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DEMOGRAPHIC TRENDS IN WEST BENGAL DURING 1901—1950

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PREFACE.

The four papers in this monograph are the outcome of a research project undertaken at the London School of Economics under the auspices of the Population Council Inc., New York who were kind enough to grant a Post-doctoral Fellowship to the author for this purpose during 1955-56.

As the product of a specific research project they all have a common objective. This objective is to demonstrate how defective or incomplete demographic series can be reconstructed with simple statistical tools and put into use. It must be emphasised that such reconstructions are not substitutes for a really complete and reliable series but are at best only makeshifts with which demographic research can be made possible specially for past periods in countries where only defective and incomplete information is available.

All the four papers arose from the need of reconstructing some time series in order to study some simple demographic problems. Thus the first paper in the present series originated from an effort to study the birth and death trends in West Bengal for the last fifty years. After the correction systems devised for this purpose were found effective in West Bengal it was tested on other provinces with similar registration systems in the second paper and some rather interesting features of the type of error that may occur due to a chronic deficiency in the administration was revealed. The third paper is the result of an effort to find out some information on differential fertility in West Bengal among different economic classes. The fourth paper again is the outcome of a project having as the objective a study of the nature of the relationship between urbanisation and the marrying age.

The amusing and rather instructive aspect of this research project is that in all the papers it is the reconstruction procedure rather than the conclusions which occupy the major part of the papers and certainly the main share of the fascination. This is instructive because it seems to the author that this would be the fate of most research on past demographic series in countries like India where demographic information is generally of a poor quality. The main problem in research on past demography here is the problem of reconstruction and correction.

Two of these papers have already been published in the Population Studies. It is hoped that the four papers together will serve as an illustration of the various ways in which it is possible to make flexible use of existing information, a knowledge of the socio-economic background and simple statistical principles in order to build up information which will at least shed some light on problems which are otherwise completely insoluble.

When the author was working as a Population Council fellow at the London School of Economics he was in close association with Prof. D. V. Glass without whose encouragement and useful comments at various stages none of these projects would have attained fruition. The author would also like to take this opportunity to acknowledge the useful comments he had from Mr. W. Parker Mauldin of the Population Council on the papers included in this series.

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A STUDY OF DEMOGRAPHIC TRENDS IN WEST BENGAL DURING 1901—1950*

From time to time attempts have been made to determine the trends of fertility of the Indian population. Actuarial analyses which have been undertaken in this connection, published in the Census Reports and elsewhere† are admitted to be in the nature of makeshifts. The difficulty with such reconstructions is that while they may adequately represent the trends and tendencies in a fairly homogeneous region or, over a short period of time, they may be misleading when the region covered is too large, or the period considered is too long. Studies covering India as a whole have in most cases to depend largely on the Census. But in the Census returns the errors in age and other details are very large and the conclusions thus depend to a great extent on the power of the particular smoothing formula which is used. But although these facts are well known, demographers dealing with India rely too often on such data for drawing conclusions not only about narrow time periods or small regions, but also for determining fertility trends and differentials over a long period and for the country as a whole.

The Census authorities decry the reliability of the census in any thing else except the total count. But such caution is not always exercised by students who use the census information on age, birthplace and other characteristics.

Perhaps the greatest difficulty arises when different census enumerations are compared with each other or are used for constructing life tables. This is mainly because, being taken once in ten years, one census differs from another in many ways. The differences are partly due to different procedures of standardisation or correction used and partly due to the differing standards of the people enumerated. One or two illustrations of the consequences of this may be of interest.

The census of 1931 used a process of redistribution to correct the age bias, especially in the group aged 0-5 years. The census of 1941 used no such process. The census of 1951 used an entirely different system of redistribution which had the reverse effect of that adopted in 1931.‡ As the raw data for 1931 and 1951 are not available, it is very difficult to reach any conclusion simply by comparing the results of the three enumerations.

There is another difficulty which is not always given due weight. This is the change in the socio-cultural standards of a people enumerated at intervals of ten years. A critical study of the data on the ages of unmarried girls in West Bengal showed that understatement of age was prevalent in the group of 5-10 years in 1911, in the group 10-15 in 1921 and 1931 and in the group 15-20 in 1941 and 1951.@ Obviously, the age considered socially marriageable shifted during 1911—51, leading to a corresponding shift in the bias.

A census to census comparison reveals some of these absurdities. The following figures show the numbers enumerated in the age group 0-1 years in 1931 and 1941 with those enumerated in the age-groups 20-21 and 10-11 in 1951 for several districts in West Bengal which are emigrating areas.

TABLE 1

Census Counts by Age Groups

District	0—1 (1931)	20—21 (1951)	0—1 (1941)	10—11 (1951)
Bankura . . .	31,557	21,270	27,200	41,300
Birbhum . . .	29,851	18,420	27,100	26,630
Midnapore . .	75,893	69,460	77,150	86,260

Since there are large numbers of deaths to be taken into account, it is obvious that the census returns of 1941 and 1951 in this case are inconsistent, though there is no equally obvious inconsistency between 1931 and 1951.

Similar inconsistency is also brought to light when census enumerations are compared with vital statistics of the region. In Table 2 census counts for the 0-1 age group in 1931 and 1941 are

* This study was undertaken on a fellowship of the Population Council Inc. held at the London School of Economics.

† Fertility trends are discussed in the Report parts of the Census of India, Vol. V, Bengal, 1911, 1921 and 1931; Vol. VI West Bengal, 1951.

‡ Methods used for correction of age bias are discussed in the Census of India, Vol. V, Bengal, 1931, p.114; Vol. VI, West Bengal 1951, Part I-A, p. 329.

@ Bias in age statements of unmarried girls are discussed in unpublished work by the author.

compared with the numbers of registered births less the estimated related deaths* in 1930 and 1940.

TABLE 2

District	Numbers in Age Group 0-1 according to			
	Census	Registration	Census	Registration
	1931	1930	1941	1940
Burdwan	44,440	30,490	38,750	45,979
Birbhum	29,581	29,606	27,100	30,004
Bankura	31,557	26,630	27,200	33,128
Midnapore	75,893	64,358	77,150	82,451
Hooghly	34,058	22,378	33,850	33,654
Howrah	32,690	21,388	39,250	30,698

If we take into consideration the generally recognised fact that the registration statistics for the region are too low by 25—50%, it is evident that the figures of infants aged 0-1 years in 1941 are hopeless underestimates whereas those of 1931 appear to show the expected ratios between census and registration figures.

From the above discussion two conclusions would appear to follow. First, corrections of census figures involve widely different factors because of the lack of a uniform procedure. Secondly, studies of demographic trends for India as a whole carried out on the basis of census data, while tempting and seemingly simple, are of rather doubtful validity.

A more realistic approach to the study of demographic trends would be to proceed step by step from smaller regions. The advantage of such an approach is that in a smaller region the data are more homogeneous. Reconstructions can therefore be based on the assumptions of a common local background. Further, in restricting the analysis to a regional scale it is possible to make more realistic estimates of the errors in the registered vital statistics of births and deaths and more effectively to correct the vital statistics of the region with the help of available local studies. Conclusions on a regional scale should thus provide a better foundation for the analysis of demographic trends than an all-India study of unknown reliability.

In the present paper an attempt is made to study the demographic trends in one region (West Bengal) over a period of nearly sixty years from 1891. By combining information from different sources it is possible to reconstruct the vital history of this area with a degree of reliability which cannot be attained if we were to concentrate solely on the census material. The trends of fertility in rural and urban districts during this period have been arrived at by pooling the information available for the area in a variety of official sources of which we may specially mention the fertility enquiries carried out in 1921, 1931 and 1951 by the census authorities† the surveys undertaken at different times by the government‡ in order to determine the accuracy of the registration figures, and the registered vital statistics for the region. This study is confined to six mainly rural districts of West Bengal and the city of Calcutta. But the results apply to West Bengal as a whole for the districts considered (Birbhum, Bankura, Midnapore, Howrah, Hooghly, 24-Parganas and Calcutta) between them cover more than 75% of the population of the area.

II

The Census authorities of Bengal conducted an enquiry into the fertility of the rural population in 1931. In 1951 the West Bengal Census authorities carried out a similar enquiry in the rural areas of West Bengal. These investigations are not perfect models of sample surveys. But they are very useful sources, generally more reliable than the census for estimating fertility. This is due to the fact that they are direct attempts at determining fertility and do not depend for their validity on a

* The coefficient relating the infants enumerated to the number registered are calculated in the Census of India, Paper No. 6, 1954 entitled "Estimation of Birth and Death Rates in India during 1941-50", p. 48. The coefficient was also calculated by the author by redistributing the infants reported dead into different months or weeks of the calendar year and hence estimating their age distribution. The two approaches gave the same result, the separation factor being 0·75.

† Fertility enquiries have been reported in the Census of India, Vol. V, Bengal, 1921 and 1931. Also Vol. VI, West Bengal, Part I-C, 1951.

‡ Surveys of tests of the accuracy of vital statistics are reported in the Census of India, Vol. V, Bengal, 1921, p.232; also Vol. VI, 1951, Part I-B entitled "Vital Statistics of West Bengal, 1941—50". Other accounts may be found in a paper by Chandra Sekaran and Deming—"On a Method of Estimating Birth and Death Rates and the Extent of Regisration" Journal of the American Statistical Association, Vol. XLIV, 1949, p. 101.

variety of assumptions that are made in computing indirect estimates. Using the data collected in 1931 we shall obtain an estimate of the annual number of births in West Bengal during 1921-30, by logistic graduation of the age specific fertility rates.

The live birth indices for West Bengal as estimated* from the fertility enquiry of 1931 are given in the following table :

TABLE 3

Duration of Marriage in Years	Estimated Number of Births per Mother
0--6	1·1
7—13	2·9
14--16	4·2
17—26	5·3
27—32	6·3

As may be expected, the fertility indices plotted against duration of marriage fall along a curve, shaped like a logistic. We may therefore fit an equation of the form

$$\alpha + \beta t = \log \left(\frac{k}{yt} - 1 \right)$$

where yt is the fertility index at t and k, α and β are constants. Fitting by the method of three points (the points being 3.5, 10.5 and 17.5, the last point obtained by a free hand graduation of the points) we obtain the equation

$$0.7597 - 0.07t = \log (7.2120/yt - 1)$$

The following table shows the fitted and the observed values in the given ranges :

TABLE 4

Duration of Marriage in Years	Fertility Indices	
	Observed	Expected
0—6	1·1	1·1
7--13	2·9	2·5
14—16	4·2	3·9
17—26	5·3	5·6
27—32	6·3	6·7

Considering the fact that the survey was based on a small sample, the fit may be regarded as reasonably satisfactory.

We may now calculate the value of yt for each year of duration of marriage. Accepting the age of marriage as being 13 years exactly, we can use this curve to calculate the age specific fertility rate for different age groups of married women. Assuming that $(yt+1-yt)$ is the net increment of fertility for those aged t in one year, we can use the expression $1000\ (yt+1-yt)$ as giving the expected number of births per 1,000 mothers aged t in any one year. In Table 5 below the values corresponding to different years of duration of marriage are given as obtained from this expression.

TABLE 5

Duration of Marriage in Years	Expected Number of Births per 1,000 Women	Duration of Marriage in Years	Expected Number of Births per 1,000 Women
4	156	19	253
5	172	20	239
6	191	21	220
7	209	22	203
8	226	23	185
9	242	24	168
10	258	25	150
11	271	26	136
12	280	27	119
13	286	28	99
14	291	29	91
15	292	30	80
16	284	31	75
17	277	32	63
18	268	..	..

We assume that a duration of 4 completed years of marriage will generally mean an age between 17-18 years (17.5) during the period under

* The fertility enquiry of 1931 gives the numbers of children living by mothers' age and the ratios of children living to total live born children for all mothers. In the survey of 1951 we have both the numbers of children living by maternal age and also the ratios of children living to total children born for the mothers in each age group. Taking the average survival ratio of 1931 as the average and assuming that the age-specific indices of 1931 are of the same order as 1951, the ratios of surviving children to children born by age of mothers in 1931, have been reconstructed. Census of India, 1931, Vol. V, Bengal and Sikkim, Part I; also Census of India, 1951, Vol. VI, Part I-C, Report.

consideration.* This assumption will not seriously affect our result as in using census age statistics we have to consider age groups at intervals of five to ten years, and the average rate for an age group will not be greatly affected by a slight shift of the age at marriage. Taking the fertility of an age group as equal to that of the mean age, we obtain the fertility rates for quinquennial groups from 15 onwards. As the groups from 20 onwards in the census are given only at ten-year intervals for separate districts, we have combined two rates for respective quinquennial groups by weighting them by the number at each age group in the province and obtaining the mean rate for a ten-year group. Thus the rate for 20-30 is obtained by combining the mean rates for 20-25 and 25-30 weighted by the numbers at these ages in the province as a whole. In Table 6 the rates thus obtained are shown in the second column. In the forth and fifth columns we have quoted similar rates for 1951 as calculated in the West Bengal Census Report of 1951 from a similar enquiry.†

TABLE 6

Age Group	Rates of Fertility per 1,000 married Women in 1931	Age Group	Rates of Fertility per 1,000 married Women in 1951	
			I	II
15—20 . .	156			
20—30 . .	263	15- -24	204	210
30- -40 . .	222	25—34	244	236
40—45 . .	63	35- -44	128	111

Combining these rates with the age distribution of married women in 1931 and 1951, we obtain the probable number of births as follows :

TABLE 7

Districts	Estimates of Births according to age-specific Fertility Rates of married Females	
	1931	1951
Burdwan	63,198	80,527
Birbhum	40,014	40,485
Bankura	43,586	40,085
Midnapore	112,043	123,703
Hooghly	42,218	51,348
Howrah	41,181	51,864
24-Parganas	104,199	143,372

To assess the reliability of the estimates we have to compare these rates with the data obtained through a resurvey of births in various districts in different years. But the estimates given in Table 7 indicate the expected levels of births in the preceding decade rather than in any specific year. To compare them with births of particular years adjustments have to be made for short range fluctuations. For this purpose we may use the ratio of year-to-year indices to ten-yearly averages of births in the Registration Department figures (we shall show later that these indices are reliable reflections of short-term fluctuations in births). Using the estimates given above as the respective averages for 1921-30 and 1941-50 and correcting them by the indices for specific years to the average of 1921-30 and 1941-50 in the registered vital statistics series, we obtain comparable figures for specific years. Table 8 shows the registered births as percentages of the adjusted estimates derived from the fertility surveys and also the registered births as percentages of the estimates obtained through resurveys in different districts in various years.

Though there is no year-by-year comparison, we have at least fairly comparable figures for a number of districts and for a number of years during the period 1921-48, and the comparison suggests that, in these districts for the years tested, our estimates are reasonably near to the results obtained by resurveys carried out at various times.

III

As there are no fertility surveys for other decades we have now to utilise the registered vital statistics of the chosen area for further reconstructions. These statistics are recognised to be extremely defective. This recognition, however, has led most demographers rather hastily to go back to census instead of making direct attempts to correct the defects—an unfortunate decision, because the registration data represent the only available continuous series which attempts a direct assessment of the number of births and deaths through a permanent agency in a routine manner. As such, the defects are more likely to be routine and systematic and gradual in their effect than arbitrary and discontinuous. And it is the routine and systematic errors

* The proportion of women marrying at different ages as found in one fertility enquiry in 1931 is 42% before they are 14, 77% before they are 17 and 95% before they are 24. Census of India, Vol. V, Bengal, 1931, Part I, p. 162.

† Census of India, Vol. VI, West Bengal, 1951, Part I-C, pp. 41-70.

which can be corrected once the nature of the defects is known. The West Bengal census authorities of 1951 have given an appraisal of the existing vital statistics of this region which is worth quoting in this respect.

TABLE 8

Districts and Years	Registered Births as *Percentages of*		Remarks on Col. 3
	Estimates obtained from age-specific Fertility Rates with Adjustments of short-term Movements	Other Estimates made independently by different Authorities	
Burdwan, Birbhum and Bankura combined (1916-20)	80·0	83·9	Estimates of col. 3 from Census of 1921*
Burdwan (1912) .	..	76·5	Resurvey during Census of 1921†
Burdwan (1920) .	78·7	..	
Bankura (1948) .	74·4	71·7	Resurvey by Dept. of Health‡
24-Parganas (1948) .	50·0	47·2	Ditto
Hooghly (1946) .	62·3	63·3	Special survey in one p.s. in Hooghly under Chandrasekar@
Hooghly (1945) .	62·4	54·5	
Bengal (1921-30) .	.	63·3	Census of 1931£
West Bengal estimate from six districts (1921-30)	71·6	..	

"Although the crude figures they review must be largely fictitious, they yet represent a picture consistent within their framework, a logic of reality in spite of the fact that the figures as such are unreal. It will be seen that under registration is fairly uniform, and does not make sudden leaps and bounds from year to year. The table exhibits ratios tensions and relations that correspond to reality even though the data themselves are unreal, and thus should not be summarily dismissed".**

But in order to use the registration data for demographic analysis, it is necessary to establish concretely the nature and magnitude of the defects to which they are subject. Occasional resurveys carried out by the Government and other agencies to estimate the amount of under registration are of some use for this purpose, but because of their infrequency do not help us to correct the series as a whole. However, a careful analysis of the registration data does furnish us with a method of obtaining an approximately correct series from the registered series itself. Table 9 gives the recorded annual birth rate per 1,000 married women aged 15-50 during 1901-10, the percentage increase in the number of married females aged 15-50 in 1941-50 as compared with 1901-10, and the percentage decline in the recorded birth rate for six rural districts of West Bengal.

TABLE 9

District	Recorded Birth Rate per 1,000 married Women (15—50) during 1901-10	Per cent Increase of married Women (15-50) since 1901-10	Per cent Decline in Birth Rate since 1901-10	Birth Rate recorded per 1,000 married Women (15--50) in 1941-50	Recorded Births in 1941-50 as Percentage of recorded Births of 1901-10
Bankura .	204	12·9	43·6	142	79
Midnapore .	188	22·8	48·0	127	83
Burdwan .	184	39·6	64·3	112	85
Hooghly .	185	41·3	51·6	122	94
Howrah .	186	71·9	97·9	94	87
24-Parganas	179	76·6	80·7	99	98

Looking at the table, we may see that in 1901-10 all the districts show a more or less similar level of fertility. Since then the decline in fertility as measured from registration statistics is in direct proportion to the increase in the number of potential mothers. We may also see that the absolute

* Census of India, 1921. Report on the age distribution and rates of mortality deduced from the Indian Census Returns of 1921 and previous enumerations. Meikle, p.52. The units for which the resurvey was carried out refer to an area adjacent to these districts.

† Census of India, 1921, Vol. V, Bengal, Part I, Report p. 232.

‡ "Vital Statistics of West Bengal 1941- -50", Census of India, Vol. VI, West Bengal, Part I-B.

@ *Estimated from data regarding different unions in a paper by Chandrasekar and Deming entitled "On a method of estimating* birth and death rates and the extent of registration". Journal of the American Statistical Association, Vol. XLIV' 1949, p. 101.

£ Census of India, 1931. Bengal and Sikkim, Report, Part I, p. 127.

** "Vital Statistics of West Bengal 1941—50", Census of India, Vol. VI, West Bengal, 1951, Part I-B, p.2.

numbers of recorded births have been fairly steady over the period for most of the districts.

This negative correlation between the number of mothers and recorded fertility in an area is also brought out in a different way in the 1948 resurvey of registration statistics.* Table 10 shows the percentage of omissions in birth registration detected in different areas, the areas being classified by the total number of births ascertained during the resurvey.

TABLE 10

Distribution of Unions by Number of Births ascertained during Resurvey	Number of Unions in the Group	Percentage of Omissions detected to Number of Births
Less than 100	2	13·7
100—200	12	18·7
200—300	11	29·4
300—400	8	31·5
400 and above	7	39·3

It may be noted that in this table the rate of omission is positively correlated with the number of births ascertained in the area and therefore presumably with the number of married females. Hence the larger the number of births in an area the higher is the proportion unregistered. A possible explanation for this is that the Registration Department has failed to deal with the increased volume of work wherever a large population increase has taken place and that the omission rate is a function of the population increase in the area.

As against this, there is another significant characteristic of these figures which suggests that the level of working efficiency of the different centres did not change abruptly from year to year. This may be seen from the short range variations in births in different districts from year to year. The figures given in Table 11 of the annual births in relation to ten-yearly averages for three districts show a high degree of correlation between districts as may be expected under normal circumstances.

TABLE 11

Year	Annual Birth Indices with ten-yearly Averages as 100		
	Burdwan	Bankura	24-Parganas
1911	110	120	116
1912	105	111	97
1913	101	100	97
1914	105	105	106
1915	87	92	96
1916	111	98	97
1917	119	94	108
1918	100	101	100
1919	73	77	83
1920	89	94	86
1921	93	91	89
1922	101	102	101
1923	103	98	103
1924	93	97	91
1925	105	109	100
1926	107	114	101
1927	101	92	89
1928	98	100	106
1929	106	108	115
1930	86	88	103
1931	95	86	94
1932	88	77	87
1933	104	94	91
1934	90	95	99
1935	98	98	111
1936	104	116	101
1937	99	113	101
1938	104	109	91
1939	102	106	109
1940	116	106	115
1941	120	117	133
1942	124	123	121
1943	100	107	95
1944	84	77	78
1945	92	99	94
1946	116	122	112
1947	97	93	88
1948	88	87	93
1949	95	95	96
1950	84	81	91

* 'Vital Statistics of West Bengal 1941-50". Census of India, Vol. VI, West Bengal, 1951, Part I-B.

Such a highly correlated movement of births in several contiguous districts implies a constancy in the registration errors, for fluctuating errors of registration would have hindered any such correlation from appearing in the data. It seems, therefore, that as absolute figures the registration data are subject to an error which is a function of the population increase but that as ratios they are subject to only a constant type of error. This could happen if the population covered by the Registration Department were more or less constant over time, while the efficiency of registration was also constant during the period. Naturally, therefore, as absolute estimates the degree of under registration will increase with a growing population. But as registration system is working with a fixed sample, the short-range fluctuations will be fairly accurately reflected in the data.

It is not difficult to visualise how such a situation might arise. The Registration Department is known to lag behind as regards expansion of staff. The traditional and still existing employee at the lowest level is the village headman. With an increasing population and with the expansion of the village area, he has not increased his own coverage. While the numbers of births and deaths have been growing he has still been covering the vital history of practically the same population as in former years, the size and number of his coverage being determined by contiguity and accessibility. In recording the births and deaths of a practically fixed sample he is also subject to some omissions. But this rate of omission, as far as his own fixed sample is concerned, is practically constant. That is, he is working at the same level of efficiency. Registering the births of a fixed number of the population with a constant rate of omission over the years he produces two features in his records :

(1) The short-range rise and fall in the area is correctly reflected in his sample and agrees with the rise and fall in contiguous areas subject to the same influences.

(2) As estimates of total births his records become more and more seriously deficient in proportion to the population increase within his jurisdiction. In districts with a static population he maintains the same level of accuracy, whereas, in districts with a rapidly increasing population his records of registered births lose all semblance to reality.

Basing ourselves upon the above analysis, we may now attempt to devise a correction formula.

Let P_0 be the initial number of married females in a registration area, and B_0 the number of births occurring in time t_0. Let the headman record b_0 out of B_0 in the same year by covering P_0 females.

His initial correction will, therefore, be B_0/b_0. At time t_1, let the married females increase to P_1, and let the number of births due to them be B_1. The headman is still covering only P_0 females (which is not even a corresponding fraction). His recorded births are therefore still of the order of b_0, subject to small changes. Let this be b_1. To correct his record we have now to adjust both for the fixed coverage of an increasing population and also for the initial error of omission.

The first correction for a fixed sample may be effected by the expression on the assumption that

$$b_1 \cdot \ p_1/P_0$$

birth rates within his sample and outside are of the same order. Multiplying this by the initial correcting factor we get the expression.

$$\frac{b_1 P_1 B_0}{P_0 b_0}$$

We have already estimated the annual births for the decades 1921-30 and 1941-50. Utilising these we can now obtain an estimate of B_0/b_0.

Correcting the average registered births per year during 1921-30 and 1941-50 for the increase in population as compared to 1901-10 we have the following estimates of the rural births in 1921-30 and 1941-50.

TABLE 12

Districts	Average Number of Births	
	1921-30	1941-50
Burdwan	44,374	57,990
Birbhum	32,811	32,871
Bankura	36,112	36,697
Midnapore	77,490	96,598
Hooghly	28,789	41,732
Howrah	29,867	37,591
24-Parganas	69,944	102,011

The ratios of these figures to the corresponding figures calculated from the fertility enquiries of 1931 and 1951 give us an estimate of the initial correction factor. The percentage ratios are given below for the two decades.

TABLE 13

Districts	Births as Proportion of Fertility Estimates in	
	1921-30	1941 50
Burdwan	73·9	77·2
Birbhum	86·7	75·1
Bankura	88·9	86·5
Midnapore . . .	75·7	80·8
Hooghly . . .	70·2	84·2
Howrah . . .	76·7	73·8
24-Parganas	69·3	76·4
Average	75·7	78·7

As was anticipated the registered births, after correction for population increase, bear similar ratios to the fertility estimates in both 1921-30 and 1941-50. These ratios thus give us an estimate of the initial correction factor. We may now reconstruct the figures of 1931-40 by the suggested process. Table 14 gives the registered average annual births after correction for population increase in Col. 2, and after further correction for initial omissions in Col. 3. For comparison we have also given the average of the two fertility estimates of 1921-30 and 1941-50.

TABLE 14

Districts	Average registered Births in 1931-40 corrected for Population Increase	Col. 2 corrected for initial Omissions	Average of Fertility Estimates of 1931 and 1951
Burdwan . .	53,673	64,200	66,189
Birbhum . .	38,070	43,910	43,562
Bankura . .	42,502	47,808	44,144
Midnapore .	97,341	120,471	113,639
Hooghly . .	29,798	47,226	44,956
Howrah . .	41,132	53,627	45,590
24-Parganas .	101,189	132,446	113,879

The reconstructions of births for the periods 1891 1900, 1901 10, and 1911-20 are made simpler by the fact that the increase of population in these periods was not very significant. Hence ignoring the deficiencies due to the first type of error and using the estimate of the initial correction factor as obtained for 1921-30 we obtain the figures in Table 15 for average annual births in 1891-1900, 1901-10 and 1911-20.

Combining the six districts we get a series of estimates from 1891-1951. The different census authorities at different periods have estimated the birth rate for the province as a whole during the respective census decades. These estimates have been obtained at different times and employing different techniques, and for the whole province. It is generally known that East Bengal has a rather higher birth rate than West Bengal and as such the estimates for the whole province would be expected to be higher than for the six districts of West Bengal with which we are concerned. Keeping such factors in mind we may compare the estimates obtained for the whole of Bengal with the estimates of the six districts as obtained by us (*see* Table 16).

TABLE 15

Districts	Estimates obtained by correcting registered Births by initial Correction Factor		
	1891-1900	1901-10	1911-20
Burdwan . .	63,198	69,146	62,489
Birbhum . .	34,658	39,527	34,858
Bankura . .	42,739	46,204	42,358
Midnapore .	121,020	126,703	113,892
Hooghly . .	44,285	49,268	46,874
Howrah . .	36,711	40,560	41,843
24-Parganas. .	83,089	107,735	109,533

The results obtained by us show a remarkable consistency and compare well with the figures estimated by the Census authorities. It may be seen that estimates for Bengal as a whole are slightly higher than for West Bengal, as was to be expected. But otherwise the results are quite consistent. In 1941-50 the various estimates refer to West Bengal only and agree closely. (The two parallel estimates in Col. 3 were obtained by the Census authorities by resurvey in the first case and

by the reverse survival method in the second). We have thus obtained a system of correction of registration figures which is based on a knowledge of local conditions, and which yields fairly satisfactory estimates over the whole of the period 1891-1951.

TABLE 16

Decade	Reconstructed Birth Rate per 1,000	Corresponding Estimates for the Province in Census	Remarks on Col. 3
1891–1900 .	43·0	43·9	Census 1911*
1901–1910 .	44·9	46·7	Ditto
1911–1920 .	41·8	44·7	Census 1921**
1921—1930 .	38·2	41·9	Census 1931†
1931—1940 .	40·0	43·7	Logistic estimate
1941–1950 .	34·8	33·5 35·4	Census 1951 West Bengal estimate‡

Having produced estimates of births for the six districts we can now proceed to reconstruct the estimates of infant mortality for these districts. Proceeding in an exactly analogous way as in the case of the birth estimates, we can formulate a correction factor for the official figures of infant mortality as follows. If D_0 be the infant mortality among live births B_0 and d_0 be the number actually registered, the initial correction factor will be D_0/d_0. The correction for a constant coverage of an increasing population here will be B_1/B_0 where B_0 is the number of births in the initial period and B_1 is the number of births in the period under consideration. Thus the formula can be expressed as

$$\frac{d_1 B_1 D_0}{B_0 d_0}$$

where d_1 is the registered number of infant deaths in the period under consideration B_1/B_0 is the ratio of the births in the period to the initial births and D_0/d_0 is the initial correction factor for infant mortality.

We can obtain an approximate estimate of D_0/d_0 from 1911-20 by considering the following formula

$$\frac{5x_1 - x_2 - 10x_3}{5}$$

where x_1 is the reconstructed average number of births in 1911-20, x_2 is the corrected census count of the 0-5 age group as estimated by census actuaries 1921, and x_3 is the average number of deaths in the 1-5 age group in 1911-20 as reported. As the death rate declines sharply after the first year, the reported number of deaths in the 1-5 year group will not unduly affect the result. By substituting the appropriate values in these expressions for 1911-20 we get an average infant mortality during the decade of 283 per 1,000 live births. The rate of infant mortality for the proclaimed clans@ reaches 298 per 1,000 in Hardy's actuarial report for 1901-10. These figures do not compare badly and we may therefore take as the initial correction factor the ratio of the above estimate of 1911-20 to the actual registered figure corresponding to this period. Applying this correction factor in the above formula we obtain the numbers of infant deaths per 1,000 live births shown in Table 17. We have included for comparison the rates calculated by different census authorities as far as they are available for Bengal as a whole.

TABLE 17

Decade	Infant Deaths per 1,000 Live Births			Remarks on col. 4
	Registered Rate	Corrected Rate	Other independent Estimates	
1911—20 .	205	283	298	Census 1911£
1921—30 .	181	253	250	Census 1931œ
1931—40 .	159	230	..	
1941—50 .	115	147	160	West Bengal Census 1951$

* Census of India, 1911, Vol. I, Part 1, Report, p. 171.

** Census of India, 1921, Vol. V, Bengal, Part I, Report, p. 212.

† Census of India, 1931, Vol. V, Bengal and Sikkim, Part I, Report, p. 127.

‡ Census of India, 1951, Vol., VI Part, I-C, p. 70. Census of India, 1954, Paper No. 6, "Estimation of birth and death rates in India during 1941-50 to 1951 Census", p. 41. Census of India, 1951, Vol. VI, Part I-B, "Vital Statistics of West Bengal, 1941-50."

@ Certain tribal groups for which complete birth and death registration was made directly by the Government. Subsequent census authorities used these rates as the nearest approximation to the birth and infant mortality rates of the country. "Memorandum on the Age Tables and Rates of Mortality of the Indian Census of 1901" by G. F. Hardy (Govt. of India, 1905).

£ "Memorandum on the Age Tables and Rates of Mortality of the Indian Census of 1901", G. F. Hardy, p. 3.

œ Census of India, 1931, Vol. I, Actuarial Report.

$ "Vital Statistics of West Bengal 1941-50". Census of India, Vol. VI, West Bengal, 1951, Part I-B.

It may be noted that the present series of infant death rates have been calculated by basing ourselves on our estimates of the births with the suggested correction procedure. The rates emerging from our calculations are reasonably near to those deriving from other census computations. This agreement is therefore also confirmatory evidence of the validity of our birth estimates themselves. On the basis of our estimates of births and deaths and the registered deaths in the age group 1-4, we can then obtain approximate estimates of the extent of underenumeration in the age group 0-5 years in the census at different periods.

TABLE 18

Period	Estimates of Children aged 0-5 from re-constructed Figures of Births and Deaths	Comparable Census Counts of Children aged 0-5 for corresponding Years	Estimated Percentage of Omissions in Census Enumerations
1916—20 . .	305,992	224,302	26·7
1926--30 . .	303,728	308,225	..
1936—40 . .	369,677	340,870	7·8
1946--50 . .	392,305	342,364	12·7

Since we have used the deaths in the 1-4 age group in the registration data there is a slight overestimation of the omissions in the census, but that is of a low order as the actual death rate in the group 1-5 declines very rapidly. We can therefore use this rate of underenumeration as a reasonable approximation.

In 1921 Meikle* estimated the underenumeration in the 0-5 age group as being of the order of 23%. This compares well with our estimate of 26.7%, considering that it was admittedly slightly too high because of the omissions of some reported deaths in the age group 1-5 years. The close agreement in 1931 also accords with expectation. In 1931 the census actuaries regrouped the original counts in such a way as to offset the tendency to underenumeration in the lower age groups. In 1941 again we can note some underestimation of the group aged 0-5. But this underenumeration, compared with 1911, has considerably diminished. This may perhaps be due to the progressive improvement of the age enumeration with advancing literacy and urbanisation of the country. In 1951 the underenumeration appears to have increased though not as much as in 1911. But this increase is probably due not so much to a decline in the accuracy of age enumeration, as to the application of a different method of smoothing the raw data. In correcting for age-bias in 1951, osculatory interpolation was used, which redistributed the figures from age one. This method does not correct underenumeration at age 0. In fact, the graduated figure, according to the census report‡ is less than the original count. The nature of the correction may thus as a whole have increased the understatement in the 0-5 age group. It is not possible to compare our estimate with the original count, but in view of the type of smoothing used it is not unlikely that the original count was of the same order of accuracy as in 1941.

IV

Basing ourselves on the kinds of estimates above we may now attempt to study the trend of fertility in our chosen area. We may begin with the rates given in Table 19--the crude birth rate and the net birth rate, the latter being the crude birth rate minus the infant mortality rate.

TABLE 19

Decade	Crude Birth Rate per 1,000	Net Birth Rate per 1,000
1891--1900	43·0	..
1901--1910	44·9	..
1911—1920	41·8	29·9
1921--1930	38·2	28·5
1931--1940	40·0	31·2
1941--1950	34·8	29·2

It may be noted that the crude birth rate has fallen more or less steadily but that the sharp decline in infant mortality has almost completely offset a similar movement in the net birth rate. The census increase in the number of infants, which

* Report of the Age Distribution and Rates of Mortality deduced from the Indian Census Returns of 1921 and Previous Enumerations" by H. G. W. Meikle (Govt. of India, 1926).

† Census of India, Vol. V, Bengal, 1931, Part I, Chapter 4.

‡ Census of India, Vol. VI, West Bengal, 1951, Part I-A, Chapter 1.

is nearly equivalent to a net birth rate, would thus fail to reveal the real trend of fertility even if the census counts of infants were correct. It would therefore be entirely inappropriate to use the census counts of infants when the infant death rate is known to be changing rapidly.

In a population growing according to a logistic law, a rise in the expectation of life is accompanied by a falling birth rate. As in the life tables since 1901 the expectation of life has been seen to be increasing, and as the Indian population also broadly follows a logistic pattern of growth, it may be of some interest to show that the birth rate as deduced from the population curve also describes a falling trend. We may for this purpose employ a logistic curve fitted to the data of Bengal by Porter in the census report of 1931. Porter's curve does not give a good approximation to the 1941 population. But as we do not intend to use these rates as a forecast but rather as an analysis of a trend, they may give us approximately correct results. We shall therefore present here a series of birth rates calculated by this method. The rates are not independent estimates and our purpose is simply to emphasise that the falling trend of birth rate in this area is not inconsistent with the population growth occurring during the period 1871-1931.

The equation of the logistic fitted by Porter in 1931 after transferring the origin to the point of inflexion is

$$N_t = 79963.1 \, e^{-0.01775t}$$

The point of inflexion falls in the year 1872 approximately.

Lotka* showed that in a logistic population the number born at a time t, (B_t) may be estimated approximately from the first two terms of an infinite series involving hyperbolic tangents as follows :

$$B_t = \frac{N_\infty}{L_0}\left\{\frac{1}{2}\left[1 - \tanh\frac{r(t-\mu_1)}{2}\right] - \frac{\mu_2 r^2}{2!4}\cdot\left[\tanh\frac{r(t+\mu_1)}{2} - \tanh^3\frac{r(t+\mu_1)}{2}\right] - \ldots\right\}$$

where $L_0 = \int_0^\infty p(a)\,da$, and $\mu_1 = \int_0^\infty a.p(a)\,da \Big/ \int_0^\infty p(a)\,da$,

L_0 and μ_1 being respectively the expectation of life and the average age of the living population in a life table where p(a) is the probability of living to age a.

Using the life tables given in the Census for 1911 and 1931 in the approximate formula.

$$B_t = \frac{N_\infty}{2L_0}\left\{1 - \tanh\frac{r(t-\mu_1)}{2}\right\}$$

we obtain an estimate of levels of birth rates per 1,000 during the respective decades as given below :

TABLE 20

Decade	Estimated Rate
1901-10	54·4
1921-30	49·7
1931-40	43·7

Accepting the fact that these figures represent only approximations to the birth rate at different periods, depending upon the mortality conditions expressed by the life tables on which they are based and upon the fitted logistic, it is interesting to note that the better the mortality conditions the lower is the level of these trend lines. Mortality conditions in Bengal, as in India as a whole, are generally recognised to be improving. The result of such an improvement will be the shifting of the birth rate to lower levels if population growth continues to follow a logistic curve.

Proceeding from the crude birth rate to the number of births per 1,000 married women, we come to a more precise index of fertility. Table 21 gives the decennial averages of reconstructed births per 1,000 married females (15-50) from 1901.

TABLE 21

Decade	Births per 1,000 married Women 15-50	1/5 of Census Counts of Infants aged 0-5 per 1,000 married Women (15-50) for corresponding Census Periods	
		Uncorrected	Corrected for Underenumeration
1901-10	264	..	..
1911-20	239	119	162
1921-30	209	132	152
1931-40	218	146	158
1941-50	198	132	151

* A. J. Lotka, Proceedings of the Second General Assembly of the International Union for the Scientific Study of Population Problems, 1931.

Side by side, for comparative purposes, we have given the ratios of one-fifth of the census counts of children aged 0-5 per 1,000 married women (15-50) an index often used by demographers as a short-cut in the study of fertility trends.

While the reconstructed births show a clear trend of decline, the census counts do not show any such tendency. These counts, being distorted both by different types of smoothing and also by a falling infant death rate, cannot be used as an index of fertility.

The final column in Table 21 shows the totals of infants aged 0-5 years corrected for under-enumeration. When the corrections have been made the census shows similar movements during 1911-50 but even then the sharp decline in infant mortality has to some extent distorted the figures both relatively and absolutely after the period 1911-20. Thus while the level of fertility, as indicated by births, is nearly 17% lower in 1941-50 than in 1911-20, the child-woman ratio is only 7% lower than the corresponding figures in 1911-20. The total decline in fertility, as measured in the first column of Table 21, appears to have been more than 21% during the last fifty years.

So far we have dealt only with rural birth rates and fertility. We shall now try to construct estimates of annual births for the city of Calcutta, and to compare the urban trend as revealed from this study with the rural trend over the same period.

The methods used in estimating correct birth rates for the rural areas cannot be applied to Calcutta. In Calcutta there is no correlation between a decline in recorded births and an increase in population. This may be seen from the following figures of rates of increase of married females aged 15-50 and registered births in Calcutta as contrasted with that of 24-Parganas.

TABLE 22

Decade	Rate of Increase per cent since 1901-10			
	Calcutta		24-Parganas	
	Married Women 15-50	Registered Births	Married Women 15-50	Registered Births
1911—20 . .	7	19	16	2
1921—30 . .	31	30	26	7
1931—40 . .	136	82	49	15
1941—50 . .	147	120	77	2

In Calcutta registered births appear to have been keeping pace with population increase, so that whatever the error of omission may be, it is not a direct function of population growth. There are additional reasons for believing that the degree of omission has been fairly constant since 1911. This may be seen by comparing the population enumerated in the 0-1 age group in the censuses of 1921, 1931, 1941 and 1951 with the corresponding estimates of the infants surviving to census date out of those born in 1920, 1930, 1940 and 1950.

TABLE 23

Year	Registered Births	Census Counts of Infants adjusted for Infant Deaths	Col. 2 as Percentage of Col. 3
1921 . .	15,375	18,469	83·2
1931 . .	23,151	26,836	86·3
1941 . .	29,730	33,790	88·0
1951 . .	48,203	55,909	86·2

The ratios of the registered births to census counts of infants show that both the census and the registration figures are fairly near to each other and differ by an almost constant fraction. The census and the registration figures would thus both appear to be more reliable than was the case in the rural areas. Somewhat similar features are also

visible if we compare the age group 0-5 as a whole with the corresponding figures of registered births.

TABLE 24

Period	Average registered Births for 5 years	Comparable Census Cohorts computed for corresponding Periods	Percentage of col. 2 to col. 3
1916—20 . .	20,576	26,243	78
1926—30 . .	28,873	38,993	74
1936--40 . .	42,535	47,513	90

As the death registration statistics of Calcutta are quite reliable registration has to take place before the body can be disposed of—we can attach more importance to these similarities than was justified for rural areas.

In a paper in Sankhya*, K. S. Ray estimated that the deficiency in birth registration amounted to about 21% in 1921-30. Several studies conducted in different wards of Calcutta Corporation by the municipal authorities also estimated the extent of omissions in registering births to be of the same order.

A fertility enquiry was conducted amongst the urban middle classes by the census authorities in 1921. Utilising this enquiry, as in the earlier analysis, by fitting a logistic curve**, we derive estimates of total births showing a rate of omission of about 20% in 1911-20. We may therefore generally state that the rate of omission in birth registration in Calcutta is of the order of 20%. This rate would seem to have remained approximately constant since 1901.

In Table 25 we have given the estimates of total annual births obtained in the different ways discussed above.

It may be noted that the estimates from fertility inquiries, and a correction of the order of 20% agree fairly closely with the correction by census ratios in 1911-20. Again the fertility estimates, the estimates of Ray and the Calcutta Corporation, and also the assumed 20% correction, agree remarkably in 1921-30 and 1931-40. For 1941-50 the fertility estimates based on the survey of 1921 are perhaps too high for the birth rate has declined since then. We have therefore taken the figures corrected on the basis of a 20% omission (which is intermediate between the census ratio and the fertility estimates) as closer to the correct figure. In any case, by making a uniform a correction of 20% we obtain a series which is very close to what should be the correct estimate. This is also reasonable from our

TABLE 25

Decade	Estimates of Births in Calcutta (Annual Average)			
	Registered Births corrected by Census Ratio	Computed from Fertility Surveys of 1921	Independent Estimates from other sources	Computed on the Basis of correcting a 20 p. c. non-registration
1901—10 .	19,454	..	..	18,773
1911--20 .	22,507	22,176	..	22,367
1921--30 .	22,709	24,262	23,960	24,470
1931—40 .	31,043	36,648	36,318	34,108
1941—50 .	38,411	41,912	..	41,388

earlier analysis which showed that even in rural areas the rate of omission has not changed significantly. Moreover, the increase of population in Calcutta has not exerted a similar burden on the Registration Department because of a simultaneous increase in hospital deliveries which are registered automatically.† The second kind of omission—previously called the initial omission—also exists in Calcutta, as is recognised by the health authorities.

It is useless to study the crude birth rate in Calcutta because of the very large proportion of males in the population. We have therefore computed for Calcutta the number of births per 1,000 married women aged 15-50 as given in Table 26. For comparison we have also given the

* K. S. Ray, "Note on the Omission in Registration of Births in the City of Calcutta", Sankhya, Vol. IV, December 1938, p. 165.

** The equation fitted was $0 \cdot 8701 - 0 \cdot 0757t = \log (5 \cdot 75/yt - 1)$.

† Reports of the Municipal Administration of Calcutta, 1910-38.

corresponding figures for the six rural and semi-urban districts.

TABLE 26

Decade	Births per 1,000 married Women 15-50		One-fifth of Census Counts of Infants in Age Group 0-5 per 1,000 married Women 15-50 for corresponding Census Periods	
	Rural Districts	Calcutta	Rural Districts	Calcutta
1901—10 .	264	178	168	118
1911—20 .	239	198	119	112
1921—30 .	209	176	132	146
1931—40 .	218	147	146	130
1941—50 .	198	134	132	150

It should be noted that the birth rates for 1941-50 include the displaced population while the child-woman ratio does not and is therefore not as comparable as for other years. The fertility rates shown here for rural areas are not strictly rural rates as some important towns are within the area included in these districts. Nevertheless, the six districts are mainly rural and the rates would not change significantly by including or excluding a few towns. Comparing the rural and the urban rate we may conclude that there is a significant urban rural differential in fertility and this is on the whole increasing. The census ratio of children (0-5) to women (15-50) given in the last two columns fails to reflect either the trend of fertility or the trend in rural-urban differentials. The failure of the census is specially marked in the case of rural areas because, as was mentioned before, of the higher rates of under enumeration. Even in urban areas there is a considerable difference owing to the fact that the census represents figures for five-year periods and is also affected by varying rates of infant mortality.

To summarise, it may be concluded that in West Bengal there has been a steady decline in the birth rate and in the indices of fertility during the last fifty years. There is a significant differential between city and rural areas, and that differential appears to be increasing. The general trend of decline was heavier during 1901-30 and has slowed down of late in rural areas, though the decline is still continuing in urban areas.

It is not possible to generalise from West Bengal experience, for that province is by no means representative of India as a whole. West Bengal had already a fairly static population for a long time while the Indian population as a whole was increasing. But the present study shows the possibility of making reasonable estimates of fertility on a smaller scale and of arriving at substantive results for homogeneous regions. Studies of this kind could be undertaken for a number of important provinces in India and would provide a more secure basis for conclusions applying to India as a whole.*

The Trend of the Birth Rate in India, 1911-50.

I

In an earlier paper** on the trends of birth rates in West Bengal, an attempt was made to estimate the true level of the birth rates in that region by devising a formula for correcting the registered vital statistics for the region on the basis of a critical study of certain systematic biases displayed by the statistics.

Since the completion of that paper the Government of India, in connection with the census of 1951, has published a report entitled Estimation of Birth and Death Rates in India during 1941-50.† In this report the actuaries associated with the census of 1951 have analysed a mass of material and have tried to arrive at firm estimates of the birth and death rates for different regions of India during 1941-50. Kingsley Davis has also tried to compute birth estimates for the major provinces of India during 1926-30.‡ These two publications thus enable us to examine two independently estimated rates of omission in the two decades (*i.e.*, 1926-30 and 1941-50).

In the earlier paper it was shown that we can apply our formula in estimating the rates of omission for several decades provided that we can use

* A second paper applying the techniques discussed above to the problem of level and trend of birth rates in India as a whole will appear in a subsequent issue of Population Studies.

** A. Ghosh, "Demographic Trends in India during 1901-50", Population Studies, Vol. IX, No. 3, March 1956, pp. 217-36.

† Census of India, Paper No. 6, 1954.

‡ K. Davis, The Population of India and Pakistan. Princeton, 1951.

the rate of omission for any specific period as a given datum. Thus using the rates of omission as estimated by the census actuaries for 1941-50 as a datum we can estimate the rates of omission for 1911-20, 1921-30 and 1931-40 from the formula itself.

In the present paper it will be shown that the formula devised for West Bengal is valid for a much larger area, comprising the provinces of Assam, Bengal, Bihar, Orissa, Uttar Pradesh, and Madhya Pradesh.† The rates of omission estimated by our formula for 1921-30 will be compared with the corresponding rates of omission for 1926-30 as estimated by Kingsley Davis, and it will be shown that in all the cases the two agree quite closely.

The only provinces in which the formula does not seem to apply are the Punjab, Madras and Bombay. The possible reason why these provinces do not follow this common pattern will be discussed and rates of omission for these three calculated on the basis of other considerations. With the estimates for these nine provinces, an all-India rate of birth and a rate of omission will be estimated for the period 1911-50.

II

While the reliability of the registration statistics in different parts of India is questioned by most experts on Indian demography, they generally agree that the registration series is still of some value for indicating the trend as it is free from sudden jumps or irregularities.‡ We also showed in our earlier study that the registration statistics are fairly consistent within their framework and suffer from systematic bias rather than random irregularities on a large scale. In analysing the series of registered births in West Bengal over a period of over fifty years we noted a number of features which revealed the existence of a systematic bias in the series. These features may be summarized as follows :

(i) The registered birth rate showed a steady decline over the years, a decline not confirmed by subsequent census counts. This decline in the birth rate was seen to be highest in the districts with a marked rise in the population. The higher the rate of increase in the population of an area, the steeper was the fall in the birth rate.

(ii) The absolute number of births registered tends to fluctuate about a mean, in spite of a sharp rise in population, and this cannot be explained even by assuming a reasonable fall in the fertility of the population.

(iii) The short-range fluctuations in the birth rate for contiguous areas throughout the last fifty years showed a high seasonal correlation which may be expected over neighbouring areas.

An analysis of the birth rate in the nine provinces we are now considering shows that in the provinces of Assam, Bengal, Bihar, Orissa, Uttar Pradesh and Madhya Pradesh most of these features are present in the registration data. The following table shows the registered birth rate for the nine provinces over the last fifty years.

TABLE 1

Provinces	Crude Birth Rate per 1,000 (registered) during				
	1901-10	1911-20	1921-30	1931-40	1941-50
Assam	35·7	32·3	30·3	25·6	16·8
West Bengal*	37·6	32·8	28·5	27·5	20·5
Bihar and Orissa	41·0	38·8	36·3	31·5	22·9
Uttar Pradesh	41·4	42·2	35·1	34·2	24·8
Madhya Pradesh	49·6	45·5	43·7	41·2	37·0
Madras	30·8	30·7	34·6	34·7	30·8
Bombay	33·4	34·2	35·9	37·2	32·9
Punjab*	41·2	43·8	42·2	43·0	39·5

*Figures for Bengal and Punjab for 1901-10 and 1911-20 refer to the provinces before the partition.

In the first five provinces (including Bihar and Orissa as one unit as in earlier official reports) the birth rate shows a consistent fall throughout the last fifty years, declining in some cases to almost

† In India before 1947 the units under direct British administration were comprised of these nine provinces. In free India these provinces have been designated as States. In this paper these units will be referred to as provinces to avoid confusion. Of the nine provinces Bengal and the Punjab were partitioned during the creation of the State of Pakistan. In the paper we refer to the regions included in the Indian Union and known as West Bengal and East Punjab.

‡ "Since the adequacy of registration has apparently changed very little in India during several decades any pronounced increase or decrease in the registered birth rate would indicate a similar trend in the actual rate", Davis, op. cit., p. 68. "It will be seen that under registration is fairly uniform and does not take sudden leaps and bounds from year to year", of Vital Statistics of West Bengal 194 —50, Census of India, 1951, Vol. VI. Part I-B, p. 2.

half the rate of 1901-10. But in the last three provinces of Bombay, Madras and the Punjab an almost constant rate is maintained throughout the period. It is significant in this connection that all Indian demographic studies agree that these three provinces maintain a reasonably efficient standard of registration.* It is also generally recognised that the provinces which show the steepest decline over the decades are also those which have the least reliable systems of registration (*e.g.*, Assam and Bengal). This feature is clearly brought out in the following table, showing the percentage omission in birth registration as estimated by the census authorities for 1941-50 and by Davis for 1926-30, with the apparent percentage fall in the birth rate as recorded since 1901-10.

TABLE 2

Provinces	Estimated Percentage of Omission in Registered Births		Per cent Fall in Birth Rate 1941-50 per cent of 1901-10
	1926-30	1941-50	
Assam . . .	45·6	64·0	53
West Bengal . .	27·9	42·1	46
Bihar and Orissa . .	22·3	39·6	44
Uttar Pradesh . .	25·4	35·8	40
Madhya Pradesh . .	7·1	18·0	25
Madras . . .	16·1	13·7	..
Bombay . . .	22·8	19·8	..
Punjab . . .	..	4·1	.

In the first five areas the rate of omission has increased considerably since 1926-30 and the birth rate has fallen sharply during the whole period, while in the last three areas the rate of omission has remained stationary and the birth rate has also continued at practically the same level. We may conclude from this that provinces with an inefficient system of registration appear to show a steady decline in the birth rate primarily because of a steadily increasing rate of omission in registration over time.

The above conclusion is reinforced if we consider the second feature noted in our earlier studies in West Bengal, that is, the constancy in the absolute number of birth registered, given below for the provinces since 1911-20.**

The first five regions do not show an increasing trend in the numbers of births while a clearly increasing trend is seen in the case of the last two regions. If we consider the very considerable increase in the population of those areas since 1911-20, a steady rise in the number of births registered would be expected, even if there had been a substantial decline in fertility. Indeed, unless there had been a sensational decline in fertility the numbers of births in all regions should have shown a steady rise. It is therefore significant that the provinces which are known to have efficient systems of registration show the expected rise. Again, as in the case of our study of West Bengal, we can see that the rate of decline in the registered

TABLE 3

Decades	Average Number of Births Registered, in 10,000's					
	Assam	Bengal	Bihar & Orissa	Uttar Pradesh	Madras	Bombay
1911—20	19	147	132	197	123	67
1921—30	20	132	123	159	142	69
1931—40	24	141	132	177	167	77
1941—50	18	133	110	154	162	74

*The census actuaries of 1951 classified the provinces as following :

A. "Registration may be regarded as reasonably satisfactory.. ...Bombay, Madras, the Punjab and Madhya Pradesh."

B. "Registration cannot be regarded as reasonably satisfactory.. .Uttar Pradesh, Bihar, Orissa, West Bengal and Assam" (op. cit., p. 2). Further .... "it appears that in States like Assam and Bihar registration is particularly bad while in Uttar Pradesh and West Bengal it is comparatively better though still bad enough. In the major portion of Madhya Pradesh and Punjab it is not unsatisfactory. As regards birth rates it seems clearly established that where the registered rate is lower the percentage omission is high. This shows that the lower birth rate which is being shown in the recent years by the registration data is due more to under registration than to any substantial reduction of births in the country", op. cit. p. 43.

**The table has been compiled from the annual figures of registration in the official health publications. The figures for 1941—50 are for the years upto 1947. The figures for Bengal is for the province before the partition.

birth rate is correlated with the rate of increase in the population. This is demonstrated in Table 4, which compares the percentage fall in the birth rate since 1911-20 with the percentage increase in the population.

TABLE 4

Province	Percentage Increase of Female Population, 1911-20 to 1941-50	Percentage Decline in Registered Birth Rate 1911-20 to 1941-50
Assam	66	48
West Bengal . . .	36	47
Bihar and Orissa . . .	27	42
Uttar Pradesh . . .	27	41
Madhya Pradesh . . .	22	19

In spite of rather wide divergencies there is a definite association between the rate of fall in the birth rate and the rate of increase of the population. This supports the view that in all these regions the rate of omission is a function of the population increase. The constancy of the absolute number of registered births suggests that in all these regions the registered births refer to a more or less fixed sample of an increasing population.

We may conclude that the first six provinces show a tendency to a systematic underestimation which would occur if a fixed sample of an increasing population were kept under observation and if the births of this fixed sample were substituted for those of the entire population, other errors being fairly constant during the period. This being so, it is worth drawing attention to the factors which might have produced the systematic bias referred to.

It is not difficult to visualise how such a situation may have arisen. The registration departments in most regions are known to be lagging behind as regards the expansion of their staff. The traditional and still existing employee at the village level is the headman or chowkidar of the village. As the population has gradually increased, the village area has also spread and the burden of work vastly increased without any augmentation of the staff to take over the extra burden. The headman has been forced to a simple solution. He has not increased his coverage with the increase of work in his jurisdiction. He has been covering the original sample and thus tracing the vital events of the same population as in the former years, this coverage being determined by contiguity and accessibility. In recording the births and deaths of a practically fixed population he is also subject to some omission. But this rate of omission, as far as his fixed sample is concerned, is practically constant. That is, he is working with the same level of efficiency. Registering the vital history of a fixed population with a constant rate of omission has produced several features in his records.

(i) The short-range rise and fall in the area is correctly reflected in the sample and is correlated with the rise and fall in the region as a whole.

(ii) As estimates of total births or deaths his records become increasingly deficient in proportion to the population increase within this legal jurisdiction. In regions with a static population he has maintained the same level of efficiency while in regions with a rapidly increasing population his record of births or deaths loses all semblance to reality.

In all the first six provinces mentioned before (*i.e.*, Assam, Bengal, Bihar, Orissa, Uttar Pradesh and Madhya Pradesh) this force had been at work and therefore the correction formulae which were devised for West Bengal may be applied in all these regions. The three exceptions to this rule are the provinces of Bombay, Madras and the Punjab. But these are exceptions which demonstrate the rule. The first six provinces discussed before are all provinces which were settled temporarily or permanently with private landlords. In all these regions the collection of land revenue and other essential revenue operations are entrusted to private landlords who maintain their own staff for this purpose. The government employed village headman is a kind of welfare officer with no important administrative responsibilities. In the other provinces (*i.e.*, Bombay, Madras and the Punjab) the case is different. These three provinces are known as ryotwari areas, in which the government collects the revenue directly from the rural people through the village headman. The village headman is thus the agency through which the government carries on important administrative functions. It is understandable that while in areas settled with private landlords the government has paid no head to the requests of the village functionary to augment his staff to keep pace with the increasing work, it has taken care to see that adequate staff is maintained in the directly settled ryotwari areas to collect the necessary revenue and

to carry out other important functions in which the government is interested. This has resulted in a gradual deterioration in the coverage of the village headman in the landlord-settled areas, though the directly settled provinces have maintained approximately a constant levels of efficiency. The problem of correcting the registration statistics for the two separate groups of provinces may thus be considered as requiring two distinct approaches.

III

In the present section we shall attempt to estimate the rate of omission in the group of privately settled provinces which have a steadily deteriorating system of registration. The correction formula for this group of provinces was devised in the earlier paper as follows :

Let P_0 be the initial female population in a region and B_0 the number of births occurring there at time t_0. Let the village official register on an average b_0 out of B_0 births in the same period, covering p_0 women. His initial correction factor will therefore be B_0/b_0. At time t_1 let the female population rise to p_1. But the official is still covering only p_0 females. Let his new birth register be b_1, which will be the order of b_0, subject to small changes. To correct his records for both the initial omission and the increase due to a fixed coverage in an increasing population, we arrive at the formula for correction as follows :

$$\frac{b_1.P_1.B_o}{P_o.b_o}$$

As the ratio P_1/P_0 can be easily evaluated for specific decades from the census, the corrected record of births for any specific period will enable us to estimate the initial error b_0/B_0.* Taking the initial decade as 1911-20, we obtain the following ratios of the average female populations of succeeding decades to that of 1911-20.

TABLE 5

Decade	Ratio of Average Female Population of Succeeding Decades to 1911-20				
	Assam	Bihar & Orissa	Madhya Pradesh	Uttar Pradesh	West Bengal
1911—20 .	1·00	1·00	1·00	1·00	1·00
1921—30 .	1·13	1·04	1·01	1·06	1·02
1931—40 .	1·40	1·16	1 12	1·11	1·16
1941—50 .	1·66	1·27	1 27	1·22	1·36

The selection of 1911-20 as the initial decade is, of course, arbitrary and has been taken because data on the present provincial units are not uniformly available before this date. But it can be easily shown that if we take any arbitrary period and its population as the initial starting point such a selection will not affect the result provided the total omission of this period is also taken as the initial omission. This may be demonstrated as follows :

Let the initial period be t_0 and the period under consideration be $ti + j$, also let ti be any intermediate period. Then the correction factor by our formula for the omission in the i th period will be

$$\frac{B_i}{b_i} = \frac{P_i.B_o}{P_o.b_o}$$

This simply implies that if the total omission in the i th period is due only to the initial omission rate and the population growth during this period, which growth has been completely excluded from the current coverage, then the correction factor for the current period may be obtained by weighting the initial correction factor by the ratio of the two populations.

Now using the i th period as the original period we obtain the correction factor for $ti + j$ in the same way as follows :

$$\frac{P_{i+j}.B_i}{P_i.b_i}$$

We can substitute in the above expression for B_i/b_i the expression given earlier in terms of the initial period t_0, as follows :

$$\frac{P_{i+j}B_i}{P_i.b_i} = \frac{P_{i+j}.P_i.B_o}{P_i.P_o.b_o} = \frac{P_{i+j}.B_o}{P_o.b_o}$$

The assumptions in this derivation is the same as in our main derivation of B_1 which is discussed earlier in this section. This is that the headman is covering an approximately fixed population with a constant efficiency and that the population which is escaping his coverage has the same rate of birth as the population which is being covered

*In the earlier paper the ratio P_1/P_0 has been taken as representing the married female population of age 15-50, which is the relevant population for birth correction in our formula. But owing to the difficulty of obtaining details by age over the entire period, and specially for the partitioned areas this population has been replaced by the total female population. However, our data will not be affected in any significant degree. The ratios of total female population in the two decades and the adult female population in the two decades are generally quite close.

by him. With these assumptions the selection of any period as the initial period and its total omission as the initial omission do not affect the calculation of the later period.

Using the ratios of the female population in 1941-50, to that in 1911-20 as given in Table 5 we obtain an estimate of the rate of omission in 1911-20 (which in this case is our arbitrary initial period) from the census estimate of the total omission in 1941-50 as follows :

$$\frac{P_{1941\text{-}50} \cdot B_{1911\text{-}20}}{P_{1911\text{-}20} \cdot b_{1911\text{-}20}} = \frac{B_{1941\text{-}50}}{b_{1941\text{-}50}}$$

where B stands for the actual births and b stands for the recorded births. Table 6 gives the initial rate of omission in our arbitrary period (1911-20) as given below :

TABLE 6

Province	Initial Rate of Omission (per cent) as derived from present Formula
Assam	35·8
West Bengal	21·5
Bihar and Orissa	22·6
Uttar Pradesh	18·5
Madhya Pradesh	0·0

Using the population ratios of Table 5 with the above rates in our formula we arrive at the rate of omission for the successive decades from 1911-20 for the different provinces as follows :

TABLE 7

Decade	Rate of Omission (per cent)				
	Assam	Bihar and Orissa	West Bengal	Uttar Pradesh	Madhya Pradesh
1911—20 .	35·8	22·6	21·5	18 5	0·0
1921—30 .	47·2	24·8	23·7	20·0	5·6
1931—40 .	57·2	32·3	32·1	27·2	10·3
1941—50 .	64·0	39·4	42·1	35·8	18·2

Comparison of these estimated rates of omission with rates estimated by Kingsley Davis for the decade 1921-30, is possible for all the provinces, save for West Bengal.* In the following table we have compared the rates estimated by Davis for 1926-30 with our rate for 1921-30 except for West Bengal. For West Bengal we have substituted alternative rates estimated by us from fertility enquiries as given in the earlier paper.**

TABLE 8

Province	Census Omission Rate for 1941-50	Omission Rate by present Formula for 1921-30	Omission Rate estimated by Davis for 1926-30
Assam . .	64·0	47·2	45·6
West Bengal .	42·1	23·7	27·9
Bihar and Orissa	39·4	24·8	25·4
Uttar Pradesh .	35·8	20·0	22·3
Madhya Pradesh	18·0	5·6	7·1

Considering our own estimates and those arrived at by Davis by the reverse survival method, the two sets are quite close in most of the cases. It appears, therefore, that our method gives valid estimates for the whole region comprising these six provinces. It is interesting to note as in Table 7 that in West Bengal, Bihar and Orissa, and Uttar Pradesh rates of omission in 1911-20 were fairly close. Assam had a poor system of registration as early as in 1911-20. This is quite likely for communications in Assam are very poor. It is most likely that the rates of omission in Assam and East Bengal (now East Pakistan) are quite high and of the same order for the same reason. Madhya Pradesh had almost complete registration in the earlier years, but with population increase the situation is fast deteriorating everywhere in this region. The highly varying rate of omission today is the result both of differing rates of population increase and also of the different initial rates with which the regions started.

IV

It has been seen that out of nine provinces, the registration system in six is increasingly underestimating the actual number of births. But we have

*Davis has calculated the omission rate in 1926-30 for Bengal as a whole. We have shown in a note in the Appendix that this rate is quite consistent, but is not applicable to West Bengal.

**Loc. cit.

a se seen that Bombay, Madras and the Punjab have more or less constant rate of registration with no evidence of any increasing inaccuracy. The following figure for the rates of omission estimated for different periods show that the rates of omission have not increased and may even have decreased slightly in these provinces.

TABLE 9

Province	Rate of Omission (per cent) Census 1901-11	Davis 1926-30	Census 1941-50
Madras .	26·5	16·1	13 7
Bombay . .	22·8	19·8	18·6
Punjab . .	7·0	..	4·1

It is not safe to suggest that there has been a consistent decline in the rate of omission as the differences in 1926-30 and 1941-50 are small, while the estimate for Madras in 1901-10 seems somewhat high. But we shall not be greatly in error if we assume a constant rate of omission for these provinces during 1911-50.

We can therefore estimate the births for Bombay, Madras and the Punjab by working on the average rate of omission during 1926-50 as derived by combining the two rates for 1926-30 and 1941-50. The average rate is taken on the assumption that the differences during this period are not significant. In any case the order of difference, especially during 1926-30 and 1941-50, is not large enough to cause any significant additional error in the estimates.

Calculating the births for the first six provinces on the basis of formula discussed in Section III, and for the last three on the basis of a constant error of omission as discussed above, we give below the corrected birth rate for the nine provinces for the decades 1911-20, 1921-30, 1931-40 and 1941-50.

TABLE 10

Province	Birth Rate per 1,000 Population Reconstructed by Present Formulae for 1911-20	1921-30	1931-40	1941-50
Assam . . .	50·3	51·3	59·8	46·7
Bihar and Orissa	50·1	46·3	46·6	37·0
West Bengal : .	41·8	37·6	40·6	35·4
Uttar Pradesh . .	51·2	42·5	47·0	38·0
Madhya Pradesh .	45·5	43·4	40·9	45·2
Madras . . .	36·1	37·5	40·8	36·2
Bombay . . .	43·3	45·0	46·7	41·3
Punjab . . .	45·6	42·3	44·8	41·1

In terms of these corrected figures Bihar and Orissa, Bengal and the United Provinces show a slight tendency to decline, though this decline is rather offset during 1931-40. The provinces of Assam, Bombay, Madhya Pradesh, Madras and the Punjab have practically remained stationary with only random fluctuations. The birth rates for the combined provinces on an all-India scale, ignoring the regions which were previously not part of British India, are given below with the registered birth rates showns for comparison.

TABLE 11

Decade	All Provinces: Registered Birth Rate per 1,000	Reconstructed Birth Rate per 1,000 from Formulae	Estimated Rate of Omission (per cent) in Registration
1911 –20 . .	37·5	45·5	18·6
1921—30 . .	34·2	42·4	19·4
1931- -40 . .	34·2	45·2	24·4
1941- 50 . .	27·5	38·8	29·2

For the group as a whole trend is perhaps slightly downwards, with an offsetting rise during 1931-40. But it is interesting to note that the effect of the increasing error of omission with time has offset this rise in the registered series, thus appearing to show a definite downward trend during the whole period. The estimated rates of omission indicate that there has been a consistent deterioration in registration throughout the period but because it has been gradual and has not disturbed the apparent trend, it is not easily detected. Unless there is a change in the registration system, this apparent downward trend will continue to appear in the registered statistics in the future.

V

An estimate of the extent of under registration of infant deaths may be obtained by methods analogous to those used for the correction of birth

registration. In the case of infant mortality we can use a correction formula expressed as follows :

$$D_1 = \frac{d_1 . B_1 . D_o}{B_o . d_o}$$

where D_1 is the actual number of infant deaths in the period under consideration ; d_1 are the recorded deaths in the period ; B_1 and B_0 are the births actually taking place during the period under consideration and the initial period; and D_0 and d_0 are the actual and the recorded infant deaths such that d_0/D_0 is the initial rate of registration. The only alteration in this case is the use of the ratio of births instead of that of the female population for correcting the increase in omission due to the increase in the population. While the ratio of population increase would have given us similar results the birth ratio may be more relevant in the case of infant deaths than a simple index of population increase. In any case the difference is the result by either calculation was found not to be very large.

From our earlier estimates of the error of omission in births registration, we can evaluate the value of B_1/B_0 for the first six provinces. As in the case of the birth correction, estimates of total omission during any period will now enable us to evaluate d_0/D_0, or the initial rate of death registration. Adopting the actuarial rate of infant mortality in the census of 1931 as the correct rate of infant mortality for 1921-30 and taking our estimates of the corrected number of births, we arrive at the following percentage of initial omission in the registration of infant mortality.

TABLE 12

Province	Estimated Rate of Omission in Infant Mortality Registration per cent
West Bengal	54·9
Assam	56·2
Bihar and Orissa	54·9
Uttar Pradesh	46·0
Madhya Pradesh	0·0
Madras	29·7
Bombay	38·5

The first set of figures shows the initial rate of omission in provinces with an increasing omission in time, while the second set shows the rate for the provinces of Bombay and Madras, with a constant rate of omission. In the Punjab the rate of omission is almost negligible.

The following table shows the rate of omission during the four decades for the different provinces, with the exception of the Punjab.

TABLE 13

Decade	Rate of Omission (per cent) in Registered Infant Mortality						
	Assam	West Bengal	Bihar and Orissa	Uttar Pradesh	Madhya Pradesh	Bombay	Madras
1911—20	56·2	47·8	54·9	46·0	..	38·5	29·7
1921—30	61·2	48·8	56·6	46·5	5·7	38·5	29·7
1931—40	68·7	55·0	61·1	53·4	10·0	38·5	29·7
1941—50	73·6	61·7	64·5	57·5	18·1	38·5	29·7

An interesting feature of the omission rate is that while the number infant deaths has been progressively underestimated, this has not affected the infant mortality rate to the same extent because of the simultaneous increase in the under registration of births. The net effect may be seen in Table 14, which shows the ratio of the recorded infant mortality rate to the corrected rate.

TABLE 14

Decade	Registered Infant Mortality Rate as percentage of Corrected Infant Mortality Rate					
	Assam	Bihar and Orissa	West Bengal	Uttar Pradesh	Madras	Bombay
1911—20	68·4	58·4	72·4	66·2	83·1	77·8
1921- -30	73·5	60·8	70·7	66·9	79·1	75·1
1931- -40	72·9	56·8	67·4	63·7	80·8	79·2
1941- 50	73·3	56·6	65·7	63·3	84·1	77·4

This result follows from our correction formula for infant mortality. Thus if D_1 be the number of infants actually dying, and B_1 the number of infants actually born, then by our formula we have

$$\frac{D_1}{B_1} = \frac{d_1 B_1 D_0}{B_0 d_0} \div \frac{b_1 P_1 B_0}{P_0 b_0}$$

Thus as B_1/B_0 is very nearly equal to P_1/P_0 in most cases, the ratio during the decades tends to be proportionate to the two initial rates of omission of births and deaths.

The estimates arrived at by our formulae may be compared with similar rates computed by other authorities using different methods. Table 15 gives the estimated rates as calculated by the census actuaries for 1901-11, 1921-30 and 1941-50. *

TABLE 15

Province	Rates of Infant Mortality per 1,000 Live Births									
	1911-20	1901-11	1911-20	1921-30		1931-40		1941-50		
	Registered Rate	Actuarial Rate	Rate from Formulae	Registered Rate	Actuarial Rate	Registered Rate	Rate from Formulae	Registered Rate	Actuarial Rate	Rate from Formulae
West Bengal . . .	205	298	283	181	242	159	230	115	160	147
Assam	208	298	330	143	235	134	236	125	237	202
Bihar and Orissa. . .	193	298	304	178	242	156	214	148	237	221
Uttar Pradesh . . .	233	298	352	178	266	153	240	120	212	210
Madras	197	274	237	178	225	177	219	152	237	202
Bombay	211	296	271	178	237	164	207	154	237	208

*Census of India 1931, Vol. I, Report, p. 161.
Census of India 1951. Paper No. 2, Life Tables, 1951 Census, Table 9, page 20 (only the upper limit of the estimated range has been given here.)

As our ow estimates are based on the rates of infant mortality in the census of 1931, the comparison with the other two estimates of 1901-11 and 1941-50 is of interest. The agreement is quite good in the case of the figures of 1941-50 where the upper range of the actuarial rate is given, though in the case of the decade of 1901-11 it is naturally not so close. It should be remembered that the census calculations are for rather wider areas and not for individual provinces. Considering the very approximate nature of these estimates, the agreement is by no means poor.

VI

The calculations of under registration in births and infant deaths may now be used to estimate the approximate number of births and the numbers surviving for specific census years. In this section we shall give such estimates for the years 1920, 1930, 1940 and 1950.

It must be noted that the correction system discussed in this paper is a correction for an average over a decade rather than for a specific year. Random fluctuations in the rate of omission in specific years will not be allowed for in our correction. But it has been pointed out earlier that the rate of omission does not show any violent change from year to year and therefore the order of such error should not be large. For comparison, Table 16, which summarizes the results, also gives the number recorded at age 0-1 in the corresponding census and the number of births estimated by the census actuaries of 1951 on the basis of the census enumerations of infants of age 0-1 in respective census years.

At the outset it may be useful to point out that the estimates of births made by the 1951 Census actuaries on the basis of the enumerated infants are, on their own admission, too low for the following reasons: First, no correction for underenumeration has been made, and secondly, registered infant deaths, which are themselves underestimates, have been used. The actuaries' opinion is quoted briefly below.*

In general, it may be seen that there is evidence of significant underenumeration in the census counts of infants aged 0-1 in all the three censuses of 1921, 1931 and 1941 in varying degrees. In 1951 there is much less evidence of underenumeration in most of the provinces, and this agrees with the general opinion of the actuaries of the 1951 Census who comment as follows :

"Leaving out Assam, practically all the past censuses in the various States give evidence of underenumeration of infants. Only 1951 Census data except for Madras do not give evidence of underenumeration according to the method adopted here."**

VII

Using our estimates of actual births, we may examine the fertility rates of married women of reproductive age. Table 17 shows the number of births per 1,000 married women aged 15-50† in the different provinces during the four decades.

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*"In all probability there is underenumeration (in the census) and not overenumeration.....If anything it may well be understated due to omission of infants from being recorded in the census. The latter is more true of the Indian census. It therefore appears that the extent of omission in registration brought out.....may well be taken as an estimate of the lower side of under registration."

"If anything, the registered value of I which is adopted in the calculations is an underestimate (of infant mortality . The combined effect is that the expression (I-r. I) is overstated with the consequent result that the number of births.....is understated." Census of India, Paper No. 6, 1954, "Estimation of Birth and Death Rates in India during 1941-50, p.50.

**Census of India, Paper No. 6, 1954, p. 53.

†Where figures of age composition for married women were not available for some regions for certain periods, estimates have been used.

TABLE 16

Province	Years	Census Counts of Infants (0-1 at Enumeration	Our Estimate of Infants aged (0-1 from Formula*	Registered Number of Births for Years of Census	Births Estimated by Actuaries from Census Counts	Our Estimates of Births from the Formula	Estimate of Under-enumeration of Infants per cent of: Registered Births	Estimate of Under-enumeration of Infants per cent of: Census Counts
Assam	1920	134,858	160,393	122,404	154,796	190,660	36	19
	1930	186,844	203,936	140,649	212,140	266,380	47	20
	1940	193,500	287,191	156,155	213,200	364,848	59	32
	1950	269,840	230,990	110,138	290,370	305,938	64	5
West Bengal	1920	510,061	505,919	544,372	603,408	639,467	21	13
	1930	581,962	511,280	517,339	675,600	678,032	24	..
	1940	565,250	925,506	657,603	632,059	957,209	31	34
	1950	591,474	684,716	440,880	650,686	761,450	42	15
Bihar and Orissa	1940	860,600	1,658,845	1,171,966	946,270	1,731,107	32	45
	1950	2,001,218	1,157,124	837,691	2,125,491	1,382,328	39	..
Uttar Pradesh	1920	1,388,700	1,568,855	1,662,192	1,642,848	2,039,499	19	19
	1930	1,497,178	1,794,000	1,693,173	1,700,758	2,116,466	20	20
	1940	1,371,700	2,159,906	1,680,595	1,514,853	2,308,509	27	34
	1950	2,056,050	1,806,004	1,295,505	2,219,158	2,017,920	36	..
Madhya Pradesh	1920	388,252	462,123	544,081	470,210	544,081	..	14
	1930	542,593	633,926	664,217	653,254	703,619	6	7
	1940	408,529	551,174	627,946	485,304	700,051	10	31
	1950	621,586	707,758	604,609	720,429	739,179	18	2
Madras	1920	969,269	1,025,492	1,023,656	1,094,972	1,204,301	15	9
	1930	1,139,207	1,481,164	1,463,962	1,308,681	1,722,237	15	24
	1940	1,140,700	1,647,512	1,584,198	1,292,724	1,863,762	15	31
	1950	1,280,190	1,622,745	1,538,540	1,408,349	1,810,047	15	22
Bombay	1920	570,145	603,945	593,175	..	750,854	21	4
	1930	647,732	766,578	716,952	..	907,534	21	16
	1940	612,500	809,035	755,817	..	956,730	21	24
Punjab	1920	381,492	356,307	402,369	444,319	..	..	..
	1930	394,957	395,494	437,486	455,177	..	..	..
	1940	362,200	485,892	522,404	420,478	..	..	25
	1950	442,870	443,548	479,429	498,727	..	..	..

*These estimates have been arrived at by correcting the registered birth and infant deaths for specific census years, and by applying a further correction for deaths occurring throughout the calendar year.

TABLE 17

Province	Births per 1,000 Married Women aged 15- -50 by Decades			
	1911-20	1921-30	1931-40	1941-50
Assam . . .	284	290	334	267
West Bengal . .	237	207	211	191
Bihar and Orissa .	254	237	230	182
Uttar Pradesh . .	260	217	234	185
Madhya Pradesh .	225	217	195	214
Madras . . .	190	196	209	181
Bombay . . .	230	239	239	208
Punjab . .	259	245	253	224
India . . .	**237**	**217**	**228**	**200**

The fertility rates show practically the same type of movement as were seen in the crude birth rates for the different provinces. There is a slight tendency towards a decline in West Bengal, Bihar, Orissa and Uttar Pradesh. Assam, Madras, Bombay and the Punjab (East) do not show any definite trend. For the country as a whole the trend seems to be one of very slight decline, and this conclusion is in broad agreement with that arrived at by Davis.*

The relative positions of the provinces have remained approximately the same throughout the period. Thus the fertility rates in Assam and the Punjab are generally higher while the rate for Madras is generally lower than that of the other provinces. Those other provinces differ from each other only to a minor degree. Indeed, considering the approximate nature of the estimates such differences should not be regarded as very significant.

Summarising the results, it may therefore be concluded that during the period 1911-50 there has been a very slight change in the fertility levels in India. Further the relative positions of different regions have remained almost constant, such changes as did take place affected the entire area equally.

*"There is some evidence here that after 1921 the birth rate started to decline slightly" ....."It would not do to extrapolate the past trend partly because of possible errors in the figures and partly because there is hardly any trend, observable", Davis, op. cit., p. 69.

APPENDIX

Note on Bengal

We have seen earlier that Kingsley Davis's estimate of a rate of omission of 41.2 per cent for Bengal in 1926-30 is different from our estimate of 27.9 per cent for West Bengal in 1921-30. It is interesting to note that Davis's estimate of the error of omission at 41.2 per cent for Bengal is also borne out by the estimate of the census actuaries of 1931, who put the figure at 37 per cent, during 1921-30. Accepting the census estimate of an omission rate of 37 per cent, the corrected birth rate gives us a figure of 41.9 per 1,000. Using this corrected rate we can work back to the rate of omission in 1911 20 by using our formula. The ratio of population increase during 1921-30 to 1911 20 for Bengal as a whole was 1.05. According to our formula the initial omission rate in 1911-20 comes out as 29 per cent, the census estimate of 1921 being 26.4 per cent, which agrees fairly well with our estimate. It is thus evident that working back to 1911-20 our formula for Bengal as a whole gives figures consistent with other estimates, accepting a figure roughly equal to Davis's estimate for 1926-30. We may, therefore, safely say that the rate for Bengal as a whole for later periods is higher than that of West Bengal. The omission rate for 1941-50 for West Bengal as calculated by the census actuaries is lower than what would be obtained for Bengal as a whole during this period. This is quite understandable if we compare rates of omission of Assam with those of West Bengal in 1941-50. In 1941-50 the rate of omission for Assam was 64 per cent against 42.1 per cent for West Bengal. East Bengal, being a very backward area as regards transport and communications and being very densely populated, it is more likely that its rate of omission will be nearer to that of Assam which is similarly placed than to that of highly urbanised West Bengal. The following table shows the relevant figures :

Decade	Registered Birth Rate for Bengal	Corrected Birth Rate Bengal	Omission Rate per cent
1911—20 . .	32·8	44·7	26 (census) 29 (formula)
1921—30 . .	28·5	41 9	37 (census 41 (Davis

As partition of the province took place in 1946 the census of 1951 is limited to the West Bengal area. Our scrutiny of both East and West Bengal thus shows that it would be wrong to compare Davis's estimate for the whole of Bengal with the area included in West Bengal which is what the census authorities have done.

On the measurement of differential fertility among the population of Calcutta and Bombay

I

In the first two papers in this monograph it was seen that to establish correctly even simple birth or death rates from official sources elaborate reconstruction procedures had to be resorted to in order to fill in the gaps, or, to adjust for known distortion in the series. It is even more difficult to come to any conclusions regarding differential fertility among the various socio-economic strata in the country as it implies a more accurate measure sufficiently sensitive to detect comparatively smaller differences that may exist among the different sections of the population in this respect.

And yet the study of differential fertility among various sections of the population often gives us important data on the nature of demographic movements and its future directions. Thus if there is considerable difference in the birth rate of the literate and the illiterate sections then it may be assumed that other conditions remaining the same the general birth rate of the population will move towards that of the literate, section as the rate of literacy in the community goes on increasing. A study of the association of fertility with other socio-economic characters of the population enables us to determine the factors influencing it and hence of determining the future possibilities in the demographic trends character of the population.

The object with which the present study was undertaken initially was to investigate whether there is any differential fertility among the different socio-economic strata of the population in urban regions in India. It was found, however, during the course of the investigation that such a study in the present state of data with respect to births, deaths etc., in most areas involve a large amount of

reconstruction and correction of existing official statistics. Since no straightforward way of getting the requisite information exists it was thought that a reconstruction however crude in nature may be of some use in this respect. It was also hoped that the system of reconstruction itself will be an object lesson in the nature and limitations of demographic statistics in India and the kind of research needed to make up for the gaps. While therefore, the conclusions arrived at through such elaborate reconstructions will be acceptable only to the extent the reconstruction itself is acceptable the study in itself may be still of sufficient interest to students of Indian demography.

The present study is confined to the two major cities of India *viz.*, Calcutta and Bombay only. As the data relating to the city of Bombay is sufficiently reliable no particular reconstruction process has been thought necessary. The bulk of the paper, therefore, is mainly devoted to a consideration of the birth rate in Calcutta for the different sections of the community.

II

The traditional analysis of differential birth rates in Indian demography is generally confined to a comparison of the rates in different castes and communities of the country mainly for the reason that some information is available on these lines and also because it is generally thought that this form of approach gives us good stratification of socio-economic characters of the population. Two such studies made during the Census of 1921 and 1931 may be briefly discussed as to their findings as it seems to demonstrate the inconclusive nature of the results arrived through this line of approach. In 1931 a survey was made in the rural areas of Bengal on the number of living births per mother in various regions of the province. The following table gives the results obtained for the various castes and communities.

TABLE 1

Caste or Community	Number of living births per mother in Bengal				
	West	Central	North	East	Total
Brahmin .	6·0	6·3	6·4	6·5	6·3
Kayastha .	5·5	6·9	6·4	5 5	5·8
Other Hindu	5·5	6·1	5·8	5·7	5·8
Muslims .	6·7	6·3	6·6	5·8	6·1
Others .	6·3	6·0	5·4	6·6	6·0

The above figures make it quite clear that even within one province the prepartition Bengal comprising West Bengal and East Pakistan of today relative position of the different castes and communities vary from region to region. The kayasthas for example, come 4th in the west, 5th in the east, 1st in the central and 2nd in the province as a whole. It becomes difficult therefore, to generalise by such classification even within one province.

When we come to similar variation in the urban areas we meet with an identical situation. In the survey of 1921 organised by the Census authorities number of births per mother was collected from different urban areas of Bengal excluding the city of Calcutta itself. The following table gives the relevant information from this enquiry.

TABLE 2

Caste or Community	Number of births per mother in urban areas of Bengal					
	Burdwan	Presidency	Rajshahi	Dacca	Chittagong	Province
Caste Hindu	5·5	5 6	5·5	5·7	5·5	5·6
Other Hindu	5·3	5 5	5·1	5·4	5·5	5·3
Muslims	5·2	5·2	6·0	5·9	6·7	6·3
Total	5 4	5·5	5·5	5·7	5·7	5·5

Here again it may be noted that the muslim community has the lowest births per mother in Burdwan and the highest in Chittagong.

It is thus evident that as far as fertility rates are concerned the relative position of the different castes and communities vary even in adjoining areas. This is not surprising as caste or community groupings are not sufficiently homogeneous for our purpose. Caste and community are certainly not good dividing lines for socio-economic purposes. Economic and caste stratification do not coincide but cut across each other in many cases. As frontiers of economic or social strata they might have been more reliable probably in much earlier time but are certainly not so today.

It is thus seen that usual lines of approach to the problem *via* the religious and caste groupings of the population do not lead to any satisfactory conclusions. In the present paper, therefore, a fresh line of approach has been taken up. This is also an indirect approach in the sense that instead

of measuring some character directly with respect to the population involved we have been forced to study regional groups classifying the regions according to the differentiating criterion, and then to study the birth rate for such regional clusters. For the purpose of socio-economic grouping we have selected the rate of female literacy in the region as the selective criterion. It has been assumed that this criterion in conditions of India during the period of the enquiry, is a very significant one from the standpoint of our study. In fact, it is even more important as a measure of an urban culture than income as there are communities in India who are quite well-to-do but are still lagging behind in their attitude with regard to the female population. In fact, under Indian conditions this rate is a sensitive index of a whole complex of social and economic characteristics of the urban population.

As it is not possible to stratify the population of the city in this manner without adequate reconstruction of the birth rates we shall first try to study the birth rates of several rather broad regional clusters of the city grouped under a wide range of literacy. This preliminary analysis will reveal the problems to be encountered and will also give us some estimates which may be used for checking purposes.

Before proceeding with the analysis we may find it useful to discuss briefly the regional units into which the city of Calcutta is divided for registration and enumeration purposes by the Municipal authorities and the nature of the vital statistics one can obtain from these regions. For reasons of lack of data for sufficiently large area for a long period we have confined the present analysis to the decade 1921-40.

III

The Municipal boundaries of Calcutta has been shifting with the increase of the population. For the present study the city consists of 32 wards grouped under 5 districts. Of these, two districts have been added to the city almost during the beginning of the period of study *i.e.*, in 1920-24 and the administration of health in these two districts did not start functioning properly at all for some time. It will be found that in many respects these two new additions to the city have to be treated with special scrutiny with respect to the data on vital statistics. An additional difficulty has been that while the original three districts are in some sense more homogeneous with fairly big middle class components these two new additions, being on the suburbs have larger working class contingents with entirely different standards of life and civic amenities. These two districts have been treated in the present section as fairly distinct clusters.

This is because the registered births of the city are recorded for each ward separately as regards all cases of home deliveries. The hospital deliveries however are recorded in the districts in which the hospital is located. This makes it impossible to estimate the births in a ward in a straight forward manner. Not only that, it makes it also difficult to correctly assess the number of births in a district. The only approximate solution to this difficulty lies in aggregating several districts together so that the hospitals which principally cater to these districts may be within the aggregation. This is certainly not a very precise method as there may be still some births registered in one of these aggregates which do not belong to the aggregate. But by and large, such a procedure will eliminate gross mistake.

There is still another difficulty in studying the problem by units of a more homogeneous type. This is the varying rates of underenumeration in different regions of the city. The municipal authorities have made some study of the extent of underenumeration by districts but not by any lower unit. To make, therefore any correction of the figures for underenumeration we are forced to units no smaller than a district.

It would have been desirable as a first approach, to study the problem at least district wise but the mix-up of hospital deliveries make it necessary to take districts I, II and III together for our studies. This is because these three districts are sufficiently compact and interconnected to make it practically impossible to separate out the hospital deliveries of these three districts on any basis. There is so much of inter-district movements in this respect that it may be generally assumed that availability of beds rather than location really is the deciding factor in determining the hospital which will be selected by a resident.

In the matter of district IV and V however we can afford to be a little less restrictive. District IV and V were during this period outlying suburbs

of the city just brought into the city administration. They were also inhabited by predominantly working class people who during this period were still not used to availing themselves of hospital services in this respect and using hospital services was still essentially a practice of the comparatively well informed and well to do sections of the population. Further, as both these districts also had hospitals of their own there would be less chance of persons in these districts to attend hospitals in I, II or III. It is, therefore, reasonable to assume that in the case of residents of these two districts (IV and V) hospital deliveries in I, II and III have less often taken place.

We have thus assumed for the purpose of this paper that the problem of intermingling of births in the hospital will in the main be eliminated if we amalgamate districts I, II, III, and keep districts IV and V as distinct regions.

This classification also satisfies the criterion of our preliminary studies as the female literacy rate in the first group consisting of I, II, III is 37.8 per mile in 1931, in the second group *e.g.*, district IV it is 23.4 per mile, and in the third group *e.g.*, district V it is 15.0 per mile. Since detectable difference in female literacy rate exists between the three regions it is possible to associate any fertility differential with such significant changes in cultural patterns. We must warn, however, that the main difficulty with such broad groupings is the heterogeneous nature of the clusters themselves. That is to say, within these groups large pockets exist with literacy rates either much higher or much lower than that shown for the average.

IV

In the first paper of this series* it was shown that a firm estimate of the births occurring in the city as a whole may be obtained by applying a uniform correction for a 20 per cent underenumeration. The following table was obtained for the average number of births in the city during 1921-30 following different methods of estimation suggested by different authorities.

TABLE 3

Source and nature of correction	Estimation of average number births during 1921-30 in Calcutta
Registration figures (uncorrected)	20,055
Registration figures (corrected for omission)	23,825
Estimates from registered births with a mark up of 20 per cent	24,470
K. S. Roy's estimate** from Census enumerations	23,960
Estimate by the author fron fertility studies	24,262
Estimate by the author from census ratios	22,709

It may be noted that all estimates point to an underenumeration of the order of around 20 per cent for the city as a whole.

To get an idea of the variation in the rates of omission in the different districts of the city we give below the ratio of omission to total births in per cent for the five districts as detected by the Health Department from the infants who came for vaccination.

TABLE 4

Year	Per cent of omission detected to total births registered by districts in the city				
	I	II	III	IV	V
1924 . .	44·0	23·6	22·4	0·9	0·7
1925 . .	26·5	11·0	20·0	3·3	1·1
1926 . .	34·4	15·6	19·5	7·6	20·8
1927 . .	28·6	26·1	21·2	1·9	7·1
1928 . .	33·4	16 4	17·1	2·5	17·8
1929 . .	31·/	17·5	20·0	5·4	17·6
1930 . .	33·3	16·6	17·9	4·4	17·8
1931 . .	30·6	13·8	12·8	4·6	17·5

*A study of the demographic trends in West Bengal etc. A. Ghosh. Population Studies 1966.

**Note on the omission in registration of birth in the city of Calcutta. K. S. Roy in Sankhya. Vol. IX, p. 165.

It should be pointed out that the present set of omission rates are based on the infants who were vaccinated and as vaccination is not by any means more than about 70 per cent or so this is not therefore a proper estimate of all the omission. But it is likely that at least in the first three districts they are reasonably near the proper estimate of the omission rate due to the fact that in these three districts a substantial number of births take place in the hospitals and other institutions and these are not necessarily vaccinated in all cases. Further, the omission rates found here do seem to agree with other estimates and are also fairly consistent from year to year. In the case of district IV and V the rate seems to be too low. We have for our purpose taken the rate for district IV to be similar to II and III. In the case of district V it is obvious that there is something wrong in the detection system. It is highly erratic. It was found in fact that the system did not work here at all. This is also demonstrated later by the fact that the births in the case of this district in particular are even less than those reported as vaccinated; if we take account of the fact that vaccination rate itself is far from 100 per cent and that there are large number of infant deaths in the very early weeks before any vaccination could take place such a gap can be explained by a much larger rate of underenumeration in this particular district.

In the case of district V, therefore, we have taken the same rate as that of district I as a lower limit of the rate of underenumeration. This was done as district V is contiguous to I and being a district which has been included in the city from only 1924, the administration did not function effectively during these years. As a tentative lower limit, therefore, the omission rate of district I will not be an unlikely level to take up for district V. Making these corrections for district IV and V it was found that we arrive at estimates of the total births in the city similar to figures established in the earlier table. In the following table is given the number of births registered and the omission rate assessed with sub-totals for a bigger aggregation comprising I, II and III together.

TABLE

Zone	Births registered (1921-30)	Omission detected	Total	Omission as per cent of all births	Omission as per cent of non-hosp. births
I . .	6,074	1,992	8,066	24·7	36·8
II . .	3,909	679	4,588	14·8	21·7
III . .	3,297	582	3,879	15·0	15·4
I-III .	13,280	3,253	16,533	19·6	22·8
IV (official)	4,123	208	4,331	4·8	5·1
IV . .	4,713	571	4,752	15·0	.
V (official) .	2,652	309	2,961	10·4	11·1
V . .	2,652	1,438	4,090	35·2	36·8
Total (official)	**20,555**	**3,776**	**23.831**	**15·8**	**17·9**
Total* .	**20,555**	**4,889**	**24,954**	**19·6**	**22·0**

*Our corrected estimate of District IV and V included.

In the final total for the city we have given two estimates taking for one of the cases the omission rates as given by the Health authorities and for the second case the estimates with corrected omission rates for districts IV and V. As is evident above the total for the city agrees well with other estimates when the corrections on district IV and V have been done on the basis of neighbouring districts of similar types.

We can now reconstruct the births for these regions also for other decades on this basis. In the following table we give the corrected number of births also for 1931-40 for the regions I—III and separately for IV and V.

TABLE 6

Zones	Corrected number of births registered	
	1921-30	1931-40
I-III	16,533	18,928
IV	4,752	7,667
V	4,090	5,665

In the above table the rate of omission for district IV has been assumed to be similar to that of II and III and raised to 15 per cent in place of the rate given by the health authorities which is 4.1 per cent. District V has been corrected as suggested earlier. Accepting these corrections as giving us a

rough estimate of the number of births in these regions we now compare the birth rate in these areas. For a comparison of the fertility of various sections of society the best indicator would be the number of births per 1,000 adult married women. In the absence of statistics for these regional clusters of the number of married women we shall consider the number of births per ,000 women. In selecting the number of women rather than the total population we have in mind the very different sex ratio among different sections of the population in the city as many working class people live without their families. The following table gives the comparative birth rates for the three regions.

TABLE 7

Zones	Rate of literacy per 1,000 women	Birth rate per 1,000 women		Infant death rate per 1,000 live births	
		1921-30	1931-40	1921-30	1931-40
I- III .	37·8	69·7	58·9	244	181
IV. .	23·4	77·9	72·?	242	187
V. .	15·0	94·7	76·0	263	219

In the case of district V the rate has been calculated on the basis of an omission rate similar to that of district I and for district IV on the basis of II and III combined as discussed before. It is evident from the above table that there is some indication of a differential fertility and that it is of the same type as in other countries *i.e.* that the more well-to-do sections have a lower rate of birth. The infant death rate also shows the expected pattern.

The above table, however, is based on a grouping of districts as units which are themselves very heterogeneous. It would be certainly more desirable to go down to smaller units for our purpose. We shall therefore try to build up alternative estimates from quite different considerations both as check on the present estimates and also for the purpose of obtaining a more refined classification of the regions by aggregating from much smaller and more homogeneous units.

For this purpose we shall try to go back to the municipal wards as the unit of classification. As pointed out earlier the main difficulty in studying with wards as the basic unit of classification is the intermingling of the births in the different hospitals coming from different wards. This makes a wardwise study of birth rates almost impossible. We shall try here therefore to use the data on infant vaccination and adult vaccination as indicators to build up the figures for births in the wards.

V

In this section we shall try to demonstrate that one can with approximation use the figure of infant vaccination to build up an alternative set of birth estimates in any area of the city. The Health Department gives the figures of vaccination of infants under one year for different wards of the city. A comparative study of these figures for the different regions reveals some interesting features. We give below for the different zones the registered number of births and the figures of vaccination of infants under one year plus the number of infants dying under one year for 1921-30 and 1931 40.

TABLE 8

Zones	1921-30		1931 40	
	Registered births	Vaccinated infants with number dead	Registered births	Vaccinated infants with number dead
I -III .	13,030	11,720	14,748	14,032
IV .	4,566	4,296	7,510	6,597
V .	2,463	2,939	3,571	3,878
Total .	**20,059**	**18,995**	**25,829**	**24,507**

It may be seen that the figures of vaccination plus the number of infant death are not very far off from those of the uncorrected figures of birth as given by the registration authorities. The figures of infant deaths have been added on to that of vaccination as the majority of infant deaths under 1 year occur in the first few weeks after birth and, therefore, they are in most cases unvaccinated. The similarity of these two sets of figures does suggest the possibility of using vaccination figures as a substitute for the registered number of births. The possibility of using these figures will also enable us to byepass the difficulties of getting the break downs for registered births for smaller units than a district. The vaccination figures are obtainable for the smallest unit *e.g.*, a ward and is free from

the difficulties we encountered with birth figures *e.g.*, hospital deliveries. But before we can use this substitute we have to get an estimate for the rate of non-vaccination for each ward just as we had to get estimates for non-registration. We now proceed to do this. It may be useful to explicitly state the basic assumption on which the present reconstruction is based. This is to postulate that the revaccination rate for adults and the corresponding rate for infants in a region can be more or less uniquely associated. Generally speaking an inspection of these rates in different areas and at different times showed that the two rates are in fact highly correlated. This high correlation is not fortuitious and may be easily explained in terms of social and economic factors. Vaccination in Indian cities is entirely voluntary and to a large extent therefore, is a function of the state of health consciousness of the population of the area. This was specially true during 1921-40 when the Health Authorities took far from adequate care in this respect. Generally, speaking the more health conscious the population in an area the more careful they were to have their infants vaccinated and to have themselves vaccinated. As people were generally more conscious of the need of primary vaccination than of revaccination the rate of primary vaccination was correspondingly higher in every locality but it generally moved in the same way as the rate of adult revaccination in the locality that is, higher the proportion of adult revaccination higher was also the corresponding rate of infant vaccination.

In the context of this phenomena it is not unreasonable to assume a constant ratio between the two rates averaged for the decade. The relation between the two rates averaged over a decade to eliminate chance variations should, therefore, be a good first approximation to the actual regression of the two. The rate of adult vaccination is obtainable for each ward. We can from this compute the rate for the city as a whole. Similarly for the city as a whole we know the corrected number of births as also the rate of the infant vaccination. We associate the rate of adult vaccination for the city with the corresponding rate of infant vaccination (always assuming that infants dying under one year are generally not vaccinated). In the following table we give these two rates and the ratio between these two rates for the city as a whole.

TABLE 9

Decade	Rate of vaccination		Ratio of col. 3 to 2
	Adult	Infant	
1921- -30 . . .	14·2	65·5	4·61
1931 40 . . .	20·9	69·8	3·34

We thus find that in the city as a whole during 1921-30 to every 142 out of 1,000 adults being vaccinated the corresponding rate for infants was 655 out of 1000 who survived. One can now use the number 655/142 as the ratio relating these two rates in different wards of the city on this basis. The following table gives the rate of adult revaccination and the estimated rate of infant vaccination for the region analysed previously.

TABLE 10

Zones	Per cent of adults vaccinated to total		Estimated per cent of surviving infants vaccinated to total	
	1921-30	1931-40	1921-30	1931-40
I- -III .	12·99	20·00	59·1	68·5
IV .	20·00	24·20	91·1	80·8
V .	..	18·30	..	61·1
Total .	**14·20**	**20·90**	**65·5**	**69·8**

Correcting the recorded number of infants vaccinated with the ratios obtained for these districts and adding the number of infants dying under one year we obtain the following estimates for the number of births in this region as against the corrected number of births estimated before.

TABLE 11

Zones	Estimated number of infants born according to			
	1921-30		1931-40	
	Registered births with correction	Vaccination records with adjustments	Registered births with correction for omission	Vaccination records with adjustments
I- -III .	16,533	17,266	18,928	18,500
IV .	4,752	4,547	7,667	7,783
V .	..	..	5,665	5,667

Though both the systems of correction are rough and ready ones they are in fair agreement with each other in an approximate sense.

It should be reasonable to use this process of adjustment also for smaller units in order to estimate the number of births in each ward from the figure of vaccination of infants and adult which are obtainable. Grouping the wards now by the rate of female literacy we obtain the following figures for the rate of adult vaccination and the corresponding rate as estimated for the infants for these regrouped areas.

It will be remembered that the corrected birth rates were obtained quite independently in section III. A corrected vaccination rate with adjustments for infants dead also brings in quite close.

TABLE 12

Regrouped wards by rate of female literacy in per cent	Rate of adult vaccination during		Rate of infant vaccination estimated	
	1921-30	1931-40	1921-30	1931 40
Upto 20 . . .	13·70	22·27	63·2	74·4
20 to 30 . . .	14·00	21·07	64·5	70·3
30 to 40 . . .	15·70	19·90	72·4	66·5

One small point should be noted here. It is generally to be expected that adult vaccination rate would be higher in areas with a higher literacy rate. But this does not seem to be so. This is due to the fact that some vaccinations in middle class areas take place through channels other than the Health department and thus escape proper documentation. But this defect will at worst inflate the birth rate in areas with higher rates of literacy to vitiate our analysis. It will however tend to work against a differential being revealed if the differential implies a higher rate in less literate regions. This may thus give us an over estimate of for the rate in regions of higher literacy.

Employing the procedure explained previously we now estimate the number of births for these regions as in the table below :

TABLE 13

Wards regrouped by rate of female literacy in per cent	Number of infants surviving one year estimated from vaccination records with correction		Number of infants dying within one year of birth		Estimated number of infants born	
	1921-30	1931-40	1921-30	1931-40	1921-30	1931-40
Upto 20 . . .	1,674	4,915	574	1,383	2,248	6,300
20 to 30 . . .	5,415	8,236	1,661	1,898	7,076	10,126
30 to 40 . . .	8,291	11,775	2,568	2,601	10,859	14,365

Using these estimated births with the number of women in these parts we obtain the following rates of birth per 1,000 women as given below :

TABLE 14

Wards regrouped	Rates of birth per 1,000 women estimated from vaccination records			
	Corrected		Uncorrected	
	1921-30	1931-40	1921-30	1931-40
Upto 20 . . .	97·8	72·0	71·5	56·5
20 to 30 . . .	78·4	67·8	57·1	51·5
30 to 40 . . .	61·4	62·3	48·4	45·1

The birth rates reconstructed from vaccination data show roughly similar types of variation as in table 7 for similar rates of literacy. Thus for a level of literacy up to 20 p. c. the figures in table 7 are 94.7 and 76.0 as against 97.8 and 72.0 in table 13 above. In the group with 20-30 per cent literacy the rates are 77.9 and 72.2 in table 7 against 78.4 and 67.8 in table 13. For the group with the highest literacy of 30 to 40 per cent these are 69.7 and 58.9 against 61.4 and 62.3 respectively. This indicates that literacy rate has an inverse relation with the birth rate in both the system of reconstruction. Obviously therefore, some reliance can be put on the conclusion obtained in this table which checks well with the result arrived at in table 7.

It will also be seen that there is an apparent fall in all these rates over time. It is however, difficult to say whether this is a trend of a fluctuation. In fact a study of these rates for Calcutta as a whole in the 1st paper showed a consistent fall during 1921-50 but not in the earlier decades. It may, therefore be concluded that possibly this fall has some elements of a secular nature but that the magnitude of this fall as seen here is open to error.

It may be realised that the procedure of correction in fact is such that the determination of the existence of differential fertility will stand or fall on that alone. The correction procedure adopted in the present case is based on the all-Calcutta ratio between the rates of adult revaccination and infant vaccination. This procedure will fail for example if it is found that in districts with a higher rate of female literacy the ratio of infant vaccination to adult vaccination is higher than in the districts with lower rates of female literacy. That is, if there is a possibility that in the comparatively backward districts proportionately more adults get vaccinated more often, than infants. As far as one can see such a chance is rather remote.

We shall now present a similar table for the birth per 1,000 women in Bombay city classifying the wards of the city by rates of female literacy. In the case of Bombay as the registration figures are reasonably correct and the data has no ambiguity a straight forward calculation of these rates are possible. In table 14 we give the rates computed for Bombay with the rates for Calcutta for comparative purposes.

TABLE 15

Rate of literacy	Birth rate per 1,000 women in Calcutta		Rate of literacy	Birth rate per 1,000 women in Bombay	
	1921-30	1931-40		1921-30	1931-40
Up to 20 .	97·8	72·0	upto 10	57·8	76·7
20 to 30 .	78·4	67·8	10 to 20	56·1	70·0
30 to 40 .	61·4	62·3	20 to 30	54·5	68·6

Two significant points may be noted. These are firstly, Bombay city also shows the same type of relationship between birth rate and the rate of literacy as does Calcutta. Secondly, the levels of birth rate for Bombay and Calcutta in 1931-40 are quite close for similar levels of literacy considering the crude nature of the reconstruction used for Calcutta. They are widely dissimilar in 1921-30 in Bombay as in this period Bombay passed through a very unusual decline of population and the city population actually decline in absolute number over the decade.

The period of 1921-30 in Bombay was reported by the Census authorities as very unusual. The city population did not show its normal increase in the Census as compared with the earlier one; in fact it showed a slight decline. This was mainly due to economic difficulties which led to a large scale exodus from the city by people who were without jobs. In all such cases of difficulties it is customary in this country as elsewhere for those who have some links with their home towns or villages to send the family home. All such cases of temporary migration would result particularly in a fall in the birth rate as families expecting children would be the first in sending the women folk home in times of economic difficulties. It is not therefore, fair to compare the birth rates of Calcutta and Bombay in 1921-30. In a more normal decade however the two rates come quite close. Since the birth rate of Bombay is a fairly reliable one while that of Calcutta has been reconstructed in a rather elaborate way this gives us some what more confidence in the estimates built up for Calcutta.

To sum them we can say that there is evidence to support a hypothesis that there is a differential rate of birth among different socio-economic groups in Calcutta and Bombay as far as the rate of literacy of the female population is an index of such classification and further that this differential has tendencies similar to that found in other more industrialised countries of the West. The groups placed higher in the socio-economic scale seem to have lower levels of birth rate than groups placed in more unfortunate position. While from the present data, we can be confident about the existence of a differential we cannot be so sure of its magnitude due to the fact that the present data has been reconstructed through a rather elaborate process.

On the influence of urbanisation on the age distribution of unmarried girls in West Bengal

I

One of the long-term effects of urbanisation in India as elsewhere has been gradually to shift the marrying age of girls from early years around 8-13 to later years around at least 15-20 or even beyond. This effect is only felt slowly over years. It can therefore be properly studied only as a secular trend. As postponing the year of marriage ,pecially during a period when fertility is high has considerable demographic importance a careful analysis of this effect of urbanisation on the age of marriage is worth making. One oi the obstacles to a study of this problem in India is that the data available on the age distribution of unmarried girls are seriously distorted by understatement of age around this critical period. This is primarily due to the fact that the marrying age of a girl was held fairly rigidly around 10-15 and any violation of this custom was socially considered to be reprehensible. Naturally, therefore, a study of this inter-relation ship of the age of unmarried girls with the level o urbanisation seriously suffers from this defect i: the census data particularly of earlier decades.

In the present paper we shall try to develop a simple correction system to remove at least to some extent the bias in the age distribution as found in the Census enumeration and to assess as far as possible on the basis of this data the nature of the relationship between the level of urbanisation and the age distribution of unmarried girls.

II

The Census Commissioners were actually aware of this bias and the effect of this bias on the age distribution of unmarried girls. In th eport of the Census of 1921 they commented as follows :

"The understatement of the age o unmarried girls no doubt increases the proportion of females unmarried between 5-15 to a certain extent .. The results are no doubt seriously effected by the fact that understatement of the age of unmarried females has resulted in an understatement of the proportion married between the ages of about 9-13 which has brought down the age at marriage*....."

*Census Report of 1921.

In 1931 the Census Commissioner also commented thus :

"Misstatement of age are very certainly influenced by sex and marital conditions, for a Hindu girl aged 15 her age is more likely to be understated if she is unmarried. In the same age group the effect of such tendencies will probably be conside able and not necessarily in the same direction or of the same strength in each sex.....

The age groups of 5-10 and 10-15 are those principally affected in the case of females .... "

These comments make it quite clear that both the Census Commissioners of 1921 and 1931 felt that this understatement of age was of sufficient importance to distort their figures with respect to the age of unmarried girls in the critical age groups.

We shall try to study this problem of distortion in seven districts of West Bengal mainly during the years 1911 1941 with occasional reference to 1951. The seven districts selected for this study are Birbhum, Bankura, Midnapore, Burdwan, Hooghly, 24-Parganas and Howrah. The following table gives the ratio of urban to total population in 921, 1931 and 1941 for these districts.

TABLE 1

District	Percentage of urban to total population		
	1921	1931	1941
Birbhum . . .	2·0	4·8	5·8
Bankura . . .	3·4	7·2	7·1
Midnapore . . .	3·6	4·9	5·9
Burdwan . . .	6·6	8·5	11·8
Hooghly . . .	16·6	18·3	20·5
24-Parganas . .	17·6	20·2	23·8
Howrah . . .	21·9	23·2	28·8

The table above shows the position of the districts as regards the level of urbanisation. The first four are very much rural districts though the fourth one is rapidly being urbanised. The last three are comparatively much more urbanised and are in fact around the city of Calcutta itself. A study of the age distribution of unmarried girls for these seven districts over the census decades should thus give us a clear picture of the influence of levels of urbanisation on this important custom of the population.

In the following table we give the percentage of unmarried girls to total number of girls within the age groups 5-10, 10-15 and 15-20 for the census years from 1911 to 1941.

TABLE 2

Percentage of unmarried girls within each age group

District	5—10				10—15				15—20			
	1911	1921	1931	1941	1911	1921	1931	1941	1911	1921	1931	1941
Birbhum .	84	89	66	93	32	39	40	57	4	5	3	14
Bankura .	83	85	65	88	28	34	38	49	4	4	3	11
Midnapore .	85	89	67	93	28	33	40	55	4	4	3	13
Burdwan .	87	90	72	92	27	40	45	54	3	4	3	13
Hooghly .	86	92	93	94	24	32	44	57	2	2	3	13
24-Parganas .	82	88	63	89	19	28	35	51	2	3	2	11
Howrah . .	88	91	73	95	20	32	45	63	3	3	5	15

Before passing on to the features of the table in which we are interested it may be of interest to point out one phenomenon which requires some explanation. This is the sudden fall in the percentage of unmarried girls in the age group 5-10 in 1931 which disturbs an otherwise rising secular trend. This is undoubtedly due to the enactment of the Child Marriage Restraint Act of 1929. This piece of legislation led as noted in the Census of 1931 "to a great rush to get children of tender age married before the Act came into force. The Census figures naturally reflect this anxiety in the vast increase in the number of both sexes returned as married at early ages which cannot be entirely explained by the considerations discussed in the last few paragraphs. Compared with 1921 there are more than seven times as many boys and eight times as many girls married at the age group 5-10. Among the muslims the proportions are higher still. Amongst those aged 0-5 years nearly eight times as many boys and more than nine times as many girls are now married as in 1921.... There can be no doubt that the normous increase was brought about to a very considerable extent by early marriage to avoid the forth coming legislation." The irregularity thus in the series in 1931 was mainly due to extraneous factor. It is worth while to note however that this legislation did not have the same effect on the 10-15 or the 15-20 group. The 10-15 group was also within the purview of the legislation but it seems that the main effect of the legislation was on those who marry off their children around 8-10 and not those who are already putting it off to a later period.

Coming to the nature of the relationship of these ratios with the levels of urbanisation we find several interesting features. These are best summarised by the following table of correlation coefficients calculated between the percentage of urban to total population and the percentage of unmarried to total number of girls in each age group.

TABLE 3

Year	Correlation coefficient between the percentages of urbanisation and ratio of unmarried girls in each age group		
	5-10	10—15	15—20
1911 . . .	0·01	0·94	—0·64
1921 . . .	0·43	-0·68	—0·84
1931 . . .	0·38	—0·18	0·35
1941 . . .	0·13	0·44	0·24
1951 . . .	..	0·58	0·28

It may be noted that in the group 5-10 there is a positive correlation throughout 1911 41. This indicates that marriage at least in the earlier years was always more prevalent in the le s urbanised areas than in the more modern ones. This is as may be expected. In 1911 and 1921, however, in the next age group of 10-15 as also in 15-20 this correlation continues to be negative. This certainly runs counter to our expectation and requires a more

careful scrutiny. One might speculate that this anomaly is due to the effect of an irregular bias in the age statement of girls of marriageable age which has been particularly strong in the urban areas. Obviously, this bias was not present in the group 5-10 to a perceptible extent due to the notion that this age group was not considered critical from the standpoint of marriage ability. The fact that this negative correlation in the later years have turned into a positive one suggests that the notion of marriageable age itself was gradually shifting to higher age groups and therefore there was no particular reason for understanding the age of girls who were in this age group in 1931, 1941 and 1951. The only explanation for this bias being more pronounced in the urbanised district than may be offered is that enumerators in rural areas are more familiar with their subjects than in the urban areas and therefore there is possibly a larger scope for understatement in the urban areas than in the rural areas. With the relaxation of the age of marriage the tendency to understatement diminished and therefore a more reasonable type of relation between the age of marriage and the level of urbanisation was revealed.

We can therefore, broadly conclude that there is definitely a positive correlation between the ratio of urban to total population and the distribution of the age of unmarried girls since 1931. It may further be concluded that possibly such a type of correlation has been destroyed in 1911 and 1921 by a differential bias in age statement in the urbanised regions. It may be added that this bias is also operative perhaps in a less marked degree in the less urban areas as well.

III

Considering the comments of the Census in the earlier sections on the distortion due to the understatement of the age of unmarried girls we shall now discuss a correction procedure with which we can to a limited extent improve the data with rather simple technique without going in for additional information from external sources which it is extremely difficult to get on this topic. The correction procedure consists in finding a suitable smoothing formula based on the available data and to use the smoothed series instead of the original series.

A study of the distribution of unmarried girls by age in the different districts as given in table 3 makes it quite clear that it is indeed a rarity for a girl to remain unmarried after the age group 10-15 is reached.

TABLE 4

Age Group	Per cent of unmarried girls to total in the group				Percentage of unmarried girls to total in the group			
	Burdwan				*Birbhum*			
	1911	1921	1931	1941	1911	1921	1931	1941
0--5	43·9	36·9	50·4	39·0	43·2	38·1	54·9	40·2
5—10	42·9	44·6	30·4	36·8	42·9	44·2	28·9	36·1
10—15	10·4	15·3	16·9	18·6	10·3	13·0	15·3	17·3
15—20	1·1	1·6	1·3	4·2	1·3	1·9	0·9	4·2
20+	1·7	1·6	1·0	1·4	2·3	2·8	0·0	2·2
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
	Bankura				*Midnapore*			
0—5	44·3	39·6	52·8	41·3	44·8	38·3	51·3	39·4
5--10	42·8	39·6	28·9	36·5	42·3	45·8	29·8	36·9
10—15	10·3	13·0	15·3	17·3	9·6	12·3	16 0	18·4
15--20	1·4	1·7	1·0	3·6	1·6	1·7	1·4	3·9
20+	1·2	6·1	2 0	1·3	1·7	1·9	1 5	1·4
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100 0
	Howrah				*Hooghly*			
0—5	48·1	40·6	50·1	39·5	48·4	40·0	47·0	40·2
5—10	40·9	40·7	30·4	37·0	42·0	44·0	29·0	28·3
10—15	8·7	12·3	17·3	18·1	6·8	11·3	17·2	18·3
15—20	0·9	0·9	1·0	4·0	1·3	1·0	1·9	4·1
20+	1·4	5·5	1·2	1·4	1·5	3·7	4·9	9·1
	100·0	100·0	100 0	100·0	100·0	100·0	100·0	100·0

As illustrative of the age distribution of girls who are unmarried by age this table for the six districts out of seven is sufficient for our purpose and it clearly shows that with age increasing the probability of remaining unmarried is sharply reduced. We may assume that the frequency of unmarried girls by age group behaves as a Poisson distribution. This assumption is in fact not an artificial one in the social conditions in this country specially with regard to the marriage customs. It is being gradually relaxed but even to-day and certainly during 1921-40 the custom of marrying off girls during or immediately after puberty was very strong. This was particularly so in the semi-rural or rural districts. In effect this meant that very few girls escaped marriage by the time they were 19 or 20 and in fact remaining unmarried with increasing age did have the properties of what one may call a rare accident. That is, the chance of being unmarried was very small compared to the corresponding chance of being married with increasing number of years. We may on this assumption use the theoretical shape of the Poisson distribution for smoothing the present series. As we are concerned with the correction of the distribution around the groups 10-15 and 15-20 we may use the truncated distribution from 10-14 for this purpose. The method of fitting a truncated Poisson distribution gives the formula for estimating the Poisson parameter as

$$x = \sum_{i=0}^{r} xi / \sum_{i=0}^{r-1} xi \qquad /$$

where i is the value or class mark and x is the estimate of the parameter and r out of k classes are being considered for the fitting.

The following table gives the graduated percentage of girls in the age group 15-20 to all families and the actually observed percentages of the same for 1921, 1931 and 1941.

TABLE 5

District	Percentage of unmarried girls in the age groups 15--20 to all girls in the group					
	1921		1931		1941	
	Actual	Graduated	Actual	Graduated	Actual	Graduated
Birbhum	4·8	10·8	2·6	7·5	14·2	13·1
Bankura	4·4	8·5	2·8	7·2	11·3	11·0
Midnapore	4·4	9·9	3·3	11·5	12·8	15·8
Burdwan	3·8	10·3	3·4	8·1	13·2	16·0
Hooghly	3·2	5·5	2·7	7·5	13·3	16·6
24-Parganas	2·9	6·5	2·3	6·3	10·5	15·0
Howrah	2·7	9·2	5·0	13·6	14·7	19·8

It may be seen that on the assumption of a Poisson distribution the estimated ratio of unmarried girls in the different districts become much larger than the original figures for the same period in the age group 15-20. It may also be seen that the gap between the actual and the estimated in 1921 and 1941 are in decreasing order. It is difficult to say anything definitive about 1931 because of the peculiar disturbances in the series for 1931 noted earlier. Accepting that the decrease in the gap between 1921 and 1941 is real this may be easily explained by the relaxation in orthodoxy on the marrying age in 1941 as compared with the earlier decade. The suitability of the Poisson distribution is further demonstrated when we consider the estimated and the actual figures for the two age groups 10-15 and 15-20 together. The following table gives the estimate for the groups combined together as actually observed and as found from the smoothing formula.

Moore : Biometrika 1952.

TABLE 6

Number of unmarried girls in the age groups 10-15 and 15-20 as estimated and actually observed

District	1921		1931		1941	
	Actual	Estimated	Actual	Estimated	Actual	Estimated
Birbhum . . .	17,692	18,746	19,446	19,440	770	768
Bankura . . .	20,654	21,134	23,393	23,957	819	817
Midnapore . .	51,190	53,404	62,609	64,797	2,178	2,120
Burdwan . .	30,940	32,258	36,788	37,805	1,264	1,261
Hooghly . . .	17,925	18,572	24,873	25,607	929	936
24-Parganas . .	36,582	37,987	51,473	53,640	2,045	2,042
Howrah . . .	16,176	16,746	27,362	28,202	1,021	1,019

As in the previous table and even more so it is evident here that the gap progressively diminished during the three decades between the observed and the estimated. In 1941 they are actually very close. This means that at least in 1941 understatement affected the group 15-20 and there was a compensatory overestimation of the group 10-15. In 1921 however there has been underestimation also in the group 10-15 which is not compensated by its aggregation with 15-20 group. It is not possible to go any further than this with the present system of correction because of the fact that the Poisson parameter has been here computed from the faulty series itself. As the group 15-20 is numerically small it was reasonable to suppose that a distortion in this group could be corrected even from the parameter of the faulty series itself. The mean of the distribution or the Poisson parameter calculated from the faulty series is an underestimate of the true mean. So long as the distortion occurs in groups which are small the mean will not itself be very much distorted. This is what happens in 1941. In other year there is also distortion in the group 10-15 and this and particularly any distortion in the group 5-10 are sure to affect the mean considerably. The correction therefore is better for later years but are not good enough for earlier years when the lower age groups are also affected by the bias.

Combining the results of table 5 and table 1 we can now calculate the correlation coefficients for the levels of urbanisation and the percentage of unmarried girls in the age group 15-20. This set of percentage is given in table 7.

TABLE 7

Year	Correlation coefficient for level of urbanisation and per cent of unmarried girls in the age group 15-20	
	Corrected	Uncorrected
1921	—0·71	—0·84
1931	0·33	0·25
1941	0·81	0·10

It is evident that the correction is in the direction which is more to be expected, that is, it is generally increasing the positive correlation or decreasing the negative where it exists. The correction is also more effective in later years than in the earlier years because of the fact that the bias is shifting to groups which are numerically smaller and, therefore, did substantially distort the mean of the distribution in later years. In the case of the earlier years the distortion is present in the numerically longer groups and the correction procedure as explained previously fails to work well.

IV

We shall now consider the percentage of the unmarried girls in all age groups above 5 to show that the negative correlation is possibly of a spurious type. Table 8 shows the percentage of unmarried girls of all age groups from 5 to 40 aggregated,

TABLE 8

District	Percentage of unmarried women of all ages above 5		
	1921	1931	1941
Birbhum . . .	18·4	14·0	22·1
Bankura . . .	18·5	14·1	20·7
Midnapore . . .	19·1	15·7	22·0
Burdwan . . .	18·1	15·3	21·9
Hooghly . . .	17·4	14·8	22·9
24-Parganas . .	19·0	14·1	22·7
Howrah . . .	18·8	17·0	24·5

The above table makes it clear that if we consider all ages above 5 the effect of misrepresentation between the groups are cancelled out and we get a more definite correlation between urbanisation and age at marriage in 1931 and 1941. This may be seen from table 9 given below :

TABLE 9

Year	Correlation coefficient
1921	—0·14
1931	0·33
1941	0·71

It is reasonable to argue that the correlation in the upper age groups where negative are spurious rather than accept the alternative hypothesis that there was in rural areas a greater percentage of unmarried girls in the upper age groups and at the same time a higher percentage of married girls in the very lowest age group *e.g.*, 5-10.

Remembering the limited nature of our correction we may therefore note that possibly in 1921 there was no significant correlation between urbanisation and age at marriage during 1921, or, earlier, but that with the passing of decades and a more significant growth of urbanisation a change of habit in the mere urban area came about leading to a positive correlation between marrying age and rate of urbanisation.

This is not unlikely. The level of urbanisation itself even in the so called urban districts was not very high in 1921. Urbanisation in reality was still too weak to make its influence felt. Social inertia was thus a powerful retarding factor in 1921, and the actual difference between urban and rural marrying age was not significant. Such a small difference may be very easily swamped by deliberate misstatement of age in critical years. We may, therefore, generally conclude:

(1) Throughout the Census years of 1911 41 there is understatement of age in girls unmarried. As the marrying age has shifted from lower to higher groups. The understatement also shifted from lower to higher age groups.

A rough correction at least for later years of 1931 and 1941 can be obtained by smoothing the data on the assumption of a Poisson type of distribution. The correction is less successful in earlier years *e.g.*, 1921.

On the corrected data a significant positive correlation between level of urbanisation as indicated by the per cent of total population living in urban areas and the ratio of unmarried girls in the critical age group of 15-20. Previous to 1921 such influence of the level of urbanisation on marrying age was weak and may have been completely distorted by bias in age-statement in the critical years of 10-15 and 15-20.

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