting is that in the age group 0-4, adjustments have been done for age distortion and omission based on Census Evaluation Study conducted in a sub sample of the Sample Registration System blocks. The Census Evaluation Study has indicated that a large proportion of children in the age group 0-4 had been omitted in the census and that ages of a number of children were distorted while reporting. In general the number of children reported in 5-9 age group was slightly reduced due to transfer of persons across the age group 0-4 and the number reported in 0-4 inflated due to omission and age distortion.

TABLE 13

Birth rates for the periods 1971-76, 1976-81 and 1971-81 by reverse survival method using child mortality estimate derived by Brass' technique

Sl. No.	India/State	Birth rates during		
		1971-76	1976-81	1971-81
1	2	3	4	5
	INDIA . . .	**37.70**	**33.93**	**35 81**
1.	Andhra Pradesh . .	38.56	29.64	33.98
2.	Bihar	41.83	34.50	38 15
3.	Gujarat . . .	35.96	32.48	34 19
4.	Haryana . . .	38.97	34.86	36.88
5.	Karnataka . . .	37.96	33.23	35 64
6.	Kerala . .	29.46	25.98	27.55
7.	Madhya Pradesh	42.39	36.43	39.24
8.	Maharashtra . .	36 20	30.77	33.35
9.	Orissa . .	39.43	33.47	36.22
10.	Punjab . . .	33.03	30.19	31.69
11.	Rajasthan	44 30	40 07	42.32
12.	Tamil Nadu	30.79	27.25	28.81
13.	Uttar Pradesh . .	43.37	39.51	41.63
14.	West Bengal. . .	36.05	30.51	33.20

Reverse survival method

The population in the age group 0-4, 5-9 reported in the 1981 census are survivors of the births during the inter censal period 1971-81. From this number, birth during the quinquennia 1976-81, 1971-76 and the decade 1971-81 can be estimated by using life table survivorship probabilities.

Two different sets of reverse survival factors have been used to estimate the number of births. In the first set the child mortality rates q(1), q(2), q(5), q(10) derived from census data on children ever born and children surviving have been made use of. The mortality rates are available for all the 14 major states.

It is generally the practice to reject the q(1) derived from the Brass technique as over estimate. Two reasons are usually given. The first one is that q(1), which is based on D(1) the proportion of children dying reported by women in the age group 15-19 is generally based on experience of a small number of married females in 15-19. In other words the reason is statistical. This however, may not hold good in case of India since the sample size is large (5%) and number of ever married women in the age group 15-19 is very large, due to early and universal marriage.

The second reason is that children of young mothers experience mortality risk well above the average, for this reason the estimate of infant mortality rate q(1), derived from D(1), frequently suggests heavier mortality than estimates derived from reports of older women. The higher mortality risk of younger mothers is however yet to be well documented. In societies wherein the first birth is eagerly awaited and the mother is in relatively healthy and is well taken care of, the mortality of children of young mothers may not necessarily be high. In view of this, the q(1) as derived has been used if the progression of q(1), q(2), q(3), q(5) is reasonable though fluctuation is not in accordance with the model pattern. Only in cases where this progression is uneven with q(1) being larger than q(2) or q(3), an attempt was made to graduate the mortality rates derived

[1] William Brass and others. 'The Demography of Tropical Africa - (Princeton. New Jersey, Princeton University Press, 1968).

TABLE 14

Birth-Rates for the periods 1971-76, 1976-81 and 1971-81 by reverse survival method using SRS Child Mortality Estimates

India/State	1971-76	1976-81	1971-81
INDIA	**39 90**	**34 64**	**37 23**
Andhra Pradesh	40 17	30 06	35 11
Bihar*	15.73	36 20	40 91
Gujarat	10.94	31.53	37 53
Haryana	40 22	35 45	37.77
Karnataka	37 63	32 90	35 30
Kerala	29.19	25.86	27.50
Madhya Pradesh	43.14	36.57	39.81
Maharashtra	35 75	29 72	32.58
Orissa	40 38	33 00	36 42
Punjab	34 28	30.20	32.29
Rajasthan	46 52	40 26	43 56
Tamil Nadu	31 76	27 70	29 51
Uttar Pradesh	48.46	41 23	44.96
West Bengal**	38 80	31.53	35 04

NOTE.—Reverse survival factors have been worked out using SRS data. The average age specific death rates for 1971-76 and 1976-81 have been used The ASMR for the age group 0-4 has been split to those of age groups 0 and 1-4 by using South Asian pattern of the United Nations model life tables for developing countries.

*In Bihar the average of the reverse survival factors for Madhya Pradesh and Orissa have been used

**In West Bengal the reverse survival factors from the child mortality estimates using Brass Technique were used after inflating them with ratio of these factors for India to the reverse survival factor from SRS for India

In other words, as far as possible adherance to original estimates derived was preferred.

Another set of child mortality estimates is available for each of the years 1971-81 from the Sample Registration system. The age specific death rates are available for the age group 0-4. These were converted into probability of death using the South Asian pattern.

Persons born during 1971-76, would be in the age group 0-4 in 1976 and 5-9 in 1981. The relevant mortality rate to reverse survive the population aged 5-9 in 1981 would be mortality rate corresponding to age group 5-9 in the period 1976-81 and those corresponding to 0-4 in the period 1971-76. Similarly the relevant mortality rate to reverse survive the population aged 0-4 in 1981 would be the rates corresponding to 0-4 in the period 1976-81 The average death rates for these years were calculated from SRS data and reverse survival factors worked out The birth rates derived using the factors are shown in the Table 14 separately for 1971-76, 1976-81, 1971-81.

The SRS system is known to be deficient in Bihar and West Bengal during most part of the period 1971-81. In view of this, different procedures have been adopted for the states. As mentioned earlier, in case of Bihar, the average of the reverse survival factors of Orissa and M.P. has been made use of. In case of West Bengal the reverse survival factor based on Brass method has been inflated by the ratio of the observed difference between SRS based and Brass based factors at national level separately for males and females.

TABLE 15

Ratio of the reverse survival factors based on mortality rates from SRS to those Based on Brass Techniques

India State	Male		Female	
	0—4	5—9	0—4	5—9
1	2	3	4	5
INDIA	**1 0182**	**1 0550**	**1.0239**	**1 0621**
Andhra Pradesh	1 0184	1 0508	1.0093	1.0449
Bihar	1 0543	1 0981	1 0422	1 0842
Gujarat	1 0597	1.1354	1 0671	1.1423
Haryana	1 0095	1.0236	1 0221	1.0358
Karnataka	0 9814	0.9886	0.9923	0.9967
Kerala	0 9924	0 9951	0.9920	1 0023
Madhya Pradesh	1 0270	1 0493	1 0088	1 0201
Maharashtra	0 9623	0 9934	0.9817	0 9987
Orissa	0.9871	1 0256	0 9960	1.0345
Punjab	1 0001	1 0295	1.0092	1.0541
Rajasthan	1.0005	1.0509	1 0089	1 0594
Tamil Nadu	1 0156	1 0352	1 0183	1.0262
Uttar Pradesh	1 0342	1 1030	1 0531	1 1332

Table 15 shows the ratio of the reverse survival factors derived by using child mortality derived from SRS and by the application of Brass technique and for India and states. As may be anticipated the reverse survival factors for the age group 5-9, based on Brass technique are distinctly lower than those of SRS at national level and in most of the states. At national level the reverse survival factor for the age group 5-9, based on SRS is about (5.5% and 6.2%) higher respectively for males and females. It may be recalled that the reverse survival factor by Brass procedure for age group '5-9' is based on q(5) and q(10) derived, which in turn are based on the reported proportion of child survival in the age groups 30-34 and 35-39. The latter is in particular subject to recall lapse particularly of children who are dead. This probably is the reason why the reverse survival based on this is lower. Thus the estimate based on this factor should be considered as a *lower limit* to the birth rate for the period 1971-76.

Statewise examination of the reverse survival factor for the age group 5-9, indicates that in the states of Karnataka, Kerala and Maharashtra both the reverse survival factors are very close for males and females. In the states of A.P., Haryana, Madhya Pradesh, Orissa, Punjab, Rajasthan and Tamil Nadu the differences are below the national average being within 6% of the SRS based factor. Major differences are noticed in Gujarat and U.P. being more than 10%.

A similar examination of the reverse survival factor for age group 0-4 indicates that the national level the reverse survival factor based on SRS is more than those based on Brass Technique by 1.8 per cent for males and 2.4 per cent for females. The factors are close for Andhra Pradesh, Haryana, Karnataka, Kerala, Madhya Pradesh (female), Maharashtra (females), Orissa, Punjab, Rajasthan and Tamil Nadu. The factor based on SRS is significantly lower for Maharashtra males. In Gujarat and Uttar Pradesh the SRS based factors are higher than the factors based on Brass technique.

TABLE 16

Birth rates by reverse survival method, adjusted for Migration

Sl. No.	State	1971-76	1976-81	1971-81
1	2	3	4	5
1.	Andhra Pradesh	40.47	30.03	35.11
2.	Bihar	45.72	36.11	40.87
3.	Gujarat	40.79	34.54	37.54
4.	Haryana	40.16	35.41	37.72
5.	Karnataka	37.64	32.85	35.27
6.	Kerala	29.46	25.77	27.45
7.	Madhya Pradesh	43.42	36.58	39.82
8.	Maharashtra	35.80	29.97	32.69
9.	Orissa	40.44	33.21	36.54
10.	Punjab	34.29	30.23	32.31
11.	Rajasthan	46.53	40.28	43.56
12.	Tamil Nadu	31.76	27.66	29.50
13.	Uttar Pradesh	48.68	41.08	45.04
14.	West Bengal	37.98	31.26	34.48

NOTE.—Total population of 1981 has been adjusted using the number of interdecadal migrants from place of birth data. The age distribution of migrants has been obtained by applying the 1971 age distribution of the migrants with duration of residence 0-9 years separately for in-migrants and out-migrants.

Adjustment of the birth rate for the effect of migration

One of the limitations of the estimates of crude birth rate by reverse survival method is that population in the age groups 0-4 and 5-9 may be affected by migration. In other words the birth rates derived would refer to the population enumerated at the time of census instead of usual resident population. In simpler terms children born in other states but enumerated in a particular state at the time of census, would be included in the state of enumeration in birth rate calculations. The effect would in general be small in states where net migration is not very significant particularly because most of the migration is in adult ages. According to the place of birth statistics impact of migration on growth rate is less than 0.05% or 0.5/1000 in the eight states of A.P., Bihar, Haryana, Karnataka, M.P., Punjab, Rajasthan and Tamil Nadu. Of the remaining states, Gujarat, Maharashtra, Orissa and West Bengal experienced in migration while Kerala and Uttar Pradesh experienced out migration. In the in-migrating states the birth rates by reverse survival factor may be over estimated. In U.P. and Kerala they may be slightly under estimated.

Adjustment for migration has been done for all the states using the age distribution of inter state inter decadal migrant obtained from 1971 census. Similar tables based on 1981 census are not available. The estimated number of net decadal migrants during the period 1971-81 based on place of birth statistics were distributed according to the age distribution of migrants obtained from 1971 census. The estimated number of migrants in age group 0-4 and 5-9 were added or subtracted from the smoothed population in these age groups depending on whether the state was experiencing out migration or in migration. Similar adjustments were made to total population of 1981 census. The birth rates were reestimated using the reverse survival factors derived from SRS and are shown in table 16.

TABLE 17

Estimates of Birth Rates using Reles Technique

India/States	1971-76	1976 81	1971-81
INDIA	**39.5**	**34.2**	**36.8**
Andhra Pradesh	39.9	29.9	34.8
Bihar	46.5	36.0	41.1
Gujarat	39 4	33.7	36.5
Haryana	41.4	34.0	37.6
Karnataka	38.8	33.1	36.0
Kerala	32.2	26.9	29.3
Madhya Pradesh	42.0	35.8	38.7
Maharashtra	36.0	30.0	32.8
Orissa	41.5	33.5	37.2
Punjab	35.0	30.1	32.6
Rajasthan	43.4	38.7	41.2
Tamil Nadu	32.9	28.2	30.3
Uttar Pradesh	44.2	39.9	42.2
West Bengal	35.8	27.7	31.6

Rele's Method:—Rele, J.R. developed a method of estimating the birth rate and G.R.R. by making use of child woman ratio. In this method the child woman ratio (children aged 0-4 divided by women aged 15-49 or children aged 5-9 divided by women aged 20-54) has been used as an indicator of fertility. The method is robust to deviations from assumptions of stability or quasi-stability. The method requires broad indications of the level of mortality indicated by e_0^0. For this purpose, the e_0^0 derived from SRS for the period 1971-76, 1976-81 have been used. The birth rates for the periods 1971-76, 1976-81 and 1971-81 are indicated in table 17. The estimates have been worked out using smoothed age data.

One of the limitations of the method is that the crude birth rate estimated is affected by the age structure of females in the age group 15-44 and sex ratio both of which may be affected by migration. In states like Kerala, Maharashtra, U.P. and West Bengal, with substantial migration, estimates by this method should be viewed with caution.

Comparison of estimates by different methods

Of the three methods discussed namely reverse survival method, Rele's method and census differencing method, estimates by Reverse Survival method using SRS child mortality is recommended for official use, since the estimated mortality rates observed on a regular basis in a selected sample of village for the last 10 years has been made use of. The census data has also been adjusted for omission and age distortion. It is also seen that the resultant birth rates when combined with the growth rates observed from census, (adjusted for migration) result in death rates which are close to SRS based crude death rates in most of the states.

Estimation of fertility using P/F technique

As already noted, the 1981 census collected data on children ever born and births during last one year. The question on children ever born was canvassed for all ever married women and that on birth during last one year canvassed for all currently married women. If one were to make an assumption that very few births have occurred to widowed and divorced females during the last one year, the births during last one year could be converted into age specific fertility rates. From these two set of data, fertility for the year 1980 can be estimated using P/F ratio technique suggested by Brass, 'W'.

The essence of Brass fertility estimation procedure is the adjustment of the age pattern of fertility derived from information on births during last one year by the level of fertility implied by the average parity of women in age groups 20-24 and 25-29. Since the current fertility has been obtained from the census question on births during last one year preceding the census the age of mother would be at the time of census, not at the time of birth. In otherwords, there would be a half a year displacement in age specific fertility rate. Brass had developed an adjustment for this situation. These have been made use of. In indentifying the adjustment factor, Brass' coefficients have been made use of. The values of (f_1/f_2) and the mean age of fertility schedule $(\overline{m})$ used in various states for locating the multipliers $(k_i's)$ are shown in table 18 separately for rural, urban and all areas. The table also shows P(45-49) and P(50), the average number of children ever born for females in age groups 40-45 and 50 and above respectively and the TFR and GFR as reported in census. Comparison of P(45-49) and P(50+) shows that, the average number of children ever born has been under reported in the latter age group, due to recall lapse. This trend is shared by all states except Kerala, Maharashtra and Punjab.

TABLE 18

Parameters used for estimation of fertility by Brass' techniques

India/State	Total/ Rural/ Urban	$\overline{m}$	f_1/f_2	P (45-49)	P50	P_3/F_3	TFR*	GFR*
1	2	3	4	5	6	7	8	9
INDIA	**Total**	**28.6**	**0.294**	**4.99**	**4.74**	**1.3619**	**3.6**	**112**
	Rural	**28.8**	**0 304**	**5.07**	**4.80**	**1.3197**	**3.9**	**119**
	Urban	**27.8**	**0.257**	**4.68**	**4.50**	**1.5118**	**2.8**	**91**
Andhra Pradesh	Total	27.8	0.468	4.34	4.06	1.4840	3.0	93
	Rural	27.8	0.494	4.35	4.08	2.4121	3.1	97
	Urban	27.7	0.393	4.29	3.93	2.3287	2.5	81
Bihar	Total	29.5	0.371	4.59	4.34	1.4415	3.6	110
	Rural	29.5	0.378	4.59	4.34	1.4122	3.7	112
	Urban	28.7	0.329	4.62	4.34	1.6650	3.1	97
Gujarat	Total	28.6	0.128	5.15	4.93	1.4616	3.2	103
	Rural	28.8	0.123	5.36	5.11	1.4208	3.5	119
	Urban	27.9	0.137	4.65	4.46	1.5624	2.6	87
Haryana	Total	28.4	0.248	6.21	6.08	1.2000	4.4	140
	Rural	28.6	0.249	6.46	6.36	1.1610	4.9	150
	Urban	27.5	0.238	5.26	5.06	1.3730	3.0	104
Karnataka	Total	28.0	0.335	5.07	4.67	1.6487	2.8	90
	Rural	28.1	0.346	5.11	4.66	1.5615	3.1	97
	Urban	27.6	0.298	4.97	4.71	1.8970	2.2	72
Kerala	Total	27.6	0.179	4.99	5.03	1.4670	2.4	78
	Rural	27.8	0.178	5.07	5.11	1.4697	2.5	81
	Urban	27.0	0.181	4.63	4.70	1.4585	2.0	69
Madhya Pradesh	Total	28.4	0.354	5.51	5.09	1.1806	4.5	141
	Rural	28.4	0.370	5.57	5.13	1.1514	4.8	147
	Urban	27.9	0.290	5.20	4.93	1.2973	3.7	119
Maharashtra	Total	27.3	0.287	4.95	4.96	1.2533	3.3	107
	Rural	27.4	0.303	5.15	5.12	1.1531	3.8	119
	Urban	27.1	0.241	4.49	4.53	1.4915	2.5	86
Orissa	Total	28.1	0.267	4.75	4.32	1.4449	3.3	103
	Rural	28.2	0.268	4.75	4.33	1.4302	3.8	103
	Urban	27.5	0.259	4.71	4.15	1.5549	4.2	103
Punjab	Total	29.1	0.121	5.28	5.37	1.5043	3.4	101
	Rural	29.3	0.115	5.46	5.50	1.4700	3.6	107
	Urban	28.3	0.135	4.80	4.91	1.5965	2.7	88

*TFR & GFR on the basis of 15—49 age group.

TABLE 18—*Contd.*

1	2	3	4	5	6	7	8	9
Rajasthan	Total	29.7	0.271	5.90	5.63	1.1066	5.4	166
	Rural	29.5	0.268	5.99	5.73	1.0555	5.8	177
	Urban	28.2	0.281	5.51	5.23	1.3255	3.9	126
Tamil Nadu	Total	27.4	0.227	4.18	3.90	1.3288	3.0	93
	Rural	27.6	0.236	4.10	3.83	1.3126	3.1	95
	Urban	27.1	0.209	4.36	4.06	1.3597	2.7	89
Uttar Pradesh	Total	29.8	0.284	5.28	4.99	1.3465	4.4	132
	Rural	29.9	0.293	5.32	5.05	1.3200	4.6	137
	Urban	29.2	0.250	5.02	4.69	1.4687	3.6	112
West Bengal	Total	27.9	0.387	5.11	4.58	1.4253	3.2	104
	Rural	28.1	0.388	5.40	4.73	1.3698	3.7	178
	Urban	27.1	0.377	4.27	4.14	1.6592	2.1	69

The mean age of the fertility schedule $(\overline{m})$ shows that in the states of Andhra Pradesh, Karnataka, Kerala, Maharashtra, Tamil Nadu and West Bengal the mean age of the fertility schedule lies between 27 and 28 years. In the states of Gujarat, Haryana, Madhya Pradesh and Orissa it lies between 28 and 29. In Bihar, Orissa, Punjab, Rajasthan and Uttar Pradesh the mean age lies between 28-29. It is also seen that in general $\overline{m}$ is lower in urban areas compared to rural areas.

TABLE 19

P/F ratio for various age groups India & States

Sl. No.	India/States	Rural/ Urban/ Total	Age group						
			15—19	20—24	25—29	30—34	35—39	40—44	45—49
1	2	3	4	5	6	7	8	9	10
1.	**INDIA**	**Rural**	**1.6620**	**1.3801**	**1.3197**	**1.2953**	**1.3119**	**1.3100**	**1.3187**
		Urban	**1.8557**	**1.5194**	**1.5118**	**1.5164**	**1.5922**	**1.6275**	**1.6876**
		Total	**1.6997**	**1.4090**	**1.3619**	**1.3431**	**1.3704**	**1.3750**	**1.3910**
2.	Andhra Pradesh	Rural	1.5290	1.4262	1.4167	1.3760	1.3994	1.3820	1.3964
		Urban	1.8566	1.7263	1.7056	1.6677	1.7449	2.1422	1.7465
		Total	1.5940	1.4930	1.4840	1.4420	1.4740	1.5250	1.4690
3.	Bihar	Rural	1.8047	1.5308	1.4122	1.3745	1.3461	1.2936	1.2652
		Urban	2.0033	1.7819	1.6650	1.6032	1.5628	1.5185	1.5198
		Total	1.8284	1.5599	1 4415	1.4004	1.3698	1.3173	1.2909
4.	Gujarat	Rural	2.0153	1.4924	1.4208	1.3959	1.4321	1.4753	1.5176
		Urban	2.1480	1.6563	1.5624	1.9773	1.6632	1.7253	1.7800
		Total	2.0545	1.5405	1.4646	1.4503	1.4979	1.5482	1.5940
5.	Haryana	Rural	1.4730	1.2470	1.1610	1.1630	1.2160	1.2810	1.3300
		Urban	1.3280	1.2860	1.3730	1.3950	1.4930	1.6500	1.7240
		Total	1.4550	1.2520	1.2000	1.2610	1.2650	1.3480	1.4010
6.	Karnataka	Rural	1.8441	1.5852	1.5615	1.5571	1.6067	1.6088	1.6552
		Urban	2.2069	1.8552	1.8970	1.9308	2.0980	2.1477	2.2910
		Total	1.9219	1.6500	1.6487	1.6552	1.7289	1.7400	1.8043
7.	Kerala	Rural	1.4357	1.3619	1.4697	1.5200	1.7281	1.8601	2.0176
		Urban	1.6094	1.3854	1.4585	1.6074	1.8633	2.0547	2.2613
		Total	1.4659	1.3659	1.4670	1.5346	1.7527	1.8928	2.0587
8.	Madhya Pradesh	Rural	1.3989	1.2306	1.1514	1.1461	1.1714	1.1743	1.1770
		Urban	1.5858	1.3158	1.2973	1.3045	1.3602	1.3850	1.4194
		Total	1.4320	1.2463	1.1806	1.1776	1.2068	1.2140	1.2209
9.	Maharashtra	Rural	1.3879	1.1896	1.1531	1.1588	1.2290	1.2925	1.3500
		Urban	1.7724	1.5134	1.4915	1.5009	1.6146	1.6644	1.7813
		Total	1.4766	1.2775	1.2523	1.2630	1.3460	1.4088	1.4803
10.	Orissa	Rural	1.7013	1.5292	1.4302	1.4042	1.4273	1.4143	1.4039
		Urban	1.8450	1.5420	1.5549	1.5327	1.5509	1.5639	1.5929
		Total	1.7172	1.4342	1.4449	1.4188	1.4411	1.4306	1.4251

TABLE 19—*Contd.*

1	2	3	4	5	6	7	8	9	10
11.	Punjab	Rural	2.1097	1.4928	1.4700	1.3873	1.3926	1.4287	1.5078
		Urban	2.3878	1.6523	1.5965	1.5508	1.6356	1.6734	1.8007
		Total	2.1802	1.5371	1.5043	1.4332	1.4551	1.4937	1.5823
12.	Rajasthan	Rural	1.4169	1.1321	1.0555	1.0243	1.0238	1.0259	1.0315
		Urban	1.6123	1.3581	1.3255	1.3091	1.3496	1.3781	1.4159
		Total	1.4568	1.1499	1.1066	1.9392	1.9073	0.9272	0.9418
13.	Tamil Nadu	Rural	1.5453	1.3319	1.3126	1.2967	1.3390	1.3163	1.3277
		Urban	1.5956	1.3315	1.3597	1.3948	1.5118	1.5624	1.6184
		Total	1.5615	1.3302	1.3288	1.3297	1.3931	1.3887	1.4125
14.	Uttar Pradesh	Rural	1.8101	1.4378	1.3200	1.2511	1.2300	1.1912	1.1733
		Urban	1.9054	1.5089	1.4687	1.4272	1.4194	1.4080	1.3945
		Total	1.8293	1.4516	1.3465	1.2813	1.2607	1.2252	1.2072
15.	West Bengal	Rural	1.5159	1.3983	1.3698	1.3996	1.4506	1.4738	1.4710
		Urban	1.6140	1.5914	1.6592	1.6635	1.8159	1.9394	2.0681
		Total	1.5300	1.4340	1.4253	1.4499	1.5209	1.5664	1.5869

The interpolation was guided by (f_1/f_2) for the first three age groups, and by the observed $(\overline{m})$ for the remaining age groups.

The (P/F) ratios for various age groups statewise are summarised in table 19 separately for rural and urban areas. In all the age groups the P/F ratios were above one. Compared to age group 15-19, P/F ratio in the age group 20-24 falls sharply in all the states indicating that fertility decline has occurred at younger ages also most probably due to rise in age at marriage. At the national level P/F ratios for the age groups 25-29, 35-39, 40-44, 45-49 are reasonably close, being around 1.31 in rural areas. Such a trend may be expected when fertility has been more or less constant and reference error remaining same for all ages. In urban areas the ratios are reasonably close in the age groups 20-34, but increase thereafter. This is consistant with the hypothesis that fertility has declined at older ages. The near constant but high values of the P/F ratios for the age groups 20-34, would imply that even in urban areas large reference errors may persist and the current fertility derived from census would require upward correction.

Three distinct patterns are noticed in the P/F ratios for age groups above 25-29. In Bihar and Uttar Pradesh the ratios exhibit a declining trend in all the age groups, both in rural and urban areas. The declining trend is much sharper in rural areas. In Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Punjab and West Bengal the ratios increase with age indicating that fertility has declined at older ages. But in rural areas the rates remain constant at older ages. This would imply that in urban areas fertility has declined in older ages while in rural areas, reference period errors may exist. In Andhra Pradesh, while in rural areas the ratios are more or less stable in the age groups 30-49, in urban areas they fluctuate indicating age misplacement errors in urban areas.

P/F ratios for the age groups 20-24 or 25-29 are commonly used in adjustment of the census data on birth during last one year. The choise of the factor P_2/F_2 or P_3/F_3 is not always unique.

Main limitation of the method of adjustment would that fertility estimates obtained by applying the method to populations where either marital fertility or age at marriage has been changing rapidly in the recent past may be subject to bias since it is no longer valid to assume that the 'historical' pattern of fertility implied by the reported average parities is equal to that embodied by the current fertility schedule. In otherwords, Brass technique would be an over estimate if fertility has been declining in the recent past, particularly in the age groups 20-24 or 25-29.

In the Indian context, (P_3/F_3) has been preferred (P_2/F_2). This is mainly due to the fact that while F_2 may not have been affected by changing marital fertility, it might be affected by the change in age at marriage. It is worth noting that in the age group 20-24, the proportion of married females has declined considerably during the decade 1971-81. As against this the proportion married has changed little during the period in the age group 25-29. There is also reason to believe that F_3 might not have changed much due to contraception during the period in the age group 25-29. Sterilisation has been the main method of contraception in India. In the four years, 1977, 1978, 1979 and 1980 immediately preceding the 1981 census, family planning programme had in general and sterilisation in particular progressed only slowly. This is evident by the almost constant percentage of couples effectively protected in these years. In view of these the ratio P_3/F_3 corresponding to age group 25-29 may be a better choice than P_2/F_2 for estimating the fertility levels during this period. The adjusted birth rates using P_2/F_2 and P_3/F_3 are presented in table 20.

The birth rate should refer to the one year period immediately preceding 1981 census i.e. for year 1980. The table 20 also shows adjusted birth rate, i.e., rates based on the reply to the question on births during last year. This has been termed as census birth rate.

Whatever be the correction adopted, whether P_2/F_2 or P_3/F_3, the corrected crude birth rates are close in Andhra Pradesh, Karnataka, Orissa, Tamil Nadu and West Bengal with difference ranging within 0.5 points. The difference is between 0.5 and 1.0 points in Maharashtra and Punjab. In six states of Bihar, Gujarat,

Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh estimates by P_3/F_2 are higher than that by P_3/F_3. In Kerala alone estimate by P^3/F^3 is higher than that of P_3/F_3. This is one of the states where due to rapid increase in age at marriage and other contraceptive practices fertility has declined in the age group 20-29, resulting in non applicability of P/F method.

Rajasthan is one state where the data based on births during last year seem to be highly useful; particularly in rural areas. The three year moving average for 1979-81 based on SRS is 38.0, while the rate based on births during last one year canvassed in census is 38.21. In Haryana urban areas the reported birth rate of 34.42 is distinctly higher than that of SRS based birth rate of 31.4 for the year 1980. In Tamil Nadu (urban) the unadjusted birth rate is close to SRS.

TABLE 20

Crude birth rate for 1980 derived by]Brass Technique

Sl. No.	India/State	T R U	Census Birth Rate@	Adjusted Birth Rate P_3/F_2	Adjusted Birth Rate P_3/F_3	SRS Birth Rate 79-81 average
1	2	3	4	5	6	7
1.	**INDIA**	**T**	**26.09**	**36.76**	**35.53**	**33.8**
		R	**27.38**	**37.79**	**36.13**	**35.3**
		U	**21.92**	**33.31**	**33.14**	**27.5**
2.	Andhra Pradesh	T	22.48	33.57	33.36	31·6
		R	23.15	33.02	32.80	32.5
		U	20.30	35.04	34.65	27.9
3.	Bihar	T	25.12	39.18	36.21	38.4
		R	25.66	39.28	36.24	39.3
		U	21.34	38.03	35.53	32.8
4.	Gujarat	T	24.77	38.16	36.16	35.1
		R	26.08	38.92	37.03	26.4
		U	21.89	36.26	34.15	31.1
5.	Haryana	T	34.83	43.61	41.80	36.8
		R	34.94	43.57	40.57	38.0
		U	34.42	44.26	47.26	30.3
6.	Karnataka	T	21.02	34.68	34.66	28.0
		R	22.42	35.54	35.00	29.0
		U	17.56	32.58	33.31	25.3
7.	Kerala	T	20.68	28.33	30.40	26.0
		R	21.17	28.79	31.12	26.4
		U	18.60	25.85	27.16	24.3
8.	Madhya Pradesh	T	31.74	39.55	37.47	37.5
		R	32.70	40.24	37.65	38.6
		U	27.95	36.78	36.26	31.6
9.	Maharashtra	T	25.19	32.18	31.55	28.3
		R	27.78	33.05	32.03	29.8
		U	20.40	30.87	30.43	25.0
10.	Orissa	T	24.14	34.62	34.88	31.9
		R	24.38	37.28	34.87	32.1
		U	22.33	34.43	34.72	29.6
11.	Punjab	T	24.06	36.98	36.09	29.6
		R	24.70	36.87	36.31	30.0
		U	21.87	36.14	34.99	28.3
12.	Rajasthan	T	36.12	41.53	39.97	37.1
		R	38.21	43.26	40.33	38.0
		U	28.21	38.31	37.39	32.6
13.	Tamil Nadu	T	23.85	31.73	31.69	28.3
		R	24.17	32.19	31.73	29.6
		U	23.21	30.90	31.56	25.2
14.	Uttar Pradesh	T	28.89	41.94	38.90	39.5
		R	29.77	42.80	39.30	40.6
		U	24.84	37.48	36.47	32.2
15.	West Bengal	T	25.00	35.85	35.63	32.5
		R	27.00	37.75	36.99	36.3
		U	17.00	27.05	28.21	19.9

@Based on births during last one year canvassed in census.

Table 21 shows age specific fertility rates adjusted by P_3/F_3 and the relevant TFR's. Despite substantial inflation of current fertility in most of the states and union territories, the TFR's which relate to the year 1980 shows a decline when compared with the corresponding figures of average number of children ever born in the age group 45-49, reported in census. The decline is more in urban areas. Only in Bihar, Madhya Pradesh (urban), Rajasthan and Uttar Pradesh the adjusted TFR is higher than the average number of children ever born reported in the age-group 45-49 in census.

TABLE 21

Age specific fertility rates adjusted by (P_3/F_3) India and States

India/States	Total Rural Urban	Age specific fertility rates (A.S.F.R.) adjusted							
		15—19	20—24	25—29	30—34	35—39	40—44	45—49	Adjusted TFR
1	2	3	4	5	6	7	8	9	10
INDIA	**Total**	**0.075**	**0.255**	**0.253**	**0.187**	**0.120**	**0.063**	**0.029**	**4.9**
	Rural	**0.079**	**0.261**	**0.257**	**0.195**	**0.128**	**0.069**	**0.030**	**5 1**
	Urban	**0.062**	**0.240**	**0.243**	**0.154**	**0.086**	**0.038**	**0.017**	**4.2**
Andhra Pradesh	*Total*	*0.113*	*0.240*	*0.205*	*0.144*	*0.093*	*0.052*	*0.030*	4.4
	Rural	0.119	0.240	0.202	0.145	0.096	0.054	0.030	4.4
	Urban	0.096	0.242	0.212	0.137	0.082	0.046	0.027	4.2
Bihar	Total	0.086	0.232	0.242	0.202	0.143	0.084	0.042	5.1
	Rural	0.086	0.229	0.239	0.202	0.145	0.084	0.044	5.1
	Urban	0.082	0.246	0.268	0.200	0.127	0.067	0.027	5.1
Gujarat	Total	0.034	0.269	0.278	0.187	0.104	0.051	0.025	4.7
	Rural	0.034	0.280	0.293	0.199	0.117	0.058	0.027	5.0
	Urban	0.034	0.250	0.253	0.158	0.075	0.031	0.017	4.1
Haryana	Total	0.071	0.280	0.301	0.202	0.120	0.059	0.026	5.3
	Rural	0.074	0.293	0.311	0.216	0.135	0.067	0.030	5.7
	Urban	*0.059*	*0.249*	*0.275*	*0.148*	*0.070*	*0.026*	*0.012*	4.2
Karnataka	Total	0.085	0.256	0.244	0.168	0.104	0.050	0.021	4.6
	Rural	0.092	0.265	0.248	0.173	0.112	0.053	0.023	4.8
	Urban	0.070	0.239	0.233	0.152	0.080	0.036	0.013	4.1
Kerala	Total	0.038	0.217	0.222	0.128	0.073	0.026	0.009	3.5
	Rural	0.040	0.222	0.228	0.134	0.078	0.029	0.009	3.7
	Urban	0.035	0.194	0.197	0.102	0.051	0.013	0.003	3.0
Madhya Pradesh	*Total*	*0.099*	*0.280*	*0.269*	*0.196*	*0.128*	*0.067*	*0.028*	5.3
	Rural	0.105	0.283	0.268	0.203	0.134	0.071	0.030	5.5
	Urban	0.078	0.270	0.269	0.169	0.099	0.049	0.195	5.6
Maharashtra	Total	0.074	0.257	0.233	0.147	0.080	0.035	0.013	4.2
	Rural	0.081	0.269	0.240	0.156	0.085	0.038	0.014	4.4
	Urban	0.058	0.240	0.228	0.127	0.067	0.024	0.007	3.8
Orissa	Total	0.075	0.280	0.251	0.176	0.110	0.053	0.022	4.8
	Rural	0.074	0.279	0.250	0.203	0.112	0.054	0.013	5.0
	Urban	0.075	0.286	0.253	0.162	0.093	0.039	0.014	4.6
Punjab	Total	0.029	0.241	0.316	0.221	0.120	0.056	0.026	4.8
	Rural	0.029	0.250	0.329	0.237	0.132	0.063	0.029	5.3
	Urban	*0.030*	*0.224*	*0.289*	*0.174*	*0.089*	*0.034*	*0.014*	4.3
Rajasthan	Total	0.077	0.284	0.302	0.242	0.166	0.091	0.040	6.0
	Rural	0.077	0.285	0.306	0.250	0.175	0.898	0.042	6.2
	Urban	0.080	0.282	0 281	0.197	0.115	0.053	0.027	5.2
Tamil Nadu	Total	0.054	0.242	0.230	0.144	0.080	0.028	0.008	4.0
	Rural	0.058	0.244	0.235	0.148	0.087	0.030	0.009	4.1
	Urban	0.050	0.239	0.220	0.132	0.065	0.020	0.007	3.7
Uttar Pradesh	*Total*	*0.075*	*0.264*	*0.285*	*0.265*	*0.172*	*0.100*	*0.048*	5.9
	Rural	0.078	0.267	0.286	0.246	0.178	0.104	0.050	6.0
	Urban	0.063	0.256	0.283	0.213	0.141	0.073	0.034	5.3
West Bengal	Total	0.095	0.247	0.238	0.162	0.105	0.050	0.021	4.6
	Rural	0.105	0.270	0.247	0.184	0.121	0.059	0.026	5.1
	Urban	0.071	0.289	0.222	0.108	0.063	0.025	0.010	3.7

TABLE 22

Estimated birth rate and death rate during 1971-81 by different methods– India and States

India/States	Population@ (in 000)	Exponential growth rate	SRS		Census Birth Rate				Death Rate			
			Birth Rate£	Death rate	Growth rate	Brass child mortality rate	SRS child mortality rate	Census differencing	Rele's method	Census differencing	Reverse survival	Rele's
1	2	3	4	5	6	7	8	9	10	11	12	13
INDIA*	**665289**		**34.49**	**14.68**	**19.81**	**35.81**	**37.2**	**37.1**	**36.8**	**14.85**	**15.0**	**14.6**
Andhra Pradesh	53550 (7.81)	2.10 2.13	33.44	14.37	19.07	33.98	35.11	35.0	34.8	13.71	13.81	13.5
Bihar	69915 (10.21)	2.17 2.21	32.23	14.40	17.83	38.15	40.87	41.4	41.1	19.33	18.77	19.0
Gujarat	34086 (4.97)	2.46 2.40	37.10	14.34	22.76	34.19	37.54	35.0	36.5	11.02	13.54	12.5
Haryana	12923 (1.88)	2.55 2.55	37.77	12.03	25.74	36.88	37.72	37.6	37.6	12.11	12.22	12.1
Karnataka	37136 (5.42)	2.39 2.37	28.84	11.40	17.44	35.64	35.27	33.8	36.0	10.10	11.57	12.3
Kerala	25454 (3.71)	1.77 1.83	27.77	7.92	19.85	27.55	27.45	26.8	29.3	8.51	9.15	11.0
Madhya Pradesh	52179 (7.62)	2.27 2.30	38.29	16.55	21.74	39.34	39.82	41.9	38.7	18.87	16.82	15.7
Maharashtra	62784 (9.17)	2.21 2.07	29.08	11.64	17.44	33.35	32.69	33.4	32.8	12.71	11.99	12.1
Orissa	26370 (3.84)	1.85 1.77	33.13	16.28	16.85	36.22	36.54	36.7	37.2	18.99	18.84	19.5
Punjab	16789 (2.44)	2.16 2.15	31.66	10.81	20.85	31.69	32.31	31.5	32.6	9.95	10.81	11.1
Rajasthan	34262 (4.99)	2.87 2.87	37.20	15.00	22.20	42.32	43.56	39.5	41.2	10.80	14.86	12.5
Tamil Nadu	48408 (7.06)	1.63 1.64	29.98	13.69	16.29	28.81	29.50	30.5	30.3	14.08	13.10	13.9
Uttar Pradesh	110862 (16.21)	2.29 2.40	41.46	20.00	21.46	41.63	45.04	44.8	42.2	20.06	21.04	18.2
West Bengal	54581 (7.97)	2.10 2.00	..	..	..	33.20	34.48	35.6	31.6	15.57	14.48	11.6

*Excluding Assam.

@Figures in bracket refer to the percentage of states population to total population of India (including projected population of Assam).

£The first figure denotes exponential growth rate worked out from census. The second figure is exponential growth rate adjusted for inter-decadal migration based on place of birth.

CHAPTER 5

SUMMARY

Estimates of birth and death rates for the decade 1971-81

Table 22 presents the estimates of birth rate and death rate by different methods for India and each of the 14 major states. At the national level estimates of birth rate cluster around 37 with reverse survival method using SRS child mortality rates of giving an estimate of 37.2. As pointed out earlier, the reverse survival method uses most of the available information. In the following paragraphs, the estimates by this method are compared with other estimates statewise. In the discussion reverse survival method stands for estimates derived by using SRS child mortality rates.

Andhra Pradesh: The estimates by reverse survival, census differencing and Rele's methods are around 35; as against 33.98 indicated by SRS. The death rates by all the three methods are also close, the estimate based on reverse survival method being 13.81.

Bihar: Birth rates by reverse survival, census differencing and by Rele's methods are all close to 41/1000 for the decade. The corresponding death rates are also close to 19/1000 for the decade to all the methods.

Gujarat: Birth rate of 37.54 by reverse survival method is distinctly higher than by census differencing methods or Rele's method, but only slightly higher than the rate of 37.10 indicated by SRS. The death rate of 13.54 by reverse survival method is the closest to the SRS death rate of 14.3, though it is still lower than that of SRS.

Haryana: The birth rate of 37.72 by reverse survival method is close to the SRS birth rate as also to the estimates by census differencing method and Rele's method. The estimates of death rate also agree closely with that of SRS.

Karnataka: Estimates of birth rate by reverse survival (both Brass and SRS child mortality) and Rele's method are distinctly higher than that of SRS. This is one of the few states where there is a close agreement between B.R. based on Brass child mortality estimates and SRS child mortality estimates, reinforcing the confidence in the estimates. The death rate of derived from reverse survival birth rate is close to SRS death rate.

Kerala: This is another state wherein both the birth rates by reverse survival method are closer. The estimated birth rate is also close to SRS birth rate. The crude death rate derived by reverse survival birth rate is higher than that of SRS. One of the reasons may be that the adjusted growth rate of 1.83 per cent per annum does not take into account the outmigration from Kerala to other countries during the decade. If this is taken into account the growth rate may be higher and death rate correspondingly lower.

Madhya Pradesh: Estimates of birth rates using reverse survival methods (both Brass and SRS child mortality) are close and higher than that of SRS. The estimates of death rate derived from this birth rate is close to the SRS death rate.

Maharashtra: All the estimates based on census age data indicated a birth rate in the range of 32.7 to 33.4; with reverse survival method using SRS child mortality giving an estimate of 32.7. In this state child mortality estimates based on Brass techniques are higher than those of SRS. As a consequence the birth rate by reverse survival method using Brass technique is higher than that using SRS. The corresponding death rate of 12.0 is close to SRS death rate of 11.6.

Orissa: Estimates of birth based on reverse survival method and census differencing method are close. In this state also Brass child mortality estimates and SRS child mortality estimates are closer. The derived birth rates, death rates are distinctly higher than those recorded by SRS.

Punjab: There is reasonable consistency among estimates of birth rate and death rate by all the methods as well as SRS estimates.

Rajasthan: This is one of the states wherein the birth rates based on census based methods are distinctly higher than that of SRS. The death rate of 14.86 based on reverse survival method is close to SRS death rate of 15.0.

Uttar Pradesh: This is another state like Rajasthan wherein birth rate of 45.0 based on reverse survival method is much higher than the SRS estimates of 41.5. The death rate based on reverse survival method is 21.0 against 20.0 based on SRS.

West Bengal: Birth rate of 34.48 and death rate of 14.48 based on reverse survival method seem reasonable when compared with estimates based on Brass method, and census differencing method. Rele's method however gives a much lower birth rate. This may probably be due to the fact that the state has during the last decade experienced considerable migration which might have affected the age structure. Death rate of 14.48 by reverse survival method is closer to the all India average death rate.

Comparison with 1961-71 decade

Estimates of birth rate (and death rate) by reverse survival method have been used for official purposes during 1961-71 decade also. The table 23 shows the birth rate, death rate and their difference for each state during the decades 1961-71 and 1971-81. In the earlier decade the child mortality estimates for reverse survival method were based on zonal life tables.

TABLE 23

Birth rate by reverse survival method, death rate and growth rate 1961-71 and 1971-81

India/States	Year	B.R.		D.R.		G.R.†	
		M	X	M	X	M	X
INDIA*	**1961-71**	**41.2**		**19.2**		**22.0**	
	1971-81		**37.2**		**15.0**		**22.2**
Andhra Pradesh	1961-71	39.2		20.4		18.8	
	1971-81		35.1		13.8		21.3
Bihar	1961-71	41.9		23.3		18.6	
	1971-81		40.9		18.8		22.1
Gujarat	1961-71	41.6		16.8		24.8	
	1971-81		37.5		13.5		24.0
Haryana	1961-71	44.5		16.8		27.7	
	1971-81		37.7		12.2		25.5
Karnataka	1961-71	39.9		17.6		22.3	
	1971-81		35.3		11.6		23.7
Kerala	1961-71	37.5		13.7		23.8	
	1971-81		27.5		9.2		18.3
Madhya Pradesh	1961-71	46.6		21.5		25.1	
	1971-81		39.8		16.8		23.0
Maharashtra	1961-71	41.0		16.9		24.1	
	1971-81		32.7		12.0		20.7
Orissa	1961-71	41.3		20.5		20.8	
	1971-81		36.5		18.8		17.7
Punjab	1961-71	36.9		17.4		19.5	
	1971-81		32.3		10.8		21.5
Rajasthan	1961-71	42.7		18.7		24.0	
	1971-81		43.6		14.9		28.7
Tamil Nadu	1961-71	36.8		16.3		20.0	
	1971-81		29.5		13.0		16.4
Uttar Pradesh	1961-71	42.5		24.2		18.3	
	1971-81		45.0		21.0		24.0
West Bengal	1961-71	44.3		18.5		25.8	
	1971-81		34.5		14.5		20.0

*Annual exponential growth rate is adjusted for migration (based on place of birth).

†Figures for 1971—81 have been calculated excluding Assam.

As is well known, the mortality rates at younger ages in the life tables are generally deficient. It was pointed out in the life table report relating to 1961-71 that if the states within the zone differ drastically in mortality conditions the birth and death rates may be biased. On the contrary during the decade 1971-81, estimates of child mortality based on observed data are available based on SRS. Independent checks have also been made on this child mortality estimates. The comparison of the estimates for the two decades is made subject to this limitation.

A comparison of the decade 1971-81 with that of 1961-71 indicates that barring U.P. and Rajasthan in all other states the crude birth rates during 1971-81 have declined. In Bihar the decline is marginal. In A.P., Gujarat, Karnataka, Orissa and Punjab the decline in crude birth rate is of the order of 4-5 points. In M.P. and Haryana it is of the order of 6-7 points. In Tamil Nadu, Maharashtra, West Bengal and Kerala the decline is more than 7 points. Even in the states of U.P., Rajasthan and Bihar the crude birth rate during 1976-81 is distinctly lower than that during 1971-76. The quantum of decline is also larger in these states indicating that even though decline in these states have started later, they have gained momentum.

Crude death rate has declined in every state without exception. The slowest decline of 1.7 points in the absolute value of crude death rate is in Orissa. In Gujarat, Tamil Nadu, Rajasthan and U.P. the decline is of the order of 3 to 4 points while in the states of Bihar, M.P., West Bengal, Maharashtra, Haryana and Kerala the decline is of the order of 4 to 5 points. A.P., Karnataka and Punjab have experienced the largest decline in crude death rate in the range of 6-7 points.

It is seen from the table 23 that growth rate during the decade 1971-81 has increased compared to the previous decade in the six states of A.P., Bihar, Karnataka, Punjab, Rajasthan and U.P. Of these states in Rajasthan and U.P., the decadal average birth rate has increased while in Bihar it has reduced slightly. In all other states the birth rate has declined during the decade. Thus the major reason for the growth rate change seems to be declining mortality. In many states, the decline in birth rate has compensated for the decline in death rate leading to a reduction in growth rate. In the states of Bihar, M.P., Orissa and U.P. the average death rates are 15/1000. In these states, therefore, there may be large reduction in crude death rate in future and consequent increase in growth rate unless checked.

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ERRATA

TO

PAPER I OF 1985: ESTIMATES OF VITAL RATES FOR THE DECADE 1971-81

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1	2	Para 4, line 1,	Infant	Child
1	2	Para 4, line 4	Feeney's	Grale & Trussels
5	1	Para 2, line 9	values	valves values lie above this valve
5	1	Para 2, line 8	$P^{18} \div P^{71}$ $10+ \quad 0+$	$P^{81} \div P^{11}$ $10+ \quad 0+$
6-7	..	Table 6, West Bengal female ratio, col. 8,	1.0006	1.0066
6-7	..	Table, 6, West Bengal female ratio, col. 9	0.9892	0.9992
6-7	..	Table 6, Uttar Pradesh, female ratio, col. 13	140.13	1·0413
8	1	Para 1, line 6	e_x/e^s_x	e^L_x/e^s_x
8	..	Table 7, heading	$e(^L_n/e^s_n$	$(e^L_x/e^s_x$
9	..	Table 8, heading	$(e^L_n/^s_n...)$	$(e^L_n/e^s_n...)$
10	1	sub-para b, line 5	be	may be
11	..	Table 11, Haryana, Preston & Bennetts Method-F	57.3	57.8
11	..	Table 11, Karnataka, SRS 1971-80 F	56.3	56.8
12	1	Bihar, line 4,	female $\overset{o}{e}...$	female $\overset{o}{e}$ is....
14	1	Para 3, line 5	p(2)....P(5)	q(2)....q(5)
14	..	Fort note 4, line 1	Alberto Public	Alberto Palloni
16-17	..	Table 12, India, Y.P.C. Col. 6	(2.03)	(2.3)
16-17	..	Table 12, Bihar, Sullivan's, col. 8	112.3	112.6
20	1	Para 4, line 1,	SRS system	SRS
22	..	Table 18, Orissa, Rural, Col. 8	3.8	3.4
22	..	Table 18, Orissa Urban Col. 8	4.2	2.9
23	..	Table 19, Andhra Pradesh Urban, col. 6	1.7036	1.7066
23	..	Table 19, Gujarat, Total, col. 6	1.4646	1.4616
25	..	Table 20, Haryana, Col. 4	T 34.83	30.27
			R 34.94	31.98
			U 34.42	24.14
25	..	Table 20, Haryana, col. 5	T 43.61	37.90
			R 43.57	39.88
			U 44.26	31.05
25	..	Table 20, Haryana, col. 6	T 41.80	36.32
			R 40.57	37.13
			U 47.26	33.15
25	2	Para 1, delete sentence "In Haryana urban areas.....for the year 1980"		
26	..	Table 21, Madhya Pradesh Urban, col. 9	0.195	0.196
27	..	Table 22, Madhya Pradesh, line 1, col. 7	39.34	39.24
29	..	Table 23, Tamil Nadu, 1961-71, D.R./M	16.3	16.8