A PRELIMINARY NOTE ON THE RATES OF MATERNAL DEATHS AND STILL-BIRTHS IN CALCUTTA.

By SIR KEDARNATH DAS, Kt., C.I.E., M.D., AND
P. C. MAHALANOBIS ASSISTED BY ANIL CHANDRA NAG, M.Sc.

INTRODUCTION

In a country like India, where the rate of mortality of mothers at delivery is very high as compared with other countries, a detailed study of maternal death-rates is likely to prove useful.

One of us (Kedarnath Das) had collected the primary statistics from the original records of the Eden Hospital, Calcutta. The material was entered in two registers, one of which covered the period 1850-1901 and contained 8804 cases, and the other covered the period 1902-1915. The present note is based on the material in the first register in which entries were available under the following heads:—

(1) Date of delivery.
(2) Race and Caste.
(3) Age of mother.
(4) Number of pregnancies.
(5) Duration of pregnancy.
(6) Character of labour—whether Natural or Complex.
(7) Presentation.
(8) Mother whether living or dead after delivery.
(9) Sex of child.
(10) Child whether living or dead after delivery.
(11) Weight and length of the new-born babe.
(12) Twins and Triplets.

The large majority of cases were 'Bengali Hindus' (6481 out of a total of 8804 in the first register). In this preliminary note we have investigated the secular trend and the seasonal variations in the rates of maternal deaths and of still-births for the group of Bengali Hindus.

THE NUMBER OF DELIVERIES

The analysis is based on 6481 cases covering the period 1850-1901, details of which will be found in Table 1.

It will be noticed that the total annual number of deliveries of Bengali Hindus in Eden Hospital increased from 45 in the year 1850 to 293 in the year 1900. This steady increase in the number of the hospital cases is only to a small extent due to the growth of population as can be easily seen from Table 2, which gives the total number of women in Calcutta in each of the Census years, and the corresponding decennial average number of maternity cases in the Eden Hospital. (Chart 1).

TABLE 1 MATERNITY STATISTICS FOR BENGALI HINDUS (CALCUTTA EDEN HOSPITAL)

Year	Total Number of deliveries	Number of Maternal deaths	Number of Still-Births		Year	Total Number of deliveries	Number of Maternal deaths	Number of Still-Births	
			Male	Female				Male	Female
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
1850	43	2	5	3	1876	110	9	12	13
51	46	2	6	1	77	94	11	10	4
52	58	1	7	1	78	96	11	9	8
53	63	10	7	4	79	82	9	11	2
54	57	1	6	0	1880	131	8	19	16
55	46	1	4	0	81	113	12	9	12
56	37	3	5	4	82	112	12	14	12
57	43	3	3	2	83	125	5	13	8
58	48	3	5	4	84	163	14	15	13
59	60	13	8	7	85	189	12	8	11
1860	53	3	8	6	86	179	12	19	18
61	65	7	5	7	87	182	15	16	8
62	44	6	10	3	88	192	6	17	13
63	48	4	12	3	89	242	11	28	24
64	84	3	4	3	1890	186	6	11	10
65	58	10	7	3	91	250	12	25	18
66	96	10	7	9	92	225	13	19	16
67	66	6	4	9	93	242	11	25	21
68	77	7	7	6	94	219	7	15	8
69	68	5	8	4	95	192	14	8	11
1870	57	2	9	3	96	264	14	13	9
71	65	3	11	7	97	280	18	26	13
72	71	4	8	1	98	267	10	20	19
73	84	3	9	3	99	253	16	24	17
74	85	3	6	5	1900	293	14	24	16
75	93	5	9	8	01	238	14	26	13

The growth in the number of hospital cases must therefore be ascribed to a change in the habit of the people, in the growing recognition of the usefulness of the hospitals,

and in the gradual breaking down of the prejudice against sending cases to the hospital. The increase in the number of beds available is also possibly a factor of some importance.

TABLE 2.—HOSPITAL CASES AND NUMBER OF FEMALES IN THE TOWN OF CALCUTTA

Census Year	Number of Females	Decennial Average of Hospital Cases	Proportion of Cases (Per 10,000)	Percentage Increase	
				Population	Hospital Cases
(1)	(2)	(3)	(4)	(5)	(6)
1872	225,267	77·6	3·45	...	...
1881	218,834	128·4	5·87	−2·9	+65·5
1891	235,148	219·4	9·33	+4·4	+182·7
1901	285,200	266·2*	9·33	+26·6	+243·0

In earlier years probably only the most complicated cases were sent to the hospital, while normal cases were kept at home. With the growth in the number of hospital cases the proportion of normal cases has probably increased.

There were large fluctuations in the number of child-births† in different months. (Table 3 and Chart 7).

TABLE 3.—MONTHLY CASES OF CHILD-BIRTHS

Months	Number of Child births in the Hospital	Difference from Average
(1)	(2)	(3)
January	485	−1
February	473	−13
March	459	−27
April	431	−55
May	412	−74
June	376	−110
July	432	−54
August	474	−12
September	532	+46
October	643	+157
November	519	+33
December	568	+82
Average	486	

The average number of cases over the whole year is 486. The difference between the actual number in each month and this average is shown in column 3 of Table 3. Squaring these differences, dividing by the average (or expected) value 486, and summing we get Pearson's $\chi^2 = 127{\cdot}56$ for 12 cells. We can now calculate the probability of occurrence of the observed system of discrepancies with the help of Elderton's Tables XII-XVI (Biometric Tables Part I, pp. 26-30). As we have calculated the expected value from the sample itself there is loss of one degree of freedom, and we may use $n' = 12$ in Elderton's Tables. We may also use R. A. Fisher's Table III (Statistical Methods for Research

*This figure is an average of five years (1897-1901).

†Twins and Premature births and all cases of incomplete entries were omitted

Workers, 4th edition, 1932, pp. 104-105) but we must use $n = 11$, since $n' = n + 1$. From Fisher's Table it is clear that P is considerably less than one per cent.*

The monthly differences must therefore be considered definitely significant. The maximum number of child-births (643) which occurs in October is 1·7 times the minimum number (376) which occurs in June. This shows that the optimum condition for pregnancy occurs in December-January, which in Bengal is the time of harvest. The season of minimum pregnancy on the other hand occurs in August-September, that is, towards the end of the monsoon season.

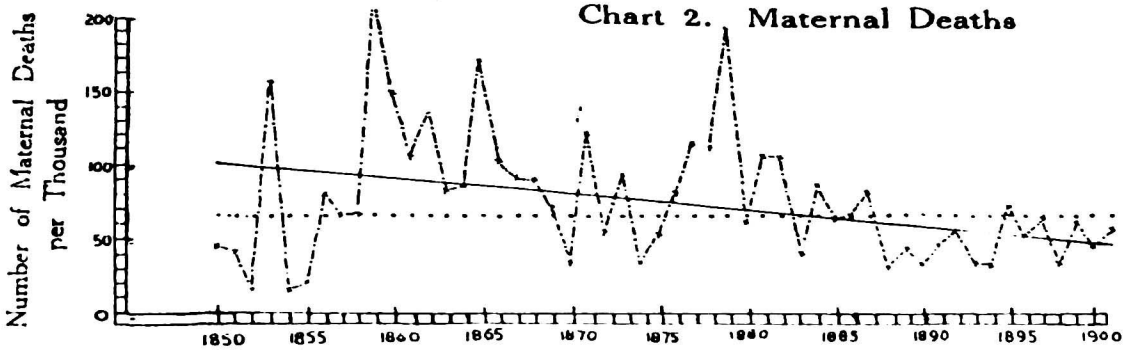
The fact of either (*a*) 'Death' or (*b*) 'Recovery' of the mother is usually recorded against each case of delivery. But unfortunately there are certain gaps in the data, and a few entries under the 'Death or Recovery' column are missing. It is extremely unlikely that cases of death went unrecorded. Cases of 'no record' were therefore most probably cases of recovery. Averages calculated on this basis agreed very well with the rest of the data (Table 4, Col. 6).

TABLE 4.—CASES OF NO RECORD OF MATERNAL DEATH OR RECOVERY.

Year	Total Number of Cases	Number of			Death-rate Calculated on the basis of	
		Deaths	Recovery	No Record	No Record as Recovery	No Record Omitted
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(A) *A period of large number of "no entries."*					
1884	168	14	147	2	8·69	8·70
85	189	12	147	30	6·35	7·55
86	179	12	155	12	6·71	7·19
87	182	15	167	0	8·24	7·24
88	192	6	123	63	3·13	4·65
89	242	11	13	218	4·54	45·83
90	186	6	2	178	3·23	75·00
91	250	12	7	231	4·80	63·16
92	225	13	6	206	5·78	68·43
93	242	11	193	38	4·55	5·39
	(B) *A period of usual entries*					
1894	219	7	207	5	3·20	3·27
95	192	14	165	13	7·30	7·82
96	254	14	241	9	5·80	5·49
97	280	18	260	2	6·43	6·48
98	267	10	255	2	3·75	3·77
99	253	16	228	9	6·33	6·56
1900	293	14	277	2	4·78	4·81
01	288	11	222	2	5·88	5·93

On the other hand, if we omit not-recorded cases altogether we reach absurd results, as can be seen from the figures given in column 7 of the same Table 4. In subsequent work we have treated all 'no record' cases as cases of 'recovery.'

*In Elderton's Table XII values of P are given up to $\chi^2 = 70$. In the present case we must therefore use the auxiliary tables in connexion with the equation (xxix) given in the Introduction to the Tables p. xxxi. The actual value of P is less than one in 10^8.



Maternity Hospital, Calcutta

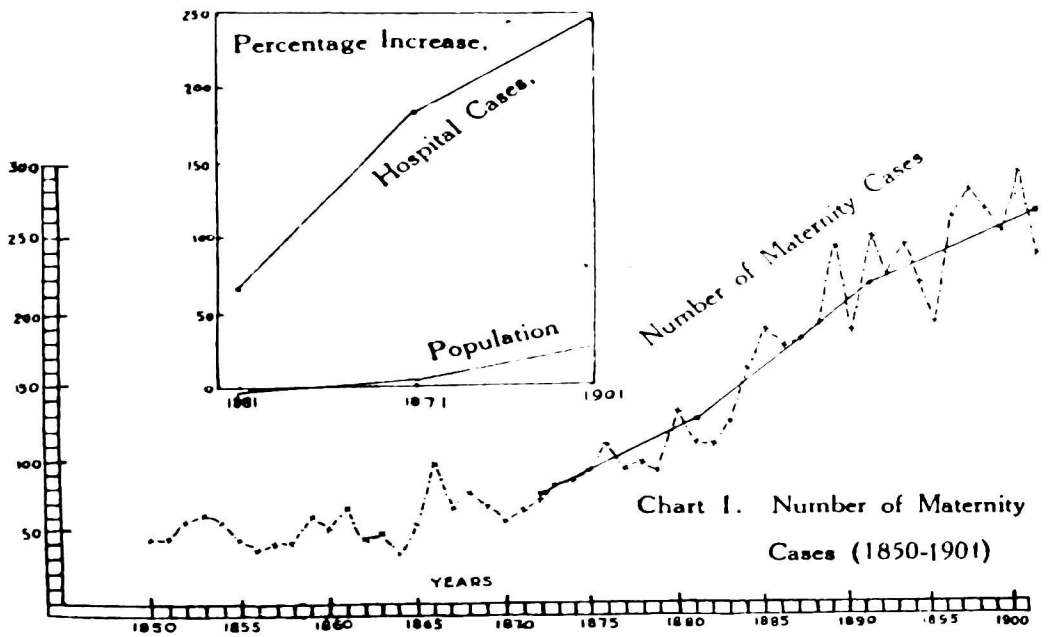
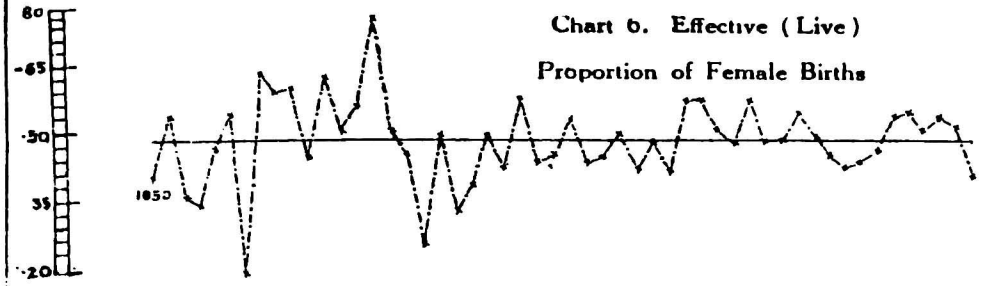
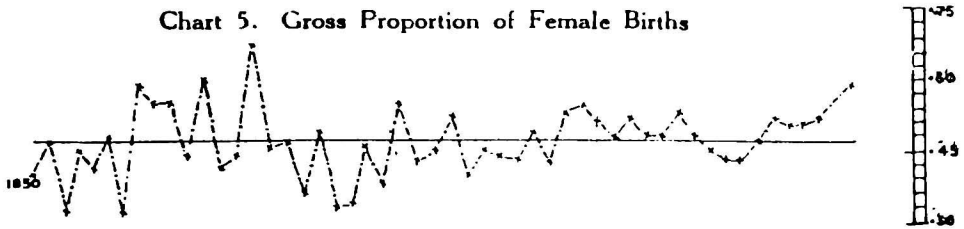
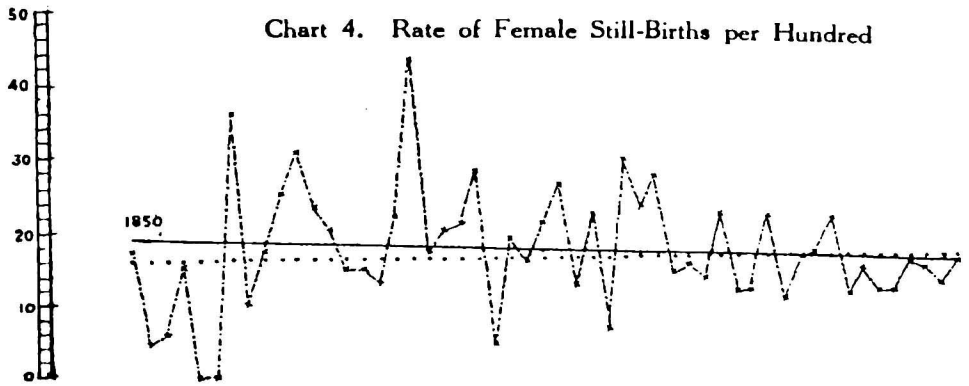


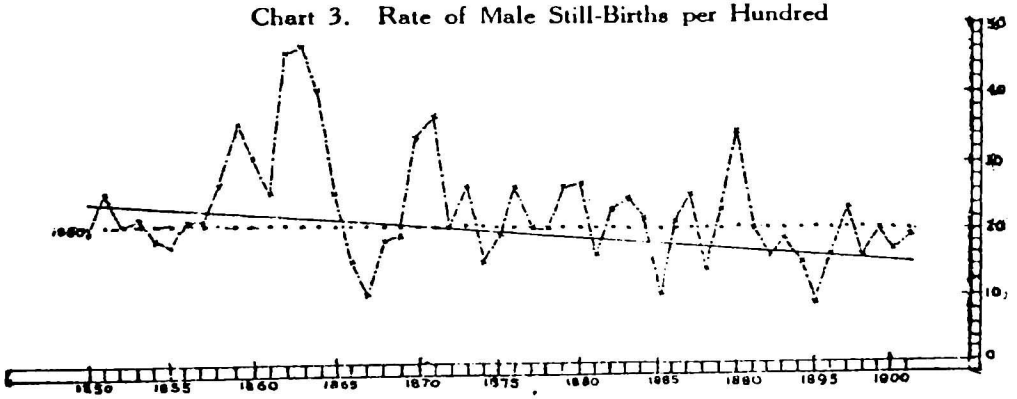
Chart 1. Number of Maternity Cases (1850-1901)

Maternity Statistics from Calcutta 1850-1901









Maternity Statistics from Calcutta 1850-1901

Maternal Deaths.

The statistical analysis was carried out systematically for the whole period. There were 431 deaths out of 6481 cases. This gives an average death-rate of 66·502 per thousand with a standard error of 3·05 per thousand. We first tested the hypothesis whether this average death-rate may be considered to have remained steady over the whole period.

Let n_t be the total number of cases, d'_t the actually observed number of deaths, and $p'_t = 1000\ d'_t/n_t$ the observed death-rate per mille in the tth year. The expected number of deaths on the assumption of a constant death-rate p_o (= 66·50 per mille in the present case) is given by $n_t.p_o$. These expected values are shown in column 6 of Table 5. The discrepancy between observed and expected values $= d'_t - n_t.p_o$. Since $d'_t = n_t.p_t$, the discrepancy may also be written as $n_t\ (p'_t - p_o)$. Squaring this discrepancy, and dividing by the expected value $n_t.p_o$, we get

$$n_t^2.(p_t - p_o)^2 / n_t.p_o = n_t.(p_t - p_o)^2 / p_o$$

as a statistical measure of the excess. Summing these values, we obtain an estimate of Karl Pearson's χ^2, or

$$\chi^2 = S_t\ [n_t.(p_t - p_o)^2 / p_o] \quad \ldots\ldots(1)$$

where S_t is a summation for all the years from $t = 1$ to $t = 52$.

The actual data are given in Table 5 and shown graphically in Chart 2.

The observed value of $\chi^2 = 108·89$ with 52 cells, and the probability of occurrence of such deviation is less than one in million. Evidently the hypothesis of a constant death-rate is not tenable, and we conclude that the maternal death-rate must have changed appreciably during the period under review.

The next step was to fit a trend line to the observed death-rates given in column 3 of Table 5. The number of cases being much smaller in earlier years, the observed death-rates were less reliable. This can be seen (Chart 2) in the wide fluctuations in earlier years. The best way of making allowances for such disparity in numbers is to give proper weights to the number of cases in fitting the trend line. Doing this, we find the equation of the weighted straight line to be :—

$$p_t = 103·30 - 1·07\ (t - 1850) \quad \ldots\ldots(2)$$

where p_t = graduated number of maternal deaths per thousand deliveries in the tth year, and t = actual year.

We may now test this hypothesis by the χ^2 test. The expected number of deaths d_t is obtained by multiplying p_t (the expected death-rate) by n_t the number of cases in the tth year. These expected values are shown in col. 7 of Table 5, while actual values are given in col. 5.

The value of $\chi^2 = 71·96$ for 52 cells. In this case we have used expected values which were calculated from the sample itself by a straight line graduation, and hence there is a loss of 2 degrees of freedom. We must use $n = 51$ in Elderton's Tables or $n = 50$ in Fisher's formula. In this case as suggested by Fisher it will be sufficient to assume that

TABLE 5—SECULAR TREND IN MATERNAL DEATH-RATES.

Year (t)	Total No of Cases (n_t)	Death-rate per Mille		Number of Deaths		
		Actual (p'_t)	Expected (Linear Trend) (p_t)	Actual (d'_t)	Expected (Constant Death-rate) ($n_t.p_m$)	Expected (Linear Trend) (d_t)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1850	45	44·5	103·3	2	2·99	4·65
51	46	43·5	102·3	2	3·06	4·70
52	58	17·2	101·2	1	3·86	5·86
53	63	158·8	100·1	10	4·19	6·31
54	57	17·6	99·0	1	3·79	5·65
55	46	21·7	98·0	1	3·06	4·51
56	37	81·1	96·9	3	2·46	3·59
57	43	69·8	95·8	3	2·86	4·12
58	43	69·8	94·7	3	2·86	4·07
59	60	216·7	93·7	13	3·99	5·62
60	53	150·9	92·6	8	3·53	4·91
61	65	107·7	91·5	7	4·32	5·95
62	44	136·4	90·5	6	2·92	3·98
63	48	83·3	89·4	4	3·19	4·92
64	34	82·3	88·3	3	2·26	3·00
65	58	172·4	87·2	10	3·86	5·06
66	96	104·2	86·2	10	6·38	8·27
67	66	90·9	85·1	6	4·38	5·62
68	77	91·0	84·1	7	4·52	8·15
69	68	73·5	82·9	5	3·79	5·64
70	57	35·1	81·9	2	4·32	4·66
71	65	123·1	80·8	8	4·72	5·25
72	71	56·3	79·7	4	5·59	5·66
73	84	95·2	78·7	8	5·65	6·61
74	85	35·3	77·6	3	6·19	6·59
75	93	53·8	76·5	5	7·32	7·11
76	110	81·9	75·4	9	6·25	8·29
77	94	117·0	74·3	11	6·38	6·99
78	96	114·6	73·3	11	6·25	7·04
79	82	198·8	72·2	9	5·45	5·92
80	131	61·1	71·1	8	8·71	9·32
81	113	106·2	70·1	12	7·52	7·91
82	112	107·2	69·0	12	7·45	7·73
83	125	41·0	67·9	5	8·31	8·49
84	163	86·9	66·9	14	10·84	10·90
85	189	63·5	65·8	12	12·57	12·43
86	179	67·1	64·7	12	11·91	11·58
87	182	82·4	63·6	15	12·10	11·58
88	192	31·3	62·6	6	12·77	12·01
89	242	45·4	61·8	11	16·10	14·88
90	186	32·8	60·4	6	12·37	11·24
91	250	48·0	59·3	12	16·63	14·84
92	225	57·8	58·3	13	14·96	13·11
93	242	85·5	57·2	11	16·10	13·84
94	219	32·0	56·1	7	14·56	12·29
95	192	73·0	55·0	14	12·77	12·49
96	264	58·1	54·0	14	17·56	14·25
97	280	64·3	52·9	18	18·62	14·81
98	267	37·5	51·8	10	17·76	13·84
99	253	63·3	50·7	16	16·83	12·84
1900	293	47·8	49·7	14	19·48	14·56
1901	288	58·8	48.6	14	15·83	11·57

$\sqrt{2\chi^2}$ is distributed normally with unit standard deviation about a mean $\sqrt{2n-1}$. We have $\sqrt{2\chi^2} = 11{\cdot}997$ and $\sqrt{2n-1} = 9{\cdot}849$. The deviation is thus 2·148 from the mean, which leads to a value of P=3 per cent. approximately.

The hypothesis of a steady decrease in the death-rate is therefore not improbable, and we may consider equation (2) to be a reliable estimate of the secular trend.

One further point in this connection deserves notice. It will be seen that in 1859 there were no less than 13 deaths out of 60, with a death rate of 216·67 per mille, which is abnormally high. The contribution to χ^2 is 8·69 for this year alone. If we omit this particular year, we get $\chi^2 = 62{\cdot}27$ for 51 cells or 49 degrees of freedom which leads to P=0·19, a satisfactory fit. We conclude, therefore that the hypothesis of a steady decrease per year in the maternal death-rate of 1·07 per mille is in satisfactory agreement with observed facts. The year 1859 was probably an exceptional one, and the high death-rate was due to extraneous factors not known to us.

Such a steady decrease may be ascribed to improved sanitary conditions and improved methods of treatment. It may also be partly due to a change in the character of the entrants. We have seen that with the growth in the number of hospital cases, the proportion of normal or less complicated cases had probably increased. Now the death-rate is of course lower among the normal or less complicated cases. The gradual increase in the proportion of less complicated cases might be expected therefore to lead to a steady fall in the maternal death-rate.

Seasonal Fluctuations in Maternal Deaths. We may next consider whether the death-rate shows any seasonal variation (Chart 8). The average for the whole year is 66·502 per mille. This will be the expected value for each month, if we assume that there is no seasonal effect. Expected values are given in column 4 of Table 6. Discrepancies are shown in column 5, squaring which, summing, and dividing by the expected values (col. 4, Table 6), we get $\chi^2 = 12{\cdot}54$ for 12 cells. The value of P is 0·327 for $n' = 12$ which shows satisfactory agreement between expected and observed values. Hence we conclude that the maternal death-rate in the Eden Hospital remained sensibly constant throughout the year, and did not show any appreciable seasonal effect.

TABLE 6 – MONTHLY INCIDENCE OF MATERNAL DEATHS

Months	Number of Cases	Number of Deaths			Actual Death-rate
		Actual	Expected (Constant Death-rate)	Difference	
(1)	(2)	(3)	(4)	(5)	(6)
January	561	31	37·24	−6·24	·0553
February	511	39	33·99	+5·01	·0763
March	494	31	32·86	−1·86	·0628
April	476	40	31·66	+8·34	·0840
May	477	27	31·72	−1·72	·0566
June	442	25	29·40	−4·40	·0566
July	514	30	34·19	−4·19	·0584
August	529	35	35·18	−0·18	·0662
September	595	46	39·57	+6·43	·0773
October	628	52	41·77	+10·23	·0828
November	634	51	42·17	+8·83	·0804
December	620	34	41·24	−7·10	·0548

TABLE 7.—MALE STILL-BIRTHS.

Year	Number of Male births	Still-Birth Rate per hundred		Still-Births.		
		Actual	Graduated (Linear trend)	Actual Number	Expected (Constant rate)	Expected (Linear trend of rate)
(t)	(m)	(p')	(p)	(d')	($m.p_0$)	($m.p$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1850	26	19·82	23·84	5	5·19	6·07
51	24	25·00	23·17	6	4·79	5·56
52	35	20·00	23·00	7	6·98	8·05
53	32	21·88	22·83	7	6·38	7·30
54	32	18·75	22·66	6	6·38	7·25
55	23	17·39	22·49	4	4·59	5·17
56	23	21·74	22·32	5	4·59	5·17
57	14	21·43	22·15	3	2·79	3·10
58	19	26·32	21·98	5	3·79	4·17
59	23	34·78	21·81	8	4·59	5·02
1860	27	29·63	21·64	8	5·39	5·84
61	20	25·00	21·47	5	3·99	4·29
62	22	45·46	21·30	10	4·39	4·68
63	26	46·16	21·13	12	5·19	5·49
64	10	40·00	20·96	4	2·00	2·10
65	28	25·00	20·79	7	5·59	5·82
66	46	15·22	20·62	7	9·18	9·18
67	38	10·53	20·46	4	7·58	7·77
68	37	18·92	20·29	7	7·38	7·51
69	41	19·51	20·11	8	8·18	8·25
1870	27	33·33	19·95	9	5·39	5·39
71	30	36·67	19·78	11	5·98	5·93
72	41	19·51	19·61	8	8·18	8·04
73	35	25·72	19·44	9	6·98	6·80
74	41	14·74	19·27	6	8·18	7·90
75	47	19·15	19·10	9	9·38	8·97
76	47	25·54	18·93	12	9·38	8·90
77	49	20·42	18·76	10	9·78	9·19
78	46	19·57	18·59	9	9·18	8·56
79	43	25·58	18·42	11	8·58	7·92
1880	71	26·77	18·25	19	14·16	12·95
81	56	16·07	18·08	9	11·17	10·12
82	60	23·33	17·91	14	10·97	10·75
83	53	24·54	17·74	13	10·57	9·40
84	70	21·43	17·57	15	13·97	12·29
85	84	9·52	17·40	8	17·76	14·61
86	90	21·11	17·23	19	17·96	15·50
87	63	25·40	17·07	16	12·57	10·75
88	120	14·17	16·90	17	23·94	20·28
89	120	23·33	16·73	28	23·94	20·07
1890	82	34·15	16·56	11	17·36	13·57
91	123	20·33	16·38	25	24·54	20·15
92	118	16·10	16·22	19	23·58	19·14
93	134	18·66	16·05	25	26·78	20·51
94	101	14·85	15·88	15	20·15	16·03
95	87	9·20	15·71	8	17·36	13·73
96	78	16·67	15·54	13	15·56	12·12
97	113	23·01	15·37	26	22·54	17·36
98	122	16·40	15·20	20	24·34	18·54
99	116	20·69	15·03	24	23·14	17·35
1900	138	17·39	14·86	24	27·53	20·24
1901	137	18·98	14·69	26	27·33	20·12

Male Still-Births.

During the period under review, we found that there were 616 cases of still-births out of 3028 total male births, while in the case of females there were 444 still births out of 2746 female-births. The still-birth rates were therefore $19{\cdot}95 \pm 0{\cdot}719$ per cent. among males, and $16{\cdot}17 \pm 0{\cdot}725$ among females. It is of some interest to note here that the total number of births as well as the number of still-births are higher in males than in females.

We shall first test the hypothesis of a constant rate of male still-births. The expected values will be given, as explained in the case of maternal deaths, by multiplying the total number of births n_t in each year by 0·1995 the average still birth-rate. The actual number of still-births is given in column 5 of Table 7, and the expected number on the assumption of a constant still-birth rate in column 6. Squaring the difference between the actual and the expected number and dividing by the expected number in each year and summing we get $\chi^2 = 77{\cdot}10$ for 52 cells. The probability of the system of discrepancies is about ·013 or about 1·3 per cent. The hypothesis of a constant male still-birth rate is hardly adequate.

The actual still-birth rates are shown in column 3 of Table 7 (Chart 3). They were graduated by a weighted straight line whose equation is given by

$$p_t = 23{\cdot}34 - 0{\cdot}17\ (t - 1850) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where p_t is the expected still-birth rate in tth year and is shown in column 4 of Table 7. Multiplying p_t by the corresponding number of births (n_t) we get the expected number of male still-births in each year shown in column 7 of Table 7. The actual numbers are given in column 5. The value of χ^2 now comes out to be 61·95 for 52 cells or $n = 50$. The corresponding probability is about 23 per cent., which shows good agreement between observed and expected values.

We conclude, therefore, that the male still-birth rate may be considered to have decreased at a constant rate of 0·17 per cent. per year during the period 1850-1901.

We can now test whether there is any seasonal variation in the proportion of still births.

Table 8.—Monthly Incidence of Male Still-Births

Months	Number of Cases	Number of Still-Births			Actual Still-Birth Rate
		Actual	Expected (Const. rate)	Difference	
(1)	(2)	(3)	(4)	(5)	(6)
January	287	49	57·26	− 8·26	·1707
February	244	56	48·68	−12·68	·1475
March ...	248	53	49·48	+ 3·52	·2137
April ...	203	45	40·50	+ 4·50	·2217
May ..	214	39	42·69	− 3·69	·1822
June	188	38	37·51	+ 0·49	·2021
July ...	237	45	47·28	− 2·28	·1899
August .	261	64	52·07	+11·93	·2452
September	288	58	56·46	+ 1·54	·2049
October	330	63	65·84	− 2·84	·1909
November	290	63	57·86	+ 5·14	·2172
December	303	63	60·45	− 2·55	·2079

The actual number of male still-births are given in col. 3 and corresponding rates are shown in col. 6 of Table 8. Assuming a constant rate of male still-births, the expected number of still-births for each month is obtained by multiplying p_0 (= 0·1995) by the total number of births in that month. Squaring the discrepancies between the observed and expected values, etc., in the usual way, we get $\chi^2 = 9{\cdot}14$ for 12 cells. P is ·609 which shows excellent agreement between observed and expected values. Hence, we can say that in the case of males, the still-birth rate does not fluctuate appreciably from month to month (chart 9).

Female Still-Births.

The actual and expected number of female still-births (calculated on the assumption of a constant still-birth rate of 16·17 per cent.) are shown in column 5 and 6 of Table 9. The corresponding value of χ^2 is 135·79 for 52 cells. The probability is negligibly small, and the hypothesis of a constant still-birth rate must be rejected in the case of females also.

The weighted line of best fit for the female still-birth rate is given by

$$p_t = 19{\cdot}32 - 0{\cdot}092\ (t - {}^{3}1850) \quad \ldots\ldots(4)$$

The actual and graduated rates are given in columns 3 and 4 of Table 9 (Chart 4), and the expected numbers of female still-births calculated from the graduated rates are shown in column 7. Comparing with actual numbers (column 5), we get $\chi^2 = 62{\cdot}21$ for 52 cells. For $n = 50$ the value of P is ·23 which is quite satisfactory. The female still-birth rate may be considered to have decreased steadily at the rate of ·092 per cent. per year.

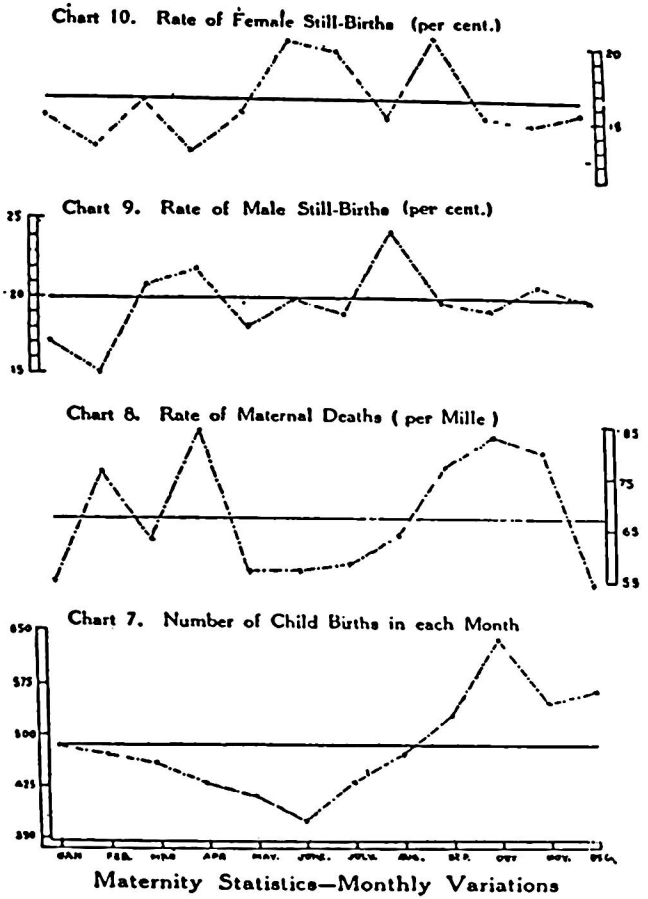
The actual and expected number of still-births for females for different months (on the assumption of a constant rate) are given in column 3 and 4 of Table 10 respectively. The value of $\chi^2 = 8{\cdot}14$ for 12 cells and the corresponding P is ·701. So in the case of females also, no significant seasonal fluctuations can be traced (Chart 10).

Table 10.—Monthly Incidence of Female Still-Births

Months	Number of Cases	Number of Still-Births			Actual Still-Birth rate
		Actual	Expected (Const. rate)	Difference	
(1)	(2)	(3)	(4)	(5)	(6)
January	193	30	32·02	− 2·02	·1515
February	229	32	37·03	− 5·03	·1397
March ...	211	35	34·12	+ 0·88	·1659
April ...	228	30	36·87	− 6·87	·1316
May ...	198	31	32·02	− 1·02	·1566
June ...	188	38	30·40	+ 7·60	·2021
July ...	195	37	31·53	+ 5·47	·1897
August ...	218	82	34·44	− 2·44	·1502
September	249	51	40·26	+10·74	·2048
October ..	313	48	50·61	− 2·61	·1534
November	259	38	41·88	− 3·88	·1467
December	265	42	42·85	− 0·85	·1585

TABLE 9.—FEMALE STILL-BIRTHS

Year (t)	Number of Female Births (n_t)	Still-Birth Rate per Hundred: Actual (p'_t)	Still-Birth Rate per Hundred: Graduated (Linear trend) (p_t)	Still-Birth: Actual Number (d_t)	Still-Birth: Expected (Constant rate) ($n_t.p_0$)	Still-Birth: Expected (Linear trend of rate) ($n_t.p_t$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1850	17	17·65	19·32	3	2·26	3·27
51	21	4·77	19·24	1	3·23	4·04
52	17	5·89	19·14	1	2·59	3·25
53	26	15·39	19·05	4	3·56	4·95
54	22	0	18·96	0	3·56	4·17
55	21	0	18·87	0	3·40	3·96
56	11	36·36	18·78	4	1·13	2·07
57	20	10·00	18·69	2	2·91	3·73
58	23	17·39	18·60	4	3·07	4·28
59	28	25·00	18·50	7	3·40	5·18
1860	21	28·57	18·42	6	2·43	3·87
61	30	23·33	18·32	7	3·72	5·49
62	15	20·00	18·23	3	1·97	2·73
63	20	15·00	18·14	3	2·75	3·63
64	20	15·00	18·05	3	2·75	3·61
65	24	12·50	17·96	3	3·40	4·31
66	41	21·95	17·86	9	5·17	7·32
67	21	42·86	17·77	9	1·94	3·73
68	35	17·14	17·68	6	4·69	6·18
69	20	20·00	17·59	4	2·59	3·52
1870	14	21·43	17·50	3	1·79	2·45
71	25	28·00	17·41	7	2·91	4·35
72	25	4·00	17·31	1	3·88	4·32
73	42	19·05	17·22	8	5·22	7·23
74	31	16·13	17·13	5	4·20	5·31
75	39	20·51	17·04	8	5·01	6·64
76	50	26·00	16·95	13	5·98	8·47
77	33	12·12	16·86	4	4·69	5·56
78	37	21·62	16·76	8	4·69	6·20
79	33	6·06	16·67	2	5·01	5·50
1880	54	29·63	16·58	16	6·14	8·95
81	53	22·64	16·49	12	6·63	8·70
82	44	27·27	16·40	12	5·17	7·22
83	59	13·56	16·31	8	8·25	9·62
84	84	15·48	16·22	13	11·48	13·62
85	88	12·50	16·12	11	12·45	14·18
86	82	21·95	16·04	18	10·35	13·14
87	68	11·76	15·94	8	9·70	10·84
88	109	11·93	15·85	13	15·52	17·27
89	110	21·82	15·76	24	13·91	17·33
1890	92	10·87	15·67	10	13·26	14·42
91	112	16·07	15·57	18	15·20	17·44
92	97	16·50	15·48	16	13·10	15·02
93	100	21·00	15·39	21	12·77	15·89
94	74	10·81	15·29	8	10·67	11·11
95	78	14·10	15·21	11	10·83	11·86
96	81	11·11	15·12	9	11·64	12·26
97	115	11·30	15·02	13	16·49	17·27
98	122	15·57	14·93	19	16·66	18·21
99	122	14·05	14·84	17	16·82	18·10
1900	121	12·03	14·75	16	18·92	17·84
1901	133	14·77	14·66	13	12·13	19·50



Maternity Statistics—Monthly Variations

Sex Ratio.

It is of some interest to study whether the sex proportion of births has remained sensibly constant during the period under review. There were altogether 2,746 female births out of a total number of births of 5,834 during 1850-1901. This gives a proportion of females of 0·4707 with a S. E. of ·0066. This corresponds to a sex-ratio of births (males : females) of 1·1093.

Multiplying the total number of births in each year by 0·4765 we can obtain the expected number of female-births on the assumption of a constant sex-ratio. The actual and expected number of female-births for each year are given in col. 3 and 4 of Table 11.

In calculating the value of χ^2 we can conveniently use the method of Brandt and Snedecor (quoted by R. A. Fisher, *Statistical Methods for Research Workers*, 1932, p. 90). Let f represent the actual number of female-births in any year of n births. Also let F total number of female-births for the whole period, and N the total number of births.

TABLE 11.—SEX-RATIO AT BIRTHS

Years	Number of Births	(A) TOTAL FEMALE BIRTHS: Actual	Proportion	Expected (Constant Sex-Ratio	Difference	Years	Number of Living Births	(B) LIVING FEMALE BIRTHS: Actual	Proportion	Expected (constant effective sex-ratio)	Difference
(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
1850	43	17	1·53	20·2	−3·2	1850	35	14	1·50	16·9	−2·9
51	45	21	1·11	21·2	−0·2	51	38	20	·90	18·3	+1·7
52	52	17	2·01	25·9	−8·9	52	44	16	1·75	21·2	−5·2
53	58	26	1·23	27·3	−1·3	53	47	22	1·14	22·7	−0·7
54	54	22	1·45	25·4	−3·4	54	48	22	1·18	23·1	−1·1
55	44	21	1·10	20·7	+0·3	55	40	21	·91	19·3	+1·7
56	34	11	2·01	16·0	−5·0	56	35	7	2·57	12·0	−5·0
57	34	20	0·70	16·0	+4·0	57	29	18	·61	14·0	+4·0
58	42	23	0·83	19·8	+3·2	58	33	19	·74	15·9	+3·1
59	51	28	0·82	24·0	+4·0	59	36	21	·71	17·4	+3·6
60	48	21	1·29	22·6	+1·6	60	34	15	1·27	16·4	−1·4
61	50	30	0·67	23·5	+6·5	61	38	23	·65	18·3	+4·7
62	37	15	1·47	17·4	−2·4	62	24	12	1·00	11·6	+0·4
63	46	20	1·30	21·7	−1·7	63	31	17	·82	14·9	+2·1
64	30	20	0·50	14·1	+5·9	64	23	17	·59	11·1	+5·9
65	52	24	1·17	24·5	−0·5	65	42	21	1·00	20·3	+0·7
66	87	41	1·13	40·9	+0·1	66	71	32	1·22	34·2	−2·2
67	59	21	1·81	27·8	−6·8	67	46	12	2·83	22·2	−10·2
68	72	35	1·06	33·9	+1·1	68	59	29	1·04	28·4	+0·6
69	61	20	2·05	28·7	−8·7	69	49	16	2·06	23·6	−7·6
70	41	14	1·93	19·3	−5·3	70	29	11	1·64	14·0	−3·0
71	55	25	1·20	25·9	−0·9	71	37	18	1·56	17·8	+0·2
72	66	25	1·64	31·1	−6·1	72	57	24	1·38	27·5	−3·5
73	77	42	0·83	36·2	+5·8	73	60	34	·76	28·9	+5·1
74	72	31	1·03	33·9	−2·9	74	61	26	1·35	29·4	−3·4
75	86	39	1·21	40·5	−1·5	75	69	31	1·23	33·8	−2·3
76	97	50	·94	45·7	+4·3	1876	72	37	·95	34·7	+2·3
77	82	33	1·49	38·6	−5·6	77	68	29	1·34	32·8	−3·8
78	83	37	1·24	39·1	−2·1	78	66	29	1·23	31·8	−2·8
79	76	33	1·30	35·8	−2·8	79	68	31	1·03	30·4	+0·6
80	125	54	1·31	58·8	−4·8	80	90	38	1·37	43·4	−5·4
81	109	53	1·06	51·3	+2·3	81	88	41	1·15	42·4	−1·4
82	104	44	1·36	49·0	−5·0	82	78	32	1·44	37·6	−5·6
83	112	59	·90	52·7	+6·3	83	91	51	·78	43·9	+7·1
84	154	84	·83	72·5	+11·5	84	126	71	·77	60·8	+10·2
85	172	88	·95	80·9	+8·9	85	153	77	·99	73·8	+3·2
86	172	82	1·10	80·9	+2·9	86	135	64	1·11	65.1	−1·1
87	131	68	·93	61·7	+6·3	87	107	60	·78	51·6	+8·4
88	229	109	1·10	107·8	+1·2	88	199	96	1·07	96·0	0
89	230	110	1·09	108·3	+1·7	89	178	86	1·07	85·8	+0·2
90	174	92	·89	81·8	+10·1	90	153	82	·87	73·8	+8·2
91	235	112	1·10	110·6	+1·4	91	192	94	1·04	92·6	+1·4
92	215	97	1·22	101·2	−4·2	92	180	81	1·22	86·8	−5·8
93	234	100	1·34	110·1	−10·1	93	188	79	1·38	90·7	−11·7
94	175	74	1·36	82·4	−8·4	94	152	66	1·30	73·8	−7·8
95	165	78	1·12	77·7	+0·3	95	146	67	1·18	70·4	−3·4
96	139	81	·96	74·8	+6·2	96	187	72	·90	65·6	+6·4
97	228	115	·98	107·3	+8·3	97	189	102	·85	91·1	+10·9
98	244	122	1·00	114·8	+7·2	98	205	103	·99	98·9	+4·1
99	237	122	·94	111·6	+10·4	99	196	104	·88	94·5	+9·5
1900	271	121	1·24	127·6	−6·6	1900	231	117	·97	111·4	+5·6
1901	225	133	·69	105·9	+27·1	1901	186	75	1·84	89·7	−14·7

The proportion of female-births for the whole period is $\bar{p}=F/N$ and $\bar{q}=1-\bar{p}$ is the proportion of male births. Then χ^2 is given by :— $\chi^2=[S(f^2/n)-F^2/N]/\bar{p}.\bar{q}$ In the present case $\bar{p}=0{\cdot}4765$, $\bar{q}=0{\cdot}5235$, $F=2780$ and $N=5834$, and $S(f^2/n)=1345{\cdot}47$. We thus get $\chi^2=83{\cdot}21$ for a 2×52−fold table. The number of degrees of freedom is $(2-1).(52-1)=51$. The value of $\sqrt{(2\chi^2)}-\sqrt{(2n-1)}=1{\cdot}95$ which is just below the 5% level. We conclude that the sex proportion of births may be considered to have remained practically constant during the period under review.

We may now consider the effective sex proportion given by the ratio of live births. The toal number of living female births were 2302 and the total number of living births were 4774 so that the effective proportion of females was 0·4822 with a S. E. of ·0072. Multiplying the effective sex-ratio by the total number of living births in each year, we get the expected number of living female births. The actual and expected number of living female births are given in columns 3 and 4 respectively of Table 11(B). The value of χ^2 was found to be 2·67 for 52 cells. P is again very high. Hence the effective sex-ratio also has remained sensibly constant. We find then that the sex-ratio for Bengal Hindu births has not varied appreciably during the whole of the period under review (1850-1901). The sex-ratio is clearly a deep seated biological constant which is not easily affected by environmental conditions.

Summary.

The present note gives a statistical analysis of the rates of maternal deaths at delivery and the proportion of still-births in males and females among Bengali Hindus for 6481 cases of delivery from the records of the Calcutta Eden Hospital for the period 1850-1901.

(1) The total number of cases increased steadily from 45 in 1850 to 293 in 1901. This increase was proportionately much greater than the growth of population, which indicates a change in the habit of the people.

(2) The number of child-births differed significantly in different months, the largest number of cases occurred in October and was 1·7 times the lowest number which occurred in June.

(3) The average maternal death-rate was 66·50 per mille. The death-rate decreased at a steady rate of 1·07 per mille per year, a linear graduation being fully adequate.

(4) The average proportion of male still-births was 19·95 per cent., but the actual proportion decreased at a steady rate of 0·17 per cent. per year.

(5) The average proportion of female still-births was 16·17 per cent. but the actual proportion decreased at a constant rate of 0·09 per cent. per year.

(6) There was no significant variation of the rates of maternal deaths or of still-births from month to month.

(7) The gross sex-ratio, *i.e.*, the ratio of the total number of female births to the total number of births, remained practically constant from year to year over the whole period (1850-1901). On the average 47·07 per cent. of the total births were female children.

(8) Omitting the cases of still-births, the effective sex-ratio was also found to remain practically constant over the period 1850-1901. On the average 48·22 females were born alive per hundred living births. Both the gross and the effctive sex-ratio thus remained practically constant and were not affected by environmental conditions.

(*March, 1934*).