

A Current Life Table for India 1968-69

Introduction

For countries like India where registration statistics are known to be defective, there are very few options open to demographers for estimating levels of mortality. Where censuses are taken at regular five-year or ten-year intervals, resort can be made to certain indirect methods for deriving estimates of mortality during the intercensal period. This approach has been used by the Indian census actuaries since the 1881 census.¹ But this method is less reliable and is unsatisfactory.

A second approach, which has been developed more recently, depends on the use of model life tables and stable population.² This procedure requires knowledge (or an informed guess) of at least two population parameters, the most commonly used being the age distribution of population from a census or survey and the rate of growth of population per annum. The limitation of the second approach is that it is not applicable*in situations where there is a violation of the underlying assumptions, or where the quality of data is poor.

A third possible approach relies on household sample surveys for obtaining basic vital rates including the age-sex specific mortality rates. In India, the National Sample Survey (NSS), established in 1950-1951 for collecting socio-economic and demographic data on an annual basis, provided data on vital rates until the 24th round (1968-1969), when the collection of data on vital rates was discontinued because of recall lapse and other non-sampling errors (especially, the "boundary bias") resulting in the underestimation of vital rates. These limitations are not peculiar to NSS, but are inherent in large scale sample surveys almost everywhere. One can rely on the systematic nature of errors in the data itself to provide the correction factors to improve them.³ An example of this is the Brass technique of estimating childhood mortality from the proportion of children surviving from among those that were ever born*.

Another method developed by R.K. Som makes use of the relationship between the recall period and the extent of omissions in the reporting of vital events⁵. This approach can be utilized for estimating current mortality levels if such retrospective sample surveys are carried out for sufficiently large samples every year. For developing countries with limited resources, such annual surveys may be a luxury they can ill afford.

In recent years, a fourth approach, known variously as the Population Growth Estimation (PGE) or Dual-Record Systems (DRS), has been utilised in several countries for measuring

current population changes and their components. This scheme consists of four essential steps, namely, (i) collection of information on vital events through two independent sources, (ii) matching of the records of the two sources to determine which events are reported by one or the other or both sources, (iii) the estimation of the number of events omitted by both sources, and (iv) derivation of the corrected vital rates.

In India, the Sample Registration System (SRS) which incorporates all the above features was experimented on a pilot basis in 1964-1966 and has since been extended to all States of India and most of the Union Territories.⁶ The sample for rural areas usually consists of 150 units in a State, the units being either the whole village, or a segment of the village if it has a population of 2000 or more. In case of urban areas, the sample varies from 60 to 100 urban blocks.

The results obtained from SRS have been encouraging.⁷ Not only are the estimates of vital rates obtained through SRS higher than those from the statutory registration and National Sample Survey which are known to be underestimates but they are also consistent with the estimates obtained through other methods of estimation.

Data and Methodology

The data used in the preparation of current life tables illustrated here are the estimated central death rates (${}_nM_a$) from SRS for rural India for 1968 and 1969 and for urban India for 1969.⁸ The estimates for urban India are derived from data for six States only, and it is assumed that these rates are representative of urban India as a whole.⁹ To eliminate year to year fluctuations in the estimated rates, and to combine the rates for rural and urban India, an appropriate set of weights derived from the 1971 census data was utilized.¹⁰ The sex-age specific death rates for all India and for rural and urban areas are shown in Table 1.

It is well known that age reporting is far from perfect in India, and, therefore, in order that the age specific death rates are reasonably correct the inaccuracies in the reporting of the age of the deceased (numerator) and of the general population (denominator) should cancel each other. A comparison of the age specific death rates for India and those for Sri Lanka suggests that the steep change in the rates for males in the age groups 10-14, 15-19 and 20-24 and for females in the age groups 30-34, 35-39 and 40-44 call for some graduation. Also it seems that greater undulations in the female rates may be due to a greater distortion of the ages of females.

One approach to the graduation of these rates is to draw upon the international experience as embodied in the model life tables to get a reasonable picture of mortality implied by these rates.¹¹ This is effected by comparing the $1000 {}_n m_x$ values for each sex and age group with the corresponding values of the series of model life tables and recording the mortality level to which each ${}_n m_x$ value corresponds most closely. If both the numerator (number of deaths) and the denominator (mid-year population) are accurate the mortality levels indicated by the ${}_n m_x$ values for successive age groups and for the two sexes should not, as a rule, vary widely or abruptly. If wide or abrupt variations are found, errors in the sex-age distribution of the estimated population or in the estimated deaths are to be suspected, unless the variations can be explained by the peculiarities of the factors of mortality in the country. In Table 2 the mortality levels from the Coale-Demeny models corresponding to the recorded sex-age specific death rates are

presented. This shows that the mortality levels obtained directly from the data are fairly smooth with the exception of a few age groups, namely 15-19 (and to a smaller extent 50-59) for males

and 38-39 (and to a smaller extent 10-14 and 20-25) for females. Also a steep rise in the levels of mortality for the terminal age group (60+) for either sex suggests that there is a greater overstatement of age in the death returns than in the estimated population and consequently the death rate of old persons tends to be exaggerated. This is also reflected in the relatively lower levels recorded for the previous (50-59) age group. This hypothesis has been used in substituting apparently more consistent levels for these two age groups, while accepting those which were calculated by the method of moving averages for the age range 5-49 years. The sequence of mortality levels thus obtained for different age groups and for the two sexes show no obvious signs of inconsistency, and on the basis of this test, they are accepted as valid¹² for the present purpose of illustration.

Derivation of Life Table Functions .

The life table death rates ($1000 \ nq_x$) were obtained by interpolation from the appropriate Coale-Demeny West models. Assuming a radix of 100,000 births the survivors^(^) to exact age x were calculated. The person-years lived in the successive age groups (${}_nL_x$) and the expectations of life at each age x (Q_x) were calculated by the use of the following formulae.

$$\begin{aligned}
 {}_2L_0 &= 0.33 I_0 + 0.67 I_1 \text{ for males} \\
 {}_1L_0 &= 0.35 I_0 + 0.65 I_1 \text{ for females} \\
 {}_4L_1 &= 1.352 I_1 + 2.648 I_5 \text{ for males} \\
 {}_4L_1 &= 1.361 I_1 + 2.639 I_5 \text{ for females} \\
 e_{80}^0 &= 3.725 + 0.0000625 I_{80} \\
 T_{80} &= e_{80}^0 I_{80} \\
 T_w &= \sum_x L_x + T_{80}
 \end{aligned}$$

The results of these computations yield the life tables for males and females shown in Tables 3 and 4.

Discussion of Results

The results now obtained may be compared with the estimates made earlier by one of the authors of this paper for the year 1965-66 from an evaluation of the statutory death registration statistics for India. " Despite the differences in the methods employed, the following figures about the levels of expectancy of life at birth and at age 5 seem to be consistent among themselves :

Measure of mortality	Present estimate based on SRS data 1968-1969	Previous estimate based on evaluation of registration 1965-1966
Expectancy of life at birth		
Males	50.4	47.6
Females	49.9	46.8
Expectancy of life at age 5		
Males	57.8	54.0
Females	57.4	53.9

It appears that mortality in India has been at very high levels despite the expansion of medical and health services that has taken place in India during the last two decades. The estimated expectancies of life at birth in India has been lower than those for Sri Lanka (61.9 for males and 61.4 for females in 1962) or for Taiwan (61.13 for males and 65.6 for females in 1960). It is apparent that the high mortality in India is a reflection of the high level of infant and early childhood mortality, and a relatively high level of mortality of females in the reproductive age groups. The high female mortality in the reproductive age groups is not peculiar to India, but appears to be a pattern in the whole of South Asia, and reflects the high maternal mortality rates prevalent in this region.¹⁵

In fact, this factor may account for the unusual sex differential in the expectancies of life at birth observed in the past, which is contrary to international experience suggesting a greater longevity for females. It seems that as a result of the social progress in the country, females are slowly catching up with males in longevity, and probably within a few years, march ahead of them.

Scope for Improvement

Since the object of the present paper is to illustrate the kind of approach that may be followed for developing current life tables for India based on SRS data, it will be in order to mention how the illustrative life tables presented here could be improved upon. There are two lines on which such improvements can be attempted. First, by making the sub-national estimates of sex-age specific death rates available from the SRS data, it would be possible to make comparisons among them. Rates for some areas that are far "out of line" with others may become apparent. A rate that is out of line with others is, of course, not necessarily wrong, but if it cannot be explained by real factors operative in the given area, it may be deemed to be inconsistent with the rest of the data and such values can be weeded out and replaced by more appropriate values. The substituted values have of course to be evaluated before a decision is taken regarding their credibility and reasonableness. In evaluating mortality curves one may apply a general rule that the death rates in rural areas tend to be higher than in the more urbanized areas.¹⁶ A weak element in the Indian life tables is assumption regarding infant and early childhood mortality rates. Depending on the assumption the investigator makes regarding them, the expectancy of life at birth is drastically changed. There is need for special studies to determine the levels of infant and early childhood mortality.

The errors in the reported specific rates may arise from errors in the recorded deaths as well as the errors in the population estimates used in the denominator for calculation of these rates. Therefore a second, perhaps a better line of approach, is to evaluate these two elements separately. This is possible only if the Registrar General of India publishes the percentage distribution of deaths and of the estimated population by age as recorded in the SRS, and also such crucial indices as the sex ratio (males per 100 females) of births, deaths and population by age. A comparison of the age proportions of deaths and population for the two sexes will provide valuable clues about possible misreporting of deaths and population in particular age sex groups. Besides, the age distribution of deaths and population will enable alternative evaluations of the levels of mortality, independent of the one provided by an examination of the age sex specific death rates.¹⁷

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As regards the techniques of life table construction in this paper, the ${}_n m_x$ values were converted into ${}_n q_x$ by using the Coale-Demeny model life tables. Instead, other methods, namely by Reed-Merrell or Grevelle¹⁵ can be utilised to calculate life tables for India.

Table 1: Age-Sex Specific Death Rates, India, 1968-1969

Age Group	MALES		FEMALES				
	Rural 1968 1969	Urban 1969	All-India* 1968- 1969	Rural 1968 1969	Urban 1969	All India* 1968-1969	
00-04	59.12 58.32	43.16	55.61	66.82 70.16	47.06	64.20	
05-09	5.55 5.79	3.67	5.26	6.26 7.71	5.45	6.68	
10-14	2.26 2.99	1.85	2.47	2.60 2.72	1.56	2.44f	
15-19	1.99 2.09	1.58	1.95f	3.34 4.22	2.82	3.59	
20-24	2.65 3.88	1.70	2.95	5.09 5.54	5.89	5.43	
25-29	3.19 3.73	2.82	3.33	6.92 5.50	3.20	5.61	
30-34	3.76 4.07	2.69	3.67	5.98 6.35	5.11	5.95	
35-39	6.23 6.54	2.44	5.60	6.09 6.05	4.35	5.73f	
40-44	7.67 8.52	7.58	7.99	7.92 7.60	5.59	7.33	
45-49	12.68 13.17	11.53	12.65	9.18 9.36	8.03	9.02	
50-59	18.99 22.36	17.80	20.10	15.35 17.76	12.16	15.68	
60+	65.08 71.21	63.49	67.21	60.54 66.48	56.76	62.16	

Source: Sample Registration Scheme, India.

* Estimated by weighted average of 1968 rural, 1969 rural and 1969 urban rates, the weights being 0.4, 0.4 and 0.2 respectively.

t This figure is low and hence the average of the rates for two adjoining age groups substituted.

Table 2: Estimates and Smoothed Levels of mortality, India, 1968-1969

Age Group	ESTIMATES LEVELS		SMOOTHED LEVELS	
	Males	Females	Males	Females
00-04	11.95	9.75	13	12
05-09	11.09	9.28	13	12
10-14	14.61	14.98*	15	13
15-19	19.26*	14.86	17	14
20-24	18.89	13.75	18	14
25-29	18.48	14.53	18	14
30-34	18.46	14.98	18	14
35-39	17.32	16.27*	17	14
40-44	16.64	15.55	17	14
45-49	14.82	15.42	15	15
50-59	15.13	14.44	15	15
60+	17.97	16.83	15.	16

Source : Derived by interpolation from the Coale-Demeny West Models

* The level is high because of the low death rate recorded for this age group. When the death rate is corrected as indicated in footnote to Table 1. a smoother progression of levels is obtained.

Table 3: Abridged Life Table for India, 1968-1969. MALES

Age group	1000 qx	Mx	Ix	<i>nLx</i>	Tx	ex
0	139.42	153.79	100000	90658.5	5038698.8	50.4
01-04	70.84	18.58	86058	328086.3	4948041.3	57.5
05-09	20.59	4.16	79961	395690.0	4619954.0	57.8
10-14	11.68	2.35	78315	389287.5	4224264.0	53.9
15-19	13.78	2.78	77400	384332.5	3834976.5	49.5
20-24	16.87	3.40	76333	378445.0	3450644.0	45.2
25-29	17.90	3.61	75045	371867.5	3072199.0	40.9
30-34	20.34	4.11	73702	364762.5	2700331.5	36.6
35-39	28.90	5.87	72203	355797.5	2335569.0	32.3
40-44	37.47	7.64	70116	344012.5	1979771.5	28.2
45-49	60.38	12.45	67489	327257.5	1635759.0	24.2
50-54	82.22	17.15	63414	304035.0	1308501.5	20.6
55-59	111.97	21.49	58200	276162.5	1004466.5	17.3
60-64	159.47	34.66	52265	240487.5	728304.0	13.9
65-69	223.76	50.39	43930	195075.0	487816.5	11.1
70-74	316.95	75.33	34100	143480.0	292741.5	8.6
75-79	444.04	114.16	23292	90602.5	149261.5	6.4
80+	1000.00	220.75	12949	58659.0	58659.0	4.5

Table 4: Abridged Life Table for India 1968-1969. FEMALES

Age group	$1000q_x$	M_x	l_x	${}_nL_x$	T_x	e_x
0	131.71	144.04	100000	91439.2	4993605.1	49.9
01-04	82.64	21.85	86829	328380.9	4902165.9	56.5
05-09	24.17	4.89	79654	393457.5	4573785.0	57.4
10-14	16.59	3.34	77729	385422.5	4180327.5	53.8
15-19	20.12	4.06	76440	378355.0	3794905.0	49.7
20-24	26.12	5.29	74902	369620.0	3416550.0	45.6
25-29	29.66	6.02	72946	359320.0	3046930.0	41.8
30-34	33.47	6.81	70782	347987.5	2687610.0	38.0
35-39	37.56	7.66	68413	335640.0	2339622.5	34.2
40-44	42.32	8.65	65843	322250.0	2003982.5	30.4
45-49	45.75	9.36	63057	308072.5	1681732.5	26.7
50-54	61.90	12.78	60172	291547.5	1373660.0	22.8
55-59	83.96	17.53	56447	270387.5	1082112.5	19.2
60-64	116.99	24.85	51708	243417.5	811725.0	15.7
65-69	172.15	37.67	45659	208645.0	568307.5	12.5
70-74	261.33	63.89	37799	164300.0	359662.5	9.5
75-79	383.99	95.04	27921	112802.5	195362.5	7.0
80+	1000.00	208.33	17200	82560.0	82560.0	4.8

References

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2. United Nations, Population Studies, No. 42, Manual IV, *Methods of Estimating Basic Demographic Measures* New York, 1967.
3. Other devices to improve the quality of data are "organizational" such as employment of the appropriate kind of field and supervisory staff, and their careful preparation for the work. These have to be done before the survey is carried out.
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5. R.K. Som, *Recall Lapse in Demographic Surveys*, Bombay, Asia Publishing House, 1970.
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7. For evaluation of SRS see B.L. Agarwal "Sample Registration in India", *Population Studies*, Vol. 23 No. 3, November 1969, pp. 379-394; also H.B. Wells and B.L. Agaawal. "Sample Registration in India", *Demography*, Vol. 4, pp. 374-387.
8. The data are from V. K. Ramabhadran and V.S. Swamy, "Measures of Mortality from the Indian Sample Registration System" in K.E. Vaidyanathan (Ed) *Studies on Mortality in India*, Institute of Rural Health and Family Planning, Gandhigram, 1971.
9. It is likely that the mortality in urban India is [slightly overstated, as some of the more progressive States are excluded.

10. The weights used are 0.4, 0.4 and 0.2 for 1968 rural, 1969 rural and 1969 urban respectively,
11. The model life tables used here are those developed by Ansley J. Coale and Paul Demeny. See Ansley J. Coale and Paul Demeny, *Regional Model Life Tables and Stable Populations*, Princeton University Press, Princeton, 1966.
12. The approach used here follows the recommendations of the U.N. for such evaluations. See United Nations Population Studies, No. 25, Manual III, *Methods for Population Projections by Sex and Age*, (ST/SOA/Series A/25) pp. 34-35.
13. Ansley Coale and Paul Demeny, *Regional Model Life Tables op. cit. p. 20*.
14. K.E. Vaidyanathan, "Testing Deficiencies in the Death Registration Statistics and Estimation of Mortality in India. 1965-1966", in K.E. Vaidyanathan (ed) *Studies on Mortality in India*, Gandhigram Institute of Rural Health and Family Planning, Gandhigram, 1971.
15. See M. A. El-Badry, "Higher Female than Male Mortality in Some Countries of South Asia: A Digest", *Journal of the American Statistical Association*, Vol. 64, No. 328 (Dec. 1969) pp. 1234 - 1245
16. See "Methods of Analytical Adjustment of Quality of Demographic Statistics" Document E/CN/ASPP/L. 11 of UNECA (July 1962)
17. An example of the evaluation of data based on the recorded age distribution of deaths is provided by the paper of Vaidyanathan, "Testing Deficiencies in Death Registration Statistics" *op cit*. An example of an evaluation based on age distribution of population is the paper by Visaria, See P.M. Visaria, "Mortality and Fertility in India", *Milbank Memorial Fund Quarterly*, Vol. XLVII, No. 1, Jan. 1969, Part 1, pages 91 -116.
18. For a detailed description of these methods, see A.J. Jaffe, *Handbook of Statistical Methods for Demographers*, Washington, U.S. Government Printing Office, 1951, pp. 3 - 41.