MORTALITY IN CHILDHOOD WITH REFERENCE TO HYGIENE.

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(With 2 Diagrams.)

THE method in which the mortality in childhood varies from age to age is a matter of very considerable interest. With each increase of unhygienic circumstances the death-rate among infants is well known to rise and it is commonly taken as a criterion of the measure of the unhealthiness of the environment. In a rough way this is quite true but it is not the only criterion, any year of life might equally well be taken. The investigation in this note is based on a tabulation made from the data published by the Registrar-General of England for the decade 1891–1900. In order to make the statistics as homogeneous as possible the registration districts have been grouped according to the infantile mortalities, intervals of ten being taken in the unit. Thus those districts with death-rates between 80 and 90 have had their populations and deaths grouped together, those between 90 and 100 likewise and so on. This has been done separately for males and females for each year of life up to five years, no further distinctions in years of life being made in the statistics.

After this grouping had been made two methods in dealing with the statistics were employed. In the first method the mean populations used to obtain the death-rates were obtained from the records in the census. In the second case the populations were estimated by taking the number of births and subtracting at each successive year of age the number of deaths, thereby arriving at a second estimate of the population. As the statistics refer to ten years there cannot be much error in the estimate apart from the error of the recorded figures. These estimates differ somewhat. It is not necessary to give the figures but the death-rates obtained in each group are given both for males and females.

It is seen when these statistics are examined, that if the infantile mortality is taken as the measure of hygiene, the mortality at each subsequent age of life can be represented very closely by a series of parabolas. The equations of these parabolas are given in the accompanying table. It will be noticed at once that the mortality at each age rises more quickly than the infantile mortality. This is very marked at the ages one to two years and two to three years, less marked between three and four years, while at the age of four and five years the relationship is very nearly a straight line. From the beginning of life therefore, up to a certain point roughly fixed at 1·8 years the influence of an unhealthy environment acts progressively. After this point the mor-

tality in childhood becomes more and more into direct linear relationship with the mortality of infants.

In making this investigation the whole infantile mortality has been taken although it is recognised that a certain amount of the infantile mortality is more or less independent of hygienic conditions. This, however, is in the nature of adding a constant and does not affect the coefficient of the square of the infantile mortality which is the important coefficient.

If we now look in detail at the equations it will be observed that the value of the coefficients of the square of infantile mortality in the case of males falls in an almost absolute geometrical progression from one to five years. In the case of females, however, there is a marked difference from this, the coefficient between three and four years of age falling suddenly and being very nearly equal to that between four and five years. The ages of children are not given with extreme accuracy in the census, the ages at death being

Table I. *Showing the death-rates per thousand at certain ages in childhood.*

(a) *The mean population calculated from the census populations.*

	MALES					FEMALES			
Group Infantile mortality	1–2 years	2–3 years	3–4 years	4–5 years	Group Infantile mortality	1–2 years	2–3 years	3–4 years	4–5 years
80–89	22·71	9·69	7·24	5·19	60–79	24·51	9·47	6·14	5·09
90–99	25·49	8·77	6·68	5·04	80–99	25·50	10·00	6·60	5·14
100–109	28·52	10·39	6·58	5·72	90–99	28·84	10·90	7·37	5·86
110–119	29·16	10·74	7·44	7·37	100–109	30·78	11·98	8·35	6·35
120–129	32·25	11·79	8·06	6·32	110–119	35·30	13·08	8·96	6·69
130–139	36·57	12·76	8·53	6·63	120–129	41·50	16·17	10·70	7·94
140–149	40·11	14·34	9·22	7·32	130–139	45·58	17·52	11·52	8·35
150–159	43·77	15·99	10·55	8·18	140–149	54·53	20·48	13·66	9·67
160–169	51·97	18·35	11·65	8·74	150–159	64·87	23·46	14·68	9·87
170–179	58·98	21·66	12·98	9·73	160–169	69·76	25·33	15·85	11·03
180–189	66·71	23·87	14·21	10·42	170–179	68·83	26·02	17·44	11·89
190–199	74·78	26·30	15·03	10·88	180–189	83·85	33·24	21·14	15·44
200–209	73·35	25·72	16·19	11·23	190–199	93·58	34·88	22·31	15·47
210–219	75·85	29·42	18·22	12·99	200–209	101·19	38·30	21·18	15·13
220–229	95·58	36·66	22·50	15·04					
230–239	105·60	40·35	22·35	14·90					

(b) *The mean population calculated from the number of births and deaths.*

	MALES					FEMALES			
Group Infantile mortality	1–2 years	2–3 years	3–4 years	4–5 years	Group Infantile mortality	1–2 years	2–3 years	3–4 years	4–5 years
80–99	24·78	9·26	7·08	5·35	60–79	24·42	9·94	6·60	5·43
100–109	27·13	10·57	6·87	6·06	80–89	25·06	10·13	7·01	5·46
110–119	28·29	11·07	7·81	6·12	90–99	27·82	11·19	7·75	6·20
120–129	30·72	11·97	8·10	6·58	100–109	30·09	12·18	8·64	6·76
130–139	34·68	12·95	8·84	6·86	110–119	33·56	13·22	9·14	6·88
140–149	37·86	14·41	9·28	7·44	120–129	39·90	16·23	10·93	8·12
150–159	42·02	16·07	10·75	8·30	130–139	42·88	17·26	11·51	8·36
160–169	49·41	18·08	11·76	8·79	140–149	51·31	20·03	13·62	9·55
170–179	55·19	21·32	12·86	9·62	150–159	60·56	22·92	14·47	9·75
180–189	62·86	23·41	14·11	10·28	160–169	65·33	24·97	15·67	10·88
190–199	69·45	25·47	14·66	10·63	170–179	63·32	25·03	17·11	11·55
200–209	67·80	25·20	16·06	11·27	180–189	74·99	32·20	20·73	14·81
210–219	68·64	27·74	17·66	12·47	190–199	84·61	33·70	22·03	15·20
220–229	88·06	35·93	21·70	14·88	200–209	91·22	37·02	21·13	15·06
230–239	94·53	38·41	21·78	14·82					

on the whole a more accurate figure but the phenomenon is equally marked when the population is estimated from the deaths. This is probably due to error in the figures but it is possible that girls may adapt themselves more rapidly than boys to a condition of equilibrium with their environment.

The manner in which the death-rates vary is shown in Diagram I. This diagram illustrates the relationship between the infantile mortality and the mortality between two and three years of age. From this diagram it will be seen that with statistics arranged so as to be as homogeneous as possible, the observations lie very closely on a graduating curve. The divergence on either

DIAGRAM I
Males
2–3 years

Females
2–3 years

DIAGRAM II
Males
2–3 years.
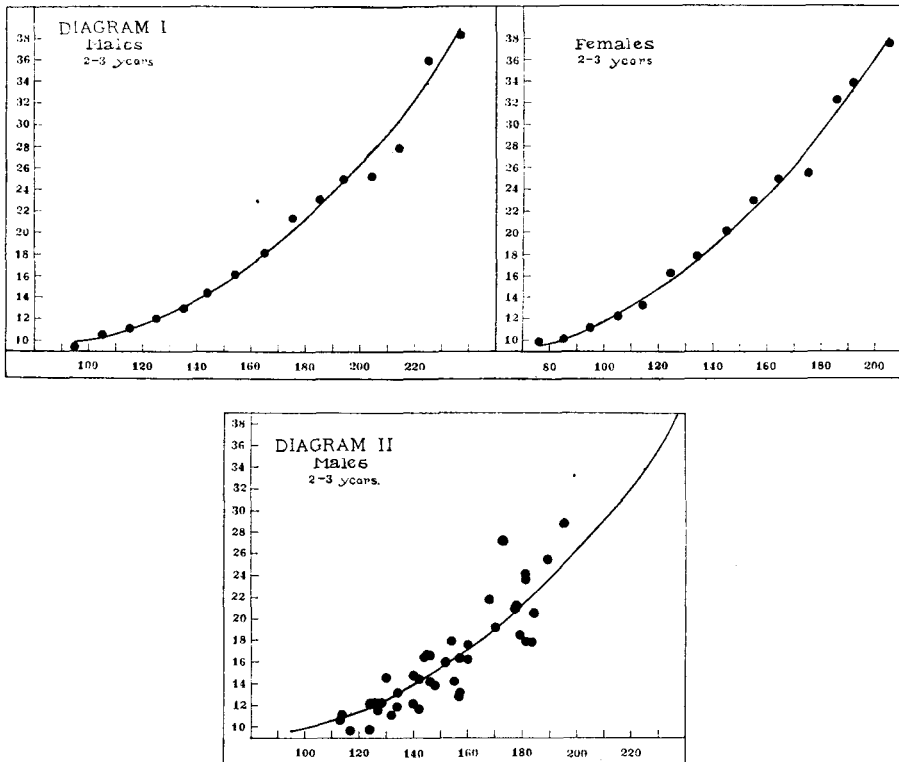
side of the curve is such that where the observations for males are in excess, the observations for females are most frequently in defect, and *vice versa*, the observations for combined sexes would therefore fit such a curve more closely, indicating that the divergence is probably due to the error of random selection.

Prior to this extraction of the statistics so as to group them in homogeneous groups as far as possible, the only information easily obtainable was with reference to the counties as a whole. The counties are, however, very far from being homogeneous units. Town and country is mixed in quite unequal proportions. It will be noticed therefore (Diagram II) that though the

curve still represents the observations a wide divergence on either side of the curve is observed. This is an illustration of the necessity of careful grouping of figures if the real relationships are to be discovered.

Table II. *Showing the relationship between the death-rates at each year of age in childhood and the infantile mortality.*

(a) *The mean population calculated from the census populations.*

AGE	MALES	FEMALES
1–2	$D_1 = 27 \cdot 068 - \cdot 255840\,I + \cdot 002445\,I^2$	$D_1 = 20 \cdot 149 - \cdot 176242\,I + \cdot 002815\,I^2$
2–3	$D_2 = 17 \cdot 072 - \cdot 196077\,I + \cdot 001231\,I^2$	$D_2 = 9 \cdot 956 - \cdot 100660\,I + \cdot 001179\,I^2$
3–4	$D_3 = 11 \cdot 378 - \cdot 112866\,I + \cdot 000687\,I^2$	$D_3 = 1 \cdot 461 + \cdot 026814\,I + \cdot 000383\,I^2$
4–5	$D_4 = 5 \cdot 749 - \cdot 031889\,I + \cdot 000306\,I^2$	$D_4 = 3 \cdot 952 - \cdot 016170\,I + \cdot 000373\,I^2$

(b) *The mean population calculated from the number of births and deaths.*

AGE	MALES	FEMALES
1–2	$D_1 = 20 \cdot 061 - \cdot 142651\,I + \cdot 001913\,I^2$	$D_1 = 17 \cdot 230 - \cdot 099419\,I + \cdot 002262\,I^2$
2–3	$D_2 = 15 \cdot 404 - \cdot 164267\,I + \cdot 001095\,I^2$	$D_2 = 10 \cdot 824 - \cdot 103291\,I + \cdot 001139\,I^2$
3–4	$D_3 = 9 \cdot 954 - \cdot 088460\,I + \cdot 000594\,I^2$	$D_3 = 3 \cdot 357 + \cdot 005359\,I + \cdot 000436\,I^2$
4–5	$D_4 = 6 \cdot 027 - \cdot 034092\,I + \cdot 000306\,I^2$	$D_4 = 5 \cdot 360 - \cdot 030482\,I + \cdot 000401\,I^2$

When D_1 is the death-rate between one and two years, etc., and I is the infantile mortality