THE INFLUENCE OF AGE OF THE GRAND-PARENT AT THE BIRTH OF THE PARENT ON THE NUMBER OF CHILDREN BORN AND THEIR SEX.

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(*From the Statistical Department of the Lister Institute.*)

(With 1 Text-figure.)

It has been already shown by Darwin and others that reproduction is a function of environment and that unfavourable conditions of life are likely to increase the number of seeds formed or offspring produced; hence so many are reproduced that the chance of the species being perpetuated is maintained, despite the unfavourable conditions for survival. To extend this idea, and say that a dying species tends to reproduce faster than one actively evolving, is a suggestion worthy of enquiry. It has been argued that the varying birth rates in man may to some extent reflect the future biological possibilities of his race. In so far as all environments are really functions of time, or, to put it another way, we measure the nature of an environment by the length of time it takes to produce a certain result, it is quite a natural sequence to consider the effect of time, that is, age on fertility. Dr Matthews Duncan and others have dealt with the immediate effect of time, that is personal age, and the question of the transmitted effect, if any, remains to be considered. If the idea that a species which is dying out tends to reproduce more rapidly, holds good for man, then our previous finding, that the later born do not on the average live so long as the earlier born, would suggest that they might possess as compensation an enhanced fertility. To solve this problem we must correlate the number of offspring produced by each unit with the age of the parents when he or she was born, the reproductive period being made constant. It is obvious that considerable difficulties will arise owing to the imperfect nature of our data, for we should possess knowledge not only of the number born alive, but also of still births and miscarriages. Should the latter not be recorded, a negative correlation is to be expected, if our previous findings are correct, for it will be remembered that the correlation between age of grandmother at the birth of the mother and the number dying in adolescent life, is about ·1 and further, that this association is more marked in early life. An idea of the value may be deduced in the following way. If we denote by X_1 the number of live births, by X_2 the number of still births, and by X_3 the grandmother's age at the birth of the mother, then the correlation of X_3 age and $X_1 + X_2$ (the total number of births) is

$$\frac{r_{13}\sigma_1\sigma_3 + r_{23}\sigma_2\sigma_3}{\sigma_3(\sigma_1^2 + \sigma_2^2 + 2r_{12}\sigma_1\sigma_2)^{\frac{1}{2}}}.$$

If r_{23} is positive, the expression will only vanish if r_{13} is negative.

With these preliminary remarks, we may turn to the actual data. The information on which the following work is based was obtained from Burke's *Peerage*, 1902, and deals with all those who actually inherited a peerage; the other members of the family are ignored. The following points deserve consideration: (1) only such members of the family as had actually been christened are given. Hence still births or such as died shortly afterwards would not be recorded. It is also probable that those who died in infancy are not fully accounted for. If the record *is* comprehensive, then the rate of infant mortality in the peerage must be under 25 per 1000 births, a somewhat unlikely figure. It is obvious that this omission will produce an inaccuracy in the actual size of the family and, as has already been stated, may tend to produce a negative correlation in the data. (2) In so far as we were dealing with males only, and some had been married twice, it was decided to count each of the latter from his first marriage to the death of his first wife and again from his second marriage to his own death or the death of his second wife and so on. (3) About 20 per cent. of those considered are still living. (4) 75 per cent. are first male births. This proportion is so large that it may appear unnecessary to consider order of birth, but, as will be seen later, some weight had to be given to it. (5) Instances where no marriage occurred are ignored.

The characters observed and the reason for choosing each were as follows:

1. Age of father at birth of peer.
2. Number of children born to peer. (These are fundamental and need no further consideration.)
3. Age of peer at marriage.
4. Age of peer at death or present age.

These are necessary because the actual space of time during which reproduction occurs must be made constant. It is unfortunate that the age of the wife was unobtainable as it is obvious that in many cases where the wife was still living, the reproductive epoch had ended before the husband's death. An attempt has been made to remove this difficulty in the second series of observations.

5. Order of male births.

It would have been better to have known the actual birth sequence, but this is not given. Even should we decide to ignore the possible pathological handicap of the first born as a statistical fallacy, we must still give order of birth some consideration, because the first male stands in a somewhat different position from that of other members of the family. He has everything to gain by a large family, with respect to the perpetuation of his house, whilst his brothers are in a position more akin to that of the prosperous middle class, where the reverse holds good, so that should a peerage fall to a later born child, it might wholly change his views respecting his responsibilities. Such a possibility renders it desirable that order should be considered. The tables formed are as follows:

TABLE I.

Age of father at birth of son and number of children born to son.

Age of father at birth	Number born																			
Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
15–16	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2
17–18	—	—	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	3
19–20	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3
21–22	6	6	4	—	3	6	3	2	1	1	1		—	—	—	—	—	—	—	33
23–24	10	7	6	8	7	13	4	5	4	3	1	3	2	—	1	—	1	—	—	75
25–26	17	1	8	9	5	9	10	8	5	8	8	2	3	2	—	—	—	—	—	95
27–28	17	6	8	12	13	15	13	6	9	5	5	3	5	1	2	—	—	—	—	120
29–30	14	9	7	13	13	8	16	9	4	5	2	4	1	1	1	1	1	—	1	110
31–32	17	12	6	15	12	9	14	10	7	5	2	4	3	—	4	—	—	—	—	120
33–34	11	6	8	9	6	3	10	12	7	10	5	3	1	2	1	—	—	—	—	94
35–36	6	5	9	12	9	10	9	6	6	2	4	4	2	1	2	—	—	—	—	87
37–38	12	3	5	12	6	14	5	7	5	5	3	3	1	—	—	—	—	—	—	81
39–40	9	4	5	1	10	9	9	5	3	6	3	1	—	—	2	—	—	—	—	67
41–42	8	6	3	4	9	5	4	3	4	2	1	1	1	—	—	—	—	—	—	51
43–44	7	2	2	2	3	3	7	5	2	2	—	—	—	—	—	—	—	—	—	35
45–46	2	3	3	4	2	2	4	1	1	3	1	1	2	—	—	—	—	—	—	29
47–48	2	3	1	—	3	2	1	1	—	—	—	2	1	—	1	1	—	—	—	18
49–50	2	3	1	2	1	—	—	—	1	1	1	1	—	—	1	—	—	—	—	14
51–52	6	1	1	2	—	2	1	1	2	—	—	—	1	—	—	—	—	—	—	17
53–54	3	—	—	2	2	—	—	—	—	—	—	—	1	1	—	—	—	—	—	9
55–56	2	1	—	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	6
57–58	2	1	—	1	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	7
59–60	1	2	1	—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	7
61–62	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2
63–64	—	—	2	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	4
65–66	—	—	—	—	—	2	—	—	—	1	—	—	—	1	—	—	—	—	—	4
67–68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69–70	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
71–72	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
73–74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75–76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79–80	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
Totals	155	82	81	111	106	117	112	85	63	59	38	33	25	9	15	2	2	—	1	1096

All $\sigma_{\text{no. born}} = 3{\cdot}5946$. $\sigma_{\text{age at birth}} = 4{\cdot}3858$. $r = -{\cdot}0203 \pm {\cdot}0198$.

If sterile mating be ignored $r = -{\cdot}0122 \pm {\cdot}0203$. $\eta_{\text{age}} = {\cdot}1943 \pm {\cdot}0196$. $\eta_{\text{number born}} = {\cdot}0882 \pm {\cdot}0202$.

TABLE II.

Age of father at birth of son and age of son at death.

Age at death

Years	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	45–46	47–48	49–50	51–52	53–54	55–56	57–58	59–60	61–62	63–64	65–66	67–68	69–70	71–72	73–74	75–76	77–78	79–80	81–82	83–84	85–86	87–88	89–90	91–92	93–94	95–96	97–98	99–100	101 & over	Totals
15–16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
17–18	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
19–20	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	3
21–22	—	—	—	—	—	—	—	—	3	2	—	1	4	1	1	—	1	—	3	—	—	—	1	2	3	—	2	1	1	1	—	3	1	—	—	1	—	—	—	—	—	32
23–24	—	—	1	—	—	—	1	3	1	4	2	3	4	1	2	2	4	3	1	3	3	6	6	1	7	2	3	4	1	2	2	—	1	2	—	—	—	—	—	—	—	75
25–26	—	—	—	2	1	—	—	2	3	1	—	2	1	3	5	1	3	3	5	9	6	3	9	3	8	3	4	9	1	1	3	2	1	1	—	—	—	—	—	—	—	95
27–28	1	—	—	—	1	1	5	2	1	2	1	2	1	6	4	2	5	6	4	1	7	8	4	10	5	8	3	6	5	4	2	2	5	2	1	1	—	1	—	—	1	120
29–30	—	—	—	—	—	—	—	—	2	5	2	4	2	5	6	4	8	3	2	3	7	2	4	6	5	4	7	4	6	6	2	4	2	1	3	2	—	—	—	—	1	112
31–32	—	—	1	1	3	—	1	2	3	3	2	4	4	3	3	5	3	6	6	5	6	6	4	1	5	9	10	4	6	2	3	4	3	1	—	—	—	1	—	—	—	120
33–34	—	—	1	—	—	—	1	1	1	2	5	3	—	2	3	3	—	6	4	6	7	3	5	7	2	8	4	4	5	2	3	2	1	3	—	—	—	—	—	—	—	94
35–36	—	—	—	—	—	1	1	2	2	3	3	3	1	5	3	6	2	2	4	2	4	2	4	2	4	2	5	6	2	1	6	2	1	2	1	—	—	—	—	—	—	84
37–38	—	—	—	—	—	2	2	1	2	1	2	2	4	—	7	2	7	3	3	3	6	6	—	—	5	4	1	3	—	3	3	1	4	2	1	1	—	—	—	—	—	81
39–40	—	—	—	2	—	—	—	—	3	2	3	2	3	2	2	1	2	1	5	3	4	—	1	4	2	3	2	7	1	3	3	2	1	1	1	—	—	1	—	—	—	67
41–42	—	—	—	—	—	2	—	1	2	1	2	—	2	2	1	7	2	2	1	2	2	2	3	2	2	3	1	3	1	2	1	2	—	—	—	—	—	—	—	—	—	51
43–44	—	—	—	—	—	—	—	—	1	1	3	—	1	—	3	—	3	3	3	—	2	—	—	1	2	1	3	1	1	2	—	1	—	1	—	—	—	—	—	—	—	33
45–46	—	—	—	—	1	—	1	1	1	—	1	1	2	3	—	1	—	—	—	—	—	1	—	2	1	—	1	2	2	2	2	1	—	—	1	—	—	—	—	—	1	28
47–48	—	—	—	—	—	—	—	—	—	1	—	1	3	—	2	—	1	1	—	2	—	2	—	1	—	—	—	1	1	—	—	—	1	1	—	—	—	—	—	—	—	18
49–50	—	—	—	—	—	1	—	—	—	—	—	2	—	1	—	1	2	1	—	2	1	1	—	—	—	1	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	15
51–52	—	2	1	—	—	2	1	—	—	—	—	1	—	1	—	1	—	—	—	—	2	1	—	1	1	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	17
53–54	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	9
55–56	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	—	—	6
57–58	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	7
59–60	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	6
61–62	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
63–64	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	4
65–66	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	4
67–68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69–70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
71–72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
73–74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75–76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79–80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	3	5	5	8	10	15	18	26	29	26	31	33	38	44	37	43	42	41	42	57	45	42	44	55	52	50	58	36	33	33	29	23	18	8	5	—	3	—	—	3	1091

$\sigma_{\mathrm{death}} = 7{\cdot}7560$. $\sigma_{\mathrm{birth}} = 4{\cdot}7216$. $r = -{\cdot}0620 \pm {\cdot}0189$.

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TABLE III.

Age of father at birth of son and age of son at marriage.

Age at birth (Years)	Age of son at marriage: 13–14	15–16	17–18	19–20	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	45–46	47–48	49–50	51–52	53–54	55–56	57–58	59–60	61–62	63–64	65–66	67–68	69–70	71–72	73–74	75–76	77–78	79–80	Totals
15–16	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	2
17–18	—	—	—	—	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
19–20	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
21–22	—	—	1	2	6	—	8	6	3	1	1	1	1	1	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33
23–24	1	—	1	2	7	14	6	11	7	6	2	4	3	2	3	1	—	2	1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	75
25–26	—	—	—	4	10	20	11	17	6	8	5	3	3	2	2	1	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	95
27–28	—	—	1	1	18	19	14	11	10	11	7	6	5	3	4	5	1	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	120
29–30	—	—	—	4	17	16	15	15	9	8	3	6	4	2	3	2	1	2	—	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	110
31–32	—	—	—	2	8	22	28	10	15	8	11	5	4	2	—	2	—	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	120
33–34	—	1	—	2	13	16	22	9	8	5	6	2	5	1	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	94
35–36	—	—	—	2	13	9	8	7	13	8	10	6	4	2	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	85
37–38	—	—	—	3	5	8	13	12	9	9	3	4	2	4	4	1	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	81
39–40	—	—	—	2	6	14	9	5	7	10	4	3	3	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	67
41–42	—	—	—	1	5	8	10	2	7	2	3	3	3	2	1	1	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	51
43–44	—	—	—	2	3	6	3	1	—	2	4	—	3	2	1	1	—	1	2	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	34
45–46	—	—	—	1	5	3	3	3	2	1	3	1	2	—	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29
47–48	—	1	1	2	1	3	1	5	—	—	1	—	2	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
49–50	—	—	—	—	1	2	1	3	3	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
51–52	—	—	—	—	5	2	1	3	1	1	1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
53–54	—	—	—	—	1	1	1	1	2	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
55–56	—	—	—	1	1	2	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
57–58	—	—	—	—	1	1	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	7
59–60	—	—	—	—	1	—	1	—	2	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	7
61–62	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
63–64	—	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
65–66	—	—	—	—	2	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
67–68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69–70	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
71–72	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
73–74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75–76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
79–80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	1	2	5	31	132	168	157	125	106	84	70	48	45	27	22	18	10	9	9	6	3	3	3	1	3	2	—	1	—	—	1	—	—	—	1092

$\sigma_{\text{age at birth}} = 4{\cdot}7216$. $\sigma_{\text{age at marriage}} = 3{\cdot}9069$. $r = -{\cdot}0398 \pm {\cdot}0194$.

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TABLE IV.

Age of son at marriage and age of son at death.

Age at marriage	Age at death																																									
Years	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	45–46	47–48	49–50	51–52	53–54	55–56	57–58	59–60	61–62	63–64	65–66	67–68	69–70	71–72	73–74	75–76	77–78	79–80	81–82	83–84	85–86	87–88	89–90	91–92	93–94	95–96	97–98	99–100	101 & over	Totals
13–14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
15–16	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
17–18	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
19–20	—	—	—	—	—	—	1	—	1	1	1	1	3	2	3	—	—	—	1	2	—	—	—	1	—	2	3	1	2	1	—	1	1	—	—	—	—	1	—	—	—	29
21–22	1	1	1	2	2	2	4	6	6	4	4	2	1	7	5	6	6	3	4	3	9	5	3	3	6	5	3	6	8	2	2	3	2	1	2	—	—	—	—	—	1	131
23–24	—	2	3	2	1	3	5	3	3	8	5	5	6	7	3	7	7	10	7	5	8	8	6	3	8	7	6	9	5	2	6	4	—	4	—	1	—	2	—	—	—	178
25–26	—	—	1	1	1	2	3	3	4	1	4	4	3	2	6	7	4	9	10	5	7	6	7	6	7	8	6	8	7	7	4	2	—	2	—	—	—	—	—	—	—	147
27–28	—	—	—	—	1	2	1	4	—	4	—	6	3	7	4	3	3	5	5	8	7	8	7	10	2	6	2	11	—	4	1	3	8	2	2	—	—	—	—	—	—	129
29–30	—	—	—	—	3	2	1	3	4	4	4	4	2	1	5	2	4	2	3	5	6	1	6	3	6	9	7	4	4	1	4	4	1	2	2	1	—	—	—	—	—	111
31–32	—	—	—	—	—	—	—	—	3	2	4	1	6	3	—	—	5	3	2	2	5	4	2	5	6	4	7	2	2	2	2	2	5	2	1	1	—	—	—	—	1	84
33–34	—	—	—	—	—	—	—	—	—	3	3	2	2	2	4	2	2	—	2	3	2	5	2	1	5	4	2	3	2	3	4	4	2	—	—	1	—	—	—	—	—	65
35–36	—	—	—	—	—	—	—	—	3	2	—	2	—	1	1	3	2	2	1	1	3	4	1	3	2	1	4	5	1	2	—	2	2	—	—	—	—	—	—	—	—	48
37–38	—	—	—	—	—	—	—	—	—	—	—	2	3	2	7	2	—	1	2	2	2	—	2	1	2	3	4	2	—	1	3	—	1	2	—	1	—	—	—	—	—	45
39–40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	1	1	2	—	3	3	1	—	1	—	2	3	—	2	1	3	—	—	—	—	—	—	—	—	—	27
41–42	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	2	2	1	5	2	—	—	2	1	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	28
43–44	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	2	2	1	—	3	—	—	2	2	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	1	18
45–46	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	1	—	1	1	—	1	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	9
47–48	—	—	—	—	—	—	—	—	—	—	—	—	—	3	2	—	—	1	—	—	2	—	—	—	—	—	—	1	2	1	—	—	—	—	—	—	—	—	—	—	—	12
49–50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	2	—	3	2	—	—	—	—	—	—	—	—	—	—	9
51–52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	6
53–54	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	3
55–56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
57–58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	3
59–60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
61–62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	3
63–64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2
65–66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
67–68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69–70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
71–72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
73–74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
75–76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
77–78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79–80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	1	3	5	5	8	11	15	19	24	29	26	30	32	39	44	35	43	42	41	42	60	45	42	44	51	53	50	59	36	33	32	29	23	17	8	5	—	3	—	—	3	1087

$\sigma_{\text{death}} = 7{\cdot}7560.\quad \sigma_{\text{marriage}} = 3{\cdot}9069.\quad r = {\cdot}1800 \pm {\cdot}0165.$

TABLE V.

Age of son at marriage and number of offspring born (all births).

Number born (Years) \ Age at marriage	13–14	15–16	17–18	19–20	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	45–46	47–48	49–50	51–52	53–54	55–56	57–58	59–60	61–62	63–64	65–66	67–68	69–70	71–72	73–74	75–76	77–78	79–80	Totals
0	—	—	1	1	15	17	17	18	14	15	9	7	12	3	4	4	3	1	2	4	1	1	1	—	2	—	—	2	—	—	—	—	—	—	154
1	—	—	—	4	10	15	6	4	9	8	3	2	5	2	3	—	4	3	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	1	81
2	—	—	—	2	10	9	13	11	7	6	3	6	3	1	4	2	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	81
3	—	—	1	2	9	12	19	12	8	8	10	9	4	5	5	2	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	121
4	1	1	2	1	14	17	13	9	11	11	6	2	5	5	1	4	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	106
5	—	—	—	2	9	20	14	18	13	8	13	10	2	2	2	1	1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	117
6	—	—	—	4	16	14	15	23	11	10	7	2	1	3	—	—	—	—	3	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	112
7	—	—	—	3	14	17	11	4	8	8	6	3	4	3	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	84
8	—	—	1	3	8	11	10	5	5	4	3	3	3	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	58
9	—	—	—	3	6	6	15	8	4	5	3	2	4	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	59
10	—	—	—	2	7	9	7	4	4	1	1	2	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	39
11	—	—	—	2	5	6	4	3	6	—	1	2	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	32
12	—	—	—	2	4	6	6	3	2	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
13	—	—	—	—	1	4	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
14	—	1	—	—	3	2	1	5	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
15	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
16	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	2	5	31	132	166	152	130	105	84	68	50	44	27	22	18	10	9	9	6	3	4	3	1	3	1	—	2	—	—	—	—	—	1	1098

$\sigma_{\text{no. born}} = 3{\cdot}5992$. $\sigma_{\text{age at marriage}} = 3{\cdot}9069$. $r = -{\cdot}2126 \pm {\cdot}0159$.

TABLE VI.

Age at death of son and number born to son.

Age at death: Years	Number born: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
21–22	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
23–24	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
25–26	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
27–28	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
29–30	4	3	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
31–32	5	2	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
33–34	3	3	3	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	15
35–36	5	4	4	3	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	19
37–38	10	3	3	3	1	2	2	—	—	—	—	—	—	—	—	—	—	—	—	24
39–40	4	4	2	5	3	6	4	—	—	1	—	—	—	—	—	—	—	—	—	29
41–42	9	2	2	1	4	4	3	1	—	—	—	—	—	—	—	—	—	—	—	26
43–44	4	3	3	5	4	1	4	2	2	—	2	—	—	—	—	—	—	—	—	30
45–46	2	3	8	3	2	3	5	1	—	—	1	2	1	—	1	—	—	—	—	32
47–48	4	4	3	7	4	4	2	4	2	3	—	—	1	—	1	—	—	—	—	39
49–50	10	4	4	5	5	3	6	2	—	2	1	1	1	—	—	—	—	—	—	44
51–52	5	3	1	6	5	4	5	2	1	2	1	—	1	1	—	—	—	—	—	37
53–54	8	2	4	7	6	5	2	1	1	1	2	2	—	—	—	—	—	—	—	41
55–56	4	4	7	3	3	3	6	2	2	1	2	2	3	—	—	—	—	—	1	42
57–58	5	4	2	2	5	5	1	5	4	1	1	3	1	—	1	—	—	—	—	40
59–60	6	2	2	3	3	6	4	3	2	4	2	2	2	—	1	—	—	—	—	42
61–62	3	3	5	11	7	5	5	7	1	4	4	3	—	1	1	—	—	—	—	60
63–64	3	2	3	8	6	9	3	5	1	2	—	1	1	—	1	—	—	—	—	45
65–66	5	1	3	1	4	7	5	4	4	1	4	—	2	—	—	—	—	—	—	42
67–68	9	1	5	3	1	6	5	4	1	3	1	1	1	2	1	—	—	—	—	44
69–70	3	2	1	6	9	4	5	2	6	6	4	1	1	—	1	—	2	—	—	53
71–72	11	2	—	4	1	3	4	9	6	2	4	3	1	1	2	—	—	—	—	53
73–74	6	4	2	2	4	5	4	7	4	6	1	2	3	—	—	—	—	—	—	50
75–76	6	4	3	3	4	6	6	7	2	3	3	6	4	—	2	—	—	—	—	59
77–78	2	1	1	2	4	2	1	6	9	5	1	1	1	—	—	—	—	—	—	36
79–80	3	4	4	1	3	4	5	2	2	—	2	1	—	—	1	1	—	—	—	33
81–82	1	1	2	4	3	5	4	1	3	6	—	1	1	1	—	—	—	—	—	33
83–84	2	1	2	2	4	6	7	2	—	2	1	—	—	—	1	—	—	—	—	30
85–86	1	1	—	3	3	3	3	2	3	1	—	1	—	—	1	1	—	—	—	23
87–88	2	—	—	1	2	—	4	2	3	2	—	—	—	2	—	—	—	—	—	18
89–90	1	—	—	—	—	1	3	1	—	1	1	—	—	—	—	—	—	—	—	8
91–92	1	1	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	5
93–94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
95–96	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	3
97–98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
99–100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
101 and over	—	—	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	3
Totals	155	82	81	110	106	119	119	85	60	59	38	33	26	8	15	2	2	—	1	1091

$\sigma_{\text{no. born}} = 3{\cdot}5992.$ $\sigma_{\text{death}} = 7{\cdot}7560.$ $r = {\cdot}3174 \pm {\cdot}0138.$

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TABLE VII.

Order of birth and age at death.

Age at birth: Years	Order: 1st	2nd	3rd	4th	5th	6th	7th	8th	Totals
21–22	1	—	—	—	—	—	—	—	1
23–24	2	—	—	1	—	—	—	—	3
25–26	2	3	—	—	—	—	—	—	5
27–28	5	—	—	—	—	—	—	—	5
29–30	6	—	2	—	—	—	—	—	8
31–32	10	1	—	—	—	—	—	—	11
33–34	12	2	1	—	—	—	—	—	15
35–36	18	1	—	—	—	—	—	—	19
37–38	18	4	2	—	—	—	—	—	24
39–40	24	4	1	—	—	—	—	—	29
41–42	21	5	—	—	—	—	—	—	26
43–44	28	2	—	—	—	—	—	—	30
45–46	24	8	—	—	—	—	—	—	32
47–48	32	4	3	—	—	—	—	—	39
49–50	39	3	2	—	—	—	—	—	44
51–52	29	6	2	—	—	—	—	—	37
53–54	31	9	1	—	—	—	—	—	41
55–56	34	6	2	—	—	—	—	—	42
57–58	35	5	1	—	—	—	—	—	41
59–60	37	5	—	—	—	—	—	—	42
61–62	51	7	2	—	—	—	—	—	60
63–64	34	6	4	1	—	—	—	—	45
65–66	36	5	1	—	—	—	—	1	42
67–68	38	5	1	—	—	—	—	—	44
69–70	40	9	3	1	—	—	—	—	53
71–72	43	8	1	1	—	—	—	—	53
73–74	39	6	4	—	1	—	—	—	50
75–76	48	8	1	2	—	—	—	—	59
77–78	26	9	1	—	—	—	—	—	36
79–80	25	4	4	—	—	—	—	—	33
81–82	20	7	3	1	—	1	—	1	33
83–84	24	5	1	—	—	—	—	—	30
85–86	19	1	1	2	—	—	—	—	23
87–88	12	3	2	1	—	—	—	—	18
89–90	6	2	—	—	—	—	—	—	8
91–92	3	—	2	—	—	—	—	—	5
93–94	2	1	—	—	—	—	—	—	3
95–96	—	—	—	—	—	—	—	—	—
97–98	—	—	—	—	—	—	—	—	—
99–100	3	—	—	—	—	—	—	—	3
101 & over	—	—	—	—	—	—	—	—	—
Totals	877	154	48	10	1	1	—	1	1092

$\sigma_{\text{death}} = 7{\cdot}7560$. $\sigma_{\text{order}} = {\cdot}6228$. $r = {\cdot}0850 \pm {\cdot}0185$.

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TABLE VIII.

Age at marriage and order of birth.

Age at marriage: Years	Order: 1st	2nd	3rd	4th	5th	6th	7th	8th	Totals
13–14	1	—	—	—	—	—	—	—	1
15–16	2	—	—	—	—	—	—	—	2
17–18	4	1	—	—	—	—	—	—	5
19–20	25	5	1	—	—	—	—	—	31
21–22	116	13	4	1	—	—	—	—	134
23–24	131	28	7	1	1	—	—	—	168
25–26	122	24	7	—	—	—	—	—	153
27–28	116	12	2	—	—	—	—	1	131
29–30	87	16	2	—	1	—	—	—	106
31–32	64	10	9	2	—	—	—	—	85
33–34	55	9	4	—	—	—	—	—	68
35–36	38	7	3	1	—	—	—	—	49
37–38	35	5	3	2	—	—	—	—	45
39–40	19	6	2	—	—	—	—	—	27
41–42	20	1	—	1	—	—	—	—	22
43–44	15	1	1	—	—	—	—	—	17
45–46	4	5	—	1	—	—	—	—	10
47–48	7	1	1	—	—	—	—	—	9
49–50	5	2	2	—	—	—	—	—	9
51–52	4	—	2	—	—	—	—	—	6
53–54	3	—	—	—	—	—	—	—	3
55–56	2	2	—	—	—	—	—	—	4
57–58	1	1	1	—	—	—	—	—	3
59–60	1	1	—	—	—	—	—	—	2
61–62	1	1	—	—	—	—	—	—	2
63–64	2	—	—	—	—	—	—	—	2
65–66	—	—	—	—	—	—	—	—	—
67–68	1	—	—	—	—	—	—	—	1
69–70	—	—	—	—	—	—	—	—	—
71–72	—	—	—	—	—	—	—	—	—
73–74	1	—	—	—	—	—	—	—	1
75–76	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	—
79–80	—	—	—	—	—	—	—	—	—
Totals	882	151	51	9	2	—	—	1	1096

$\sigma_{\text{age at marriage}} = 3{\cdot}9069.$ $\sigma_{\text{order}} = {\cdot}6228.$ $r = {\cdot}0959 \pm {\cdot}0182.$

TABLE IX.

Age of father at birth of son and order of birth.

Age at birth: Years	Order: 1st	2nd	3rd	4th	5th	6th	7th	8th	Totals
15–16	2	—	—	—	—	—	—	—	2
17–18	3	—	—	—	—	—	—	—	3
19–20	2	—	1	—	—	—	—	—	3
21–22	29	3	1	—	—	—	—	—	33
23–24	70	4	—	1	—	—	—	—	75
25–26	82	9	3	1	—	—	—	—	95
27–28	107	8	5	1	—	—	—	—	121
29–30	89	17	3	1	—	—	—	—	110
31–32	95	18	6	—	1	—	—	—	120
33–34	74	15	4	—	—	—	—	—	93
35–36	71	12	2	—	—	—	—	—	85
37–38	60	12	9	—	—	—	—	—	81
39–40	50	13	2	1	1	—	—	—	67
41–42	39	7	5	—	—	—	—	—	51
43–44	23	8	3	—	—	—	—	—	34
45–46	17	8	2	2	—	—	—	—	29
47–48	15	3	—	—	—	—	—	—	18
49–50	10	3	—	1	—	—	—	—	14
51–52	14	1	1	1	—	—	—	—	17
53–54	5	3	—	1	—	—	—	—	9
55–56	4	1	—	—	—	—	—	1	6
57–58	5	1	1	—	—	—	—	—	7
59–60	4	3	—	—	—	—	—	—	7
61–62	1	1	—	—	—	—	—	—	2
63–64	3	—	1	—	—	—	—	—	4
65–66	2	1	—	1	—	—	—	—	4
67–68	—	—	—	—	—	—	—	—	—
69–70	—	1	—	—	—	—	—	—	1
71–72	—	1	—	—	—	—	—	—	1
73–74	—	—	—	—	—	—	—	—	—
75–76	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	—
79–80	—	1	—	—	—	—	—	—	1
Totals	876	154	49	11	2	—	—	1	1093

$\sigma_{\text{age at birth}} = 4{\cdot}7216$. $\sigma_{\text{order}} = {\cdot}6228$. $r = {\cdot}1546 \pm {\cdot}0171$.

TABLE X.

Order of birth and number born.

	Number born																			
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
Order of birth 1st	126	85	68	83	88	94	94	71	48	39	34	25	19	7	12	2	2	—	1	898
2nd	21	9	10	21	15	15	14	10	6	12	4	4	6	2	2	—	—	—	—	151
3rd	8	4	3	5	3	7	2	4	3	6	—	2	—	—	1	—	—	—	—	48
4th	2	2	—	2	—	—	—	—	1	2	—	1	—	—	—	—	—	—	—	10
5th	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	2
6th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8th	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	157	100	81	111	106	116	111	85	59	59	38	33	25	9	15	2	2	—	1	1110

$\sigma_{\text{no. born}} = 3{\cdot}5992$. $\sigma_{\text{order}} = {\cdot}6228$. $r = +{\cdot}0212 \pm {\cdot}0198$.

TABLE XI.

	Standard deviation σ_x	Standard deviation σ_y	Coefficient of correlation
Age of father at birth of son (1) and number born to son (2)	Birth = 9·44 years	Number = 3·60	$r_{12} = -{\cdot}020 \pm {\cdot}020$
Age of father at birth of son (1) and age of son at marriage (3)	Birth = 9·44 „	Marriage = 7·81 years	$r_{13} = -{\cdot}040 \pm {\cdot}020$
Age of father at birth of son (1) and age of son at death or present age (4)	Birth = 9·44 „	Death = 15·51 „	$r_{14} = -{\cdot}062 \pm {\cdot}019$
Age of father at birth of son (1) and order of birth (5)	Birth = 9·44 „	Order = ·62	$r_{15} = {\cdot}155 \pm {\cdot}017$
Number born to son (2) and age of son at marriage (3)	Number 3·60	Marriage = 7·81 „	$r_{23} = -{\cdot}213 \pm {\cdot}016$
Number born to son (2) and age of son at death or present age (4)	Number 3·60	Death = 15·51 „	$r_{24} = {\cdot}318 \pm {\cdot}014$
Number born to son (2) and order of male birth (5)	Number 3·60	Order = ·66	$r_{25} = {\cdot}021 \pm {\cdot}020$
Age of son at marriage (3) and age of son at death or present age (4)	Marriage = 7·81 „	Death = 15·51 „	$r_{34} = {\cdot}180 \pm {\cdot}017$
Age of son at marriage (3) and order of male birth (5)	Marriage = 7·81 „	Order = ·66	$r_{35} = {\cdot}096 \pm {\cdot}018$
Age of son at death or present age (4) and order of birth (5)	Death = 15·51 „	Order = ·66	$r_{45} = {\cdot}085 \pm {\cdot}019$

It is to be noted that of the first four coefficients in Table XI, that is the correlation of age at birth with the other characters, r_{12}, r_{13}, r_{14} are small and negative and r_{15} substantial and positive. The last result is of course expected. Order of birth correlated with the same variables gives small and positive values in every case. Hence it is obvious that order is a factor, and must be made constant. Whether this arises from biological or social considerations, need not be considered here. The remaining three r_{23}, r_{24}, r_{34}, are naturally substantial. We can now proceed to eliminate the disturbing factors, first making the reproductive period constant. We have:

Age of father at birth of son and number born to son. With age at marriage and death of son constant:

$$_{34}r_{12} = \cdot 013 \pm \cdot 020.$$

Order of male birth and number born to son. With age at marriage and death of present age constant:

$$_{34}r_{25} = -\cdot 037 \pm \cdot 019:$$

Age of father at birth of son and order of male birth. With age at marriage and death of son or present age constant:

$$_{34}r_{15} = \cdot 178 \pm \cdot 017.$$

It is to be noted that the partial correlations of age at birth with other variables for constant reproductive period have become positive. Now making order of male birth constant, we have for age of father at birth of son and number born to son:

$$_{345}r_{12} = \cdot 082 \pm \cdot 019.$$

The total correlation ratios are as follows:

Mean number born to sons for arrays of father:

$$\eta = \cdot 088 \pm \cdot 020,$$

which if corrected by Pearson's method (*Biom.* VIII, p. 254) becomes indeterminate.

Mean ages of fathers for arrays of number born to sons:

$$\eta = \cdot 194 \pm \cdot 020.$$

If corrected $= \cdot 11$.

The regression is apparently not linear. The conclusion however from the above result would appear to be that the later born do tend to enjoy a higher fertility than those born at earlier years, although the intensity of association is not great. As has been already stated, it is probable that age at death as indicating the close of the reproductive period rather overestimates the correction necessary for this event. Accordingly the data were selected in a more stringent way. Only such first born males as survived to the fiftieth year were considered. It was hoped in this case, that as all but a small number of families would be

TABLE XII.

Age of father at birth of son and number of offspring born to son surviving at least 50 *years.*

Age of father at birth of son: Years	Number born: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
15–16	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2
17–18	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
19–20	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
21–22	4	1	2	1	2	4	2	2	1	1	1	—	—	—	—	—	—	—	—	21
23–24	6	3	3	7	5	8	3	5	2	2	—	2	2	—	1	—	1	—	—	50
25–26	9	2	6	6	3	5	8	8	2	6	8	2	2	1	—	—	—	—	—	68
27–28	10	5	5	11	8	9	10	4	7	4	5	2	4	1	1	—	—	—	—	86
29–30	7	3	4	7	9	7	10	8	3	5	2	2	—	—	1	1	1	—	1	71
31–32	7	6	3	5	10	6	11	5	7	3	2	3	3	—	3	—	—	—	—	74
33–34	6	4	8	—	3	3	7	8	6	7	5	1	—	2	1	—	—	—	—	61
35–36	4	2	1	6	8	5	6	4	3	2	2	3	1	1	1	—	—	—	—	49
37–38	4	—	2	7	5	10	4	4	3	4	2	2	1	—	—	—	—	—	—	48
39–40	5	2	2	1	4	5	5	5	1	1	1	1	—	—	1	—	—	—	—	34
41–42	3	3	1	1	5	3	2	2	4	1	—	1	1	—	—	—	—	—	—	27
43–44	2	2	1	1	1	1	4	4	1	1	—	—	—	—	—	—	—	—	—	18
45–46	—	—	1	1	2	1	2	—	1	—	1	1	1	—	—	—	—	—	—	11
47–48	1	1	—	—	2	1	1	1	—	—	—	1	1	—	—	1	—	—	—	10
49–50	—	2	—	2	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	7
51–52	1	—	1	—	—	2	—	—	2	—	—	—	1	—	—	—	—	—	—	7
53–54	1	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—	—	—	—	4
55–56	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	2
57–58	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	3
59–60	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	2
61–62	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
63–64	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
65–66	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
67–68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69–70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
71–72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
73–74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75–76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
77–78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79–80	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
Totals	72	36	41	56	69	74	76	64	44	37	31	22	18	6	10	2	2	—	1	661

$\sigma_{\text{no. born}} = 3{\cdot}4765$. $\sigma_{\text{age at birth}} = 3{\cdot}9348$. $r = {\cdot}0367 \pm {\cdot}0255$.

completed, any correction for death would be unnecessary and that to make the reproductive epoch constant, we should only have to correct for age at marriage. Unfortunately this restriction rather tends to underestimate the effect of death, as a proportion of the males was reproduced after the limit selected. The coefficients found were:

Age of father at birth of son (1) and number born to son (2):

$$r_{12} = {\cdot}037 \pm {\cdot}027.$$

Age of father at birth of son (1) and age of son at marriage (3)·

$$r_{13} = {\cdot}04 \pm {\cdot}02.$$

Age of son at marriage (3) and number born to son (2):

$$r_{23} = -\cdot 214 \pm \cdot 016$$

and, making age at marriage constant, ${}_3r_{12} = \cdot 034 \pm \cdot 027$.

The correlation ratios are:

(1) Means of fathers' age for arrays of number born $= \cdot 145$; the corrected value is indeterminate.

(2) Means of number born to son for fathers' age $= \cdot 017$, and the corrected value is also indeterminate.

In so far as in the present case, we are underestimating the effect of age of son at death and in the first series we tended to overestimate it, the true value of the correlation must be between $\cdot 08 \pm \cdot 02$ and $\cdot 03 \pm \cdot 03$, a value which though small suggests some real degree of association. Bearing in mind that a negative correlation was to be expected in view of the incompleteness of the record had the true value been zero, it can be inferred that as the age of the father at the birth of the son increases, the family born to the son also increases. A point to be noted is that the later born tend to mate earlier and it is conceivable that there is some association between early marriage and a large family irrespective of the longer reproductive period. It would seem that the average age at marriage during the last century has increased to some extent, which may be simply part of the general change in the country, or because the character of the Peerage has altered. Although heterogeneity in material always causes difficulty in interpreting results, still in the present case it is probable that the values obtained are not seriously prejudiced as the two distributions have the same mode and a general rough similarity.

TABLE XIII.

Age at marriage of peers of the present and previous generations.

Age at marriage	Dead	per thousand	Living	per thousand
0—19	5	6	—	—
20—29	294	366	87	302
30—39	338	421	138	479
40—49	127	158	40	139
50—59	29	36	17	59
60—69	5	6	6	21
70—79	3	4	—	—
80 & over	1	1	—	—
Totals	802		288	

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The third series of data deals with the possible influences of the age of the grandmother on the number of children born to the mother. The details of this material have been already given in the previous paper and its shortcomings discussed. Unfortunately no correction could be made for age at marriage and present age, though many of the mothers were under forty-five years at the time of inquiry. The material therefore corresponds to our total correlation in the peerage data, with this difference. In the former, the information was obtained through surviving children, in the latter through parents whether living or dead. The fallacies need not be enumerated again. We have

Age of grandmother at birth of mother and number born to mother:

$$r = -\cdot06 \pm \cdot15,$$

which corresponds to the total correlation in the peerage data (Table I).

If the coefficients of correlation found are significant of an actual bias, it will be of interest to see what effect alteration in the reproductive habits of a community are likely to have upon its characters. To solve this problem, we must know for the periods under examination in what way the births have been distributed with respect to the age of the parent at birth. In the following data which were collected through the working of the Education Act, 1907, in Middlesbrough, the age of parent at birth of a school population is given along with the age of the grandmother when the mother was born.

TABLE XIV.

Age of grandmother at birth of mother and age of mother when child is born.

		Age of grandmother						
		20 years and under	21st to 25th year	26th to 30th year	31st to 35th year	36th to 40th year	41 years and over	Totals
Age of mother	20 years and under	14	27	30	26	7	10	114
	21st to 25th year	59	132	122	98	58	34	503
	26th to 30th year	66	144	156	117	74	45	602
	31st to 35th year	48	93	103	76	48	7	375
	36th to 40th year	27	68	51	47	33	13	239
	41 years and over	16	12	21	12	6	7	74
	Totals	230	476	483	376	226	116	1907

$\sigma_{\text{grandparent}} = 1\cdot40$. $\sigma_{\text{parent}} = 1\cdot23$. $r = \cdot0013 \pm \cdot012$.

Mean age grandparent $= 29\cdot20$ years and parent $= 29\cdot42$ years.

The standard deviations are:

Age of grandparent $7{\cdot}01 \pm {\cdot}08$ year.
Age of parent $6{\cdot}15 \pm {\cdot}07$ year.

It is evident that these are different distributions.

The mean age of grandparents is $29{\cdot}20 \pm {\cdot}45$ year.
The mean age of parent is $29{\cdot}42 \pm {\cdot}45$ year.

That is, the mean age of parent at birth for the working class population of Middlesbrough in 1901 was ·22 year or nearly three months later than in 1871. The difference in comparison with the probable error is not significant, but the standard deviations are significantly different, the older generation being somewhat more variable. On examining the distribution, it is seen that the locus of the means of the curves is not materially shifted, but in the case of the present generation the rise and fall are much steeper.

The following possibilities must be considered:

(1) The extreme units are reproducing faster and hence these mothers are more frequently counted owing to the method of selection. The method of selection was through the children.

(2) The offspring of the extreme births may possess a low survival value, and hence the parents born early and late are not enumerated as frequently as they should be. It is obvious if these causes are operative, as our previous results suggest, they might tend to neutralise each other. Should either be predominant, we should expect some correlation between age of parent at birth of mother and age of mother at birth of child positive in the first instance and either positive or negative in the second, but much smaller. The correlation actually found was $\cdot 0013 \pm \cdot 0120$.

The third and most likely explanation is that in the period under examination the customs of the populations dealt with have changed. The diminution of births at the earlier ages is explained by the alteration in the age at marriage. The following figures taken from the Registrar-General's Annual Report for 1913 give the proportion of married women in the population aged 15–45 years.

	Ages			
Year	15—20 years	20—25 years	25—35 years	35—45 years
1871	1·3	13·9	45·5	39·3
1901	0·7	11·8	46·8	40·7

Hence the fall of births occurring at 25 and under is due to the smaller number of women married. The fall at the end of life finds its most probable reason in the shrinkage in the mean size of the family, dependent on the fall in the birth rate from 102·7 (in 1876) per 1000 women 15–45 to 74·5 in 1901. The actual fall in the population dealt with was not so large as this. If this explanation is correct, we can naturally ask, what effect the alteration in our methods of reproduction will have upon the life expectancy of the succeeding generation? If there be really a negative association between the age of parent at birth of offspring and the length of life of the latter as our previous results indicated, and if the regression were strictly linear, then the tendency should be toward a decrease of longevity. If however the regression be non-linear, as our actual data suggested, those born at maturity living the longest, it might be reasonable to expect a significant increase. We are not in a position definitely to answer this question, but our object will have been achieved if those who are able to carry out a more comprehensive inquiry, make further researches into this rather important subject. The obvious difficulty is to isolate such an effect as we here postulate in view of the undoubted increase in the mean after lifetime at nearly all ages, as shown in the Registrar-General's last life table, much of which can hardly be ascribed to anything but the general improvement of the conditions of life common in greater or less degree to the whole population.

Age of parent at birth of child and its sex.

A further series on the same lines as the above was also collected with the object of deciding whether this factor of time played any part in sex determination, and as to whether it offered any explanation of the ratios observed from year to year.

The question however as to whether the sex ratio at birth can be taken as correctly representing the conception ratio, requires investigation before deductions can be drawn from coefficients based on live births. It is probable that the smaller the accident rate, the more likely is the ratio at birth to approach the conception ratio. All observers are agreed that initial births show a slight excess of males (Newcomb, Geissler), and it has been found that a comparatively small number of first births are lost by accident, though a fairly large proportion usually included die during the birth and are still born. Further than this, Cobb using Geissler's data has confirmed the conclusion that

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large families show an excess of male births. Now it is a reasonable suggestion that where the family is large, the accident rate must be small, provided we are dealing with a homogeneous population, hence the inference that the alteration in the sex ratio is dependent on a closer approximation to the conception rate, is a feasible one. Turning to the converse aspect, it has been observed that illegitimate children show a preponderance of females in practically all European countries, and it is known that the probability of such living one year is smaller than with legitimate children, especially in the case of males. Hence it is hardly an assumption to say that the illegitimate accident rate is high also. Consequently we should expect a low male-female ratio at birth. In support of this contention, Newcomb from French statistics has shown that the male ratio rises when accidents are included, as well as still births. The following figures are taken from Heape's paper dealing with the population of Cuba. The numbers are large so that the differences may be taken as statistically significant.

	Still births per 1000 births	Sex ratio living births	Legitimate	Illegitimate
White population	31	1084	1076	1040
Black population	57	1012	1067	960

Heape however gives some biological considerations and quotes certain experiments by Vernon (*P. Roy. Soc.* LXV, 1899, p. 350) against the view that the pre-natal death rate is differential, and that a decrease in the accident rate is necessarily followed by an increased male-female ratio.

We find however

	Percentage illegitimate	Marriage per 1000 population	Union by consent
White population	18·72	32·34	7·54
Black population	65·78	9·57	24·57

The number of single men and women is stated to be very large. We can assume from this that promiscuous intercourse must be common and sexual disease may be prevalent, so that beyond the still births, there may have been large numbers of abortions and miscarriages, especially amongst the blacks. Hence the differences of the sex ratios might find a very ready explanation, on the assumption of a heavy pre-natal male death rate. In fact these figures might be used in support of such an argument. Lewis again finds that in rural districts the ratio is higher than in towns. A fact which might be explained as due to the higher accident rate in urban districts.

Rosenfeld (cited by Lewis) gives the sex ratio for still births as varying from 1200 to 1700 and states that their inclusion with live births increases the ratio from 1054 to 1086. Hence the accident rate must have been from 50–220 per 1000 live births. From direct inquiry in Middlesbrough the rate when abortions, miscarriages and still births were included was 70 per 1000.

If we take the male and female death rate at ages for England and Wales from 1838 to 1911 and subtract the one from the other and divide each by the general death rate for each age period, the final result will be indicative of the rate of change in the relative mortality for each group.

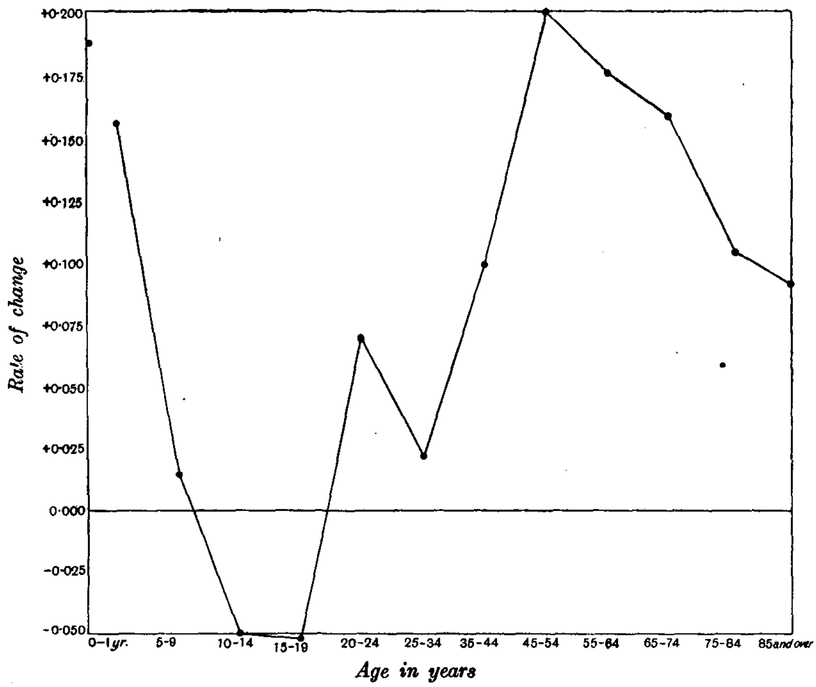
The figures are as follows:

Age period	Male death rate per 1000 living	Female death rate per 1000 living	General death rate per 1000 living	$\frac{\text{Difference}}{\text{General Rate}}$
0– 1 year	160	132	146	·1917
0– 4 years	65·8	56·2	61	·1573
5– 9 „	6·6	6·5	0·1	·0154
10–14 „	3·7	3·9	3·8	–·0526
15–19 „	5·3	5·6	5·4	–·0558
20–24 „	7·1	6·6	6·8	·0735
25–34 „	8·4	8·2	8·3	·0241
35–44 „	12·2	11·0	11·6	·1034
45–54 „	18·5	15·0	16·7	·2096
55–64 „	33·1	27·7	30·2	·1788
65–74 „	67·8	59·1	63·1	·1378
75–84 „	146·0	131·4	137·7	·1060
85 and over	304·5	277·4	287·8	·0938

The trend of these figures will be appreciated by a glance at the following diagram (p. 147).

It will be seen that from birth to the age group 15–19, the relative disadvantage of the male declines, and consequently the trend of the post-natal mortality figures are consistent with a belief that the male handicap exists, and may even be accentuated, in the ante-natal period. It should be noted that the difference persists for some years after the first and cannot therefore be a mere reflection of the fact that more males die owing to injury at birth consequent upon the larger size of the male head. It has been shown in a previous paper that infantile mortality and pre-natal death rates are highly correlated, and it is hardly an assumption to say that the rates of accidents and miscarriages are even more closely associated with the post-natal death rate during the first month. If therefore we can use this figure as indicative of the pre-natal death rate, for any group of the population, then the deductions made from the evidence already given would lead us to expect the sex ratio at birth to vary inversely with the death rate in the first month. From the Registrar-General's Report for 1912, the death rates for the

Curve showing rate of change of difference between male and female mortality at all ages.



initial month of life are given for groups according to occupation in the case of legitimate and illegitimate children. Taking the illegitimate according to the occupation of the mother, we have the following figures.

Group I. Consists of six subgroups with lowest infantile mortality.

	Number of births		Sex ratio	Death rate 1st month
	Males	Females		
Commercial clerks	127	109	1092	67·8
Milliners	76	51		63·0
Shop-assistants	357	358		46·1
Paper workers	73	70		49·0
Nurses	56	47		48·5
Teachers	57	48		85·7
	746	683		54·6

The sex ratio is high and the occupations consist of selected or higher grade work.

Group II. Consists of six groups of highest infantile mortality.

	Number of births Males	Females	Sex ratio	Death rate 1st month
Other workers in dress	53	50		38·8
Wool and worsted manufacture	268	278		82·4
Barmaids	133	142		69·1
Cotton manufacture	883	824	1012	83·2
Costermongers, etc.	130	141		118·1
Earthenware manufacture	107	120		61·7
	1574	1555		81·8

This group is of a distinctly lower grade than the previous one. In the first case, the sex ratio of 1092 accompanies an initial (first month) death rate 54·6, and in the second case a ratio of 1012 is associated with a death rate of 81·8.

Group III. If those subgroups which consist of approximately 2000 births are selected, the same association is observed.

	Number of births Males	Females	Sex ratio	Death rate 1st month
Unoccupied	3751	3622	1035	95·0
Cotton and woolworkers	1151	1102	1044	82·8
Charing and laundry	1371	1441	1051	72·0
Domestic servants	8784	8273	1062	68·5

The association is so marked, that provided the initial assumption is correct, the conclusion must be that the ratio is dependent on the numbers dying before birth. The same point can be illustrated by the legitimate births grouped according to the occupation of the father. The classes are the same as are described on page xli, Registrar-General's Report for 1912.

		Number of births Males	Females	Sex ratio	Death rate in 1st month
Class I	Professional	31,590	30,330	1041	30·2
,, II	Intermediate	56,578	54,504	1038	36·5
		88,168	84,834	1039	34·5
Working Classes.					
Class III	Skilled workman	100,370	96,361	1041	36·8
,, IV	Intermediates	73,396	70,750	1037	38·6
,, V	Unskilled workers	88,517	85,416	1036	42·5
,, VI	Textile workers	12,208	11,920	1024	44·4
,, VII	Miners	50,519	48,692	1038	46·5
,, VIII	Agricultural labourers	16,140	15,634	1032	36·8
Total III–VIII		341,150	328,773	1038	40·4

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The association is not so marked as in the case of illegitimate children; this may be due to the grouping or to the special characteristics of some of the classes: thus Class II consists partly of those whose social conditions might place them in Class I or III, and Class VII (miners) is notorious for the low standard of life to which it attains in morals and cleanliness.

In spite of the variations I think we can conclude that considerable support is supplied by these figures to the probable existence of a differential pre-natal death rate.

Turning to the more reliable method of direct observation, the following figures have been collected from numerous sources (Prinzing).

	Males	Females
Living births	106	100
Born dead over 6 months old	130	100
Under 6 months old	160	100

The larger size of the male and its greater difficulty in delivery would account for some at least of the deaths after the sixth month. However we find that out of 3777 still births reported as having occurred in the city of Hamburg in 1903, 2220 or 58·8 per cent. were dead before the onset of labour and 1437 or 38·8 died during delivery; hence the excess of males among still births can hardly be due, in the majority of cases, to mechanical difficulties of delivery. The following figures are quoted from the *Annual Statistical Report of the City of Paris*, 1901–2. Number of abortions out of 100 conceptions:

	Percentage of sex			
Age of mother	Male	Female	Together	Ratio
15–20 years	3·8	2·7	6·5	1·4
21–25 „	3·6	2·4	6·0	1·5
26–30 „	4·0	3·1	7·1	1·3
31–35 „	4·7	3·1	7·8	1·5
36–40 „	5·1	3·2	8·1	1·6
41–45 „	5·2	4·1	9·3	1·3
45 and over	6·5	6·2	12·7	1·1

The ratios for ages over 40, being based upon small absolute numbers, may be neglected and the remaining series does suggest that the male child is more likely to be lost through abortion than the female, and that as the mother increases in age the ratio also increases. For still births (six months and over), according to the age of the mother, the figures are as follows:

Age of mother	Number of still births per 100 born	Males per 100 females
under 17 years	5·9	157
17–20	4·4	132
20–25	4·6	119
25–30	4·8	118
30–40	5·8	123
over 40 years	7·8	123

The excess of males in the earlier years is partly accounted for by the greater difficulties experienced in the initial birth and the large size of the male.

The following figures given by Treichler (quoted from Prinzing) bear this out:

Birth order	Number of children born dead per 100 born
1st	5·1
2nd–3rd	3·8
4th–6th	4·6
7th–9th	5·8
10th–12th	7·9
13th and over	8·4

It will be seen that the rate is highest for first births and we have noted above that there is some excess of males amongst first births. It is also of interest to notice that the death rates, in respect to order, closely agree with similar figures, giving the number dying in the first year after birth. It will be remembered that a high correlation between death before and after birth was found in the previous paper.

The ratio between the pre-natal male and female death rates may be reached by direct or indirect calculation. The direct method is troublesome but is more complete and may be stated as follows. Let α and β be the numbers of male and female conceptions; a_1, b_1, and a_2, b_2 rates of miscarriages and still births; then we have the following conditions[1]:

$$\frac{\alpha a_1}{\beta b_1} = 1{\cdot}6 \quad\ldots\ldots\ldots\ldots\ldots\ldots(1),$$

$$\alpha a_1 + \beta b_1 = {\cdot}1\,(\alpha + \beta) \quad\ldots\ldots\ldots\ldots\ldots\ldots(2),$$

$$\frac{\alpha a_2\,(1 - a_1)}{\beta b_2\,(1 - b_1)} = 1{\cdot}3 \quad\ldots\ldots\ldots\ldots\ldots\ldots(3),$$

$$\frac{\alpha\,(1 - a_2)\,(1 - a_1)}{\beta\,(1 - b_2)\,(1 - b_1)} = 1{\cdot}06 \quad\ldots\ldots\ldots\ldots\ldots\ldots(4),$$

$$\alpha a_2\,(1 - a_1) + \beta b_2\,(1 - b_1) = 0{\cdot}03\,\{\alpha\,(1 - a_1) + \beta\,(1 - b_1)\}\,..(5),$$

[1] Assuming the ratios cited from Prinzing and that 3 % of all births are still births, while 10 % of all conceptions abort or miscarry before viable term.

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i.e. five equations between six unknowns, but since the ratio $\frac{\alpha}{\beta}$ is only required, there are really only five unknowns.

Let $$A = \frac{\alpha}{\beta},$$

then $$\frac{a_1}{b_1} A = 1{\cdot}6,$$

$$Aa_1 + b_1 = {\cdot}1\,(A + 1),$$

$$A\,\frac{a_2}{b_2}\left(\frac{1 - a_1}{1 - b_1}\right) = 1{\cdot}3,$$

$$A\,\frac{(1 - a_2)\,(1 - a_1)}{(1 - b_2)\,(1 - b_1)} = 1{\cdot}06.$$

$$Aa_2\,(1 - a_1) + b_2\,(1 - b_1) = {\cdot}03\,\{A\,(1 - a_1) + (1 - b_1)\}.$$

Solving these equations:

A (ratio of male to female conceptions)	=	1·110,
a_1 (male miscarriage rate)	=	·1170,
b_1 (female miscarriage rate)	=	·0811,
a_2 (male still birth rate)	=	·0329,
b_2 (female still birth rate)	=	·0270,

and the ratios are:

Male to female live births	1·06,
Male to female still births	1·3,
Male to female abortions	1·6,
Total death rate in first six months	10·0,
Total death rate sixth month to birth	3·0,

which agree with the original conditions.

The series already given with respect to the rising differential death rate after birth can now be completed. The figures run as follows:

Ratio male to female death rate:

First six months	1·44,
Sixth month to birth	1·22,
First year	1·21, etc.

A sequence which confirms the previous deduction.

The following figures taken from Auerbach's paper on the sex ratios in Buda-Pest exemplify the indirect method. The essential difference is that in this case we proceed backwards.

			Death rates		
	Males	Females	Male	Female	Ratio
Born alive	57,142	54,000	—	—	1·057
Born dead	2,030	1,643	·0343	·0299	1·160
Alive before birth	59,172	55,643			
Died at 6th, 7th, 8th month	1,464	1,262	·0241	·0222	1·089
Alive up to 6th month	60,636	56,905			
Died at 5th month	1,340	824	·0217	·0143	1·518
Alive up to 4th month	61,976	57,729			
Died at 4th month	10,583	4,622	·1459	·0741	1·968
Total conceptions	72,559	62,351			

The values differ slightly from those already given, since in the previous calculation only three figures were retained and the calculation was not so detailed, but the order is of course the same.

These results are used in the paper cited to explain the differences found in the sex ratios of certain sections of the inhabitants in Buda-Pest.

The determination of sex in an early embryo is a matter of some difficulty and many must be ignored on the ground that none of the distinctive features are present. In so far as the female genitalia more closely resemble at all stages the primitive state previous to the fourth month, a relatively larger number of males will be ignored than females. Further any abnormality or other conditions which would have led to a state of hypospadias is more likely to resemble a female than a male. The probability is therefore that figures relative to the sex ratio of embryos rather underestimate the proportion of males.

It is of interest to note that Punnett in his investigation on material taken from the census of 1901 and using proportion of servants as an index of nutrition found that if the London boroughs were divided into three groups the following ratios would be obtained:

(1)	Less than 15 per cent. indoor servants.	Sex ratio	101·0
(2)	Between 15 per cent. and 30 per cent.	,,	102·2
(3)	Over 30 per cent.	,,	103·7
	Peerage		107·6

He also points out that infant mortality is high in the poorer districts and that first and second births show some increase in the proportion of males. He concludes that nutrition alone cannot explain the results obtained.

The pre-natal death rate may be however an important factor in determining the sex ratio at birth not only of these groups but also of any community. For example, should the present crusade in this country relative to expectant mothers and the establishment of ante-natal clinics have the desired effect, it would be reasonable to expect as a result of the fall in ante-natal mortality an increase in the male-female ratio.

Unfortunately no data are available in this country with respect to abortions and miscarriages, still material has been collected which may be reasonably supposed to follow closely the ante-natal death rates. To test this hypothesis, as Punnett had already done, the areas constituting the County of London (Census 1911), were selected and for each borough the sex ratio, fertility based on married women 15–45 years, the proportion of servants per 100 families and the mean age of married women 15–45 years were chosen as variables for the following reasons:

I. *Fertility*. This may affect the sex ratio in two ways: (1) first births have a slight tendency to an excess of males (Newcomb), (2) a similar condition has been shown to exist for large families (Cobb, Geissler). It is obvious that the correlation between fertility and sex ratio is non-linear and hence any value of the correlation coefficients obtained will probably underestimate the actual association.

II. *Proportion of Servants per cent.* It is probable that where the amenities and comforts of life are enjoyed to the extent that domestic help allows, the chances of accident before full time and death in the first year will be reduced: the actual accident rate would be infinitely better, but some of the correlation will be shown by using infant mortality as a measure of ante-natal mortality.

III. *Mean age of married women* 15–45 *years*. This is not synonymous with the mean age at birth of offspring, but it is assumed that the two are highly correlated. A closer approximation to the mean age of reproducing women can be obtained by using Newsholme and Stevenson's method of correcting the birth rate for age distribution. They used the following factors taken from the statistical returns for Sweden:

Age of mother	Birth rate per 1000 married women
15–20 years	518
20–25 ,,	451
25–30 ,,	375
30–35 ,,	312
35–40 ,,	250
40–45 ,,	142

The objection to the use of these rates for changing the mean age of married females to mean age of reproducing women is the extreme doubt as to their applicability to the various London areas. It may be observed that the birth rate based on the married women shows little difference from that corrected with the aid of the above age birth rates. The data are as follows:

Table giving the sex ratio, proportion of servants, fertility and mean age of married women for the London Boroughs.

Borough	Sex ratio boys per 1000 girls	Fertility per 1000 women 15—45	Number of domestic servants per 1000 families	Mean age of married women
Battersea	·9817	19·80	10·63	33·64
Bermondsey	1·0010	25·26	4·25	33·26
Bethnal Green	1·0430	25·40	3·49	32·95
Camberwell	1·0200	19·74	11·75	33·69
Chelsea	1·0540	17·48	55·07	33·92
Deptford	1·0314	20·92	11·44	33·52
Finsbury	1·0518	24·33	5·02	33·33
Fulham	1·0144	18·97	13·89	33·43
Greenwich	·9659	20·39	18·90	33·78
Hackney	1·0797	19·45	12·86	33·56
Hammersmith	1·0552	18·37	13·50	33·45
Hampstead	·9836	14·13	75·75	34·38
Holborn	·9685	15·71	19·37	33·45
Islington	1·0320	19·33	10·04	33·45
Kensington	1·1075	17·67	72·39	33·96
Lambeth	1·0702	18·90	13·04	33·60
Lewisham	1·0774	16·53	24·64	34·21
Paddington	·9979	17·58	41·85	33·71
Poplar	1·0697	25·12	5·42	33·24
Marylebone	1·0327	17·18	49·35	33·64
St Pancras	1·0670	19·55	12·42	33·22
Shoreditch	1·0443	25·67	3·92	33·19
Southwark	·9891	22·83	5·15	33·14
Stepney	1·0646	25·36	6·43	32·89
Stoke-Newington	1·0691	17·37	20·71	33·87
Wandsworth	1·0093	16·76	24·73	34·07
Westminster	1·0447	13·71	56·44	33·93
Woolwich	1·0522	17·75	12·73	34·01
Means	1·0349	19·688	21·97	33·59
Standard deviations	·0327	3·420	20·64	·33

The coefficients of correlation for the variables are:

Sex ratio (1) and fertility (2):

$$r_{12} = \cdot 091 \pm \cdot 126.$$

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Sex ratio (1) and proportion of servants (3):

$$r_{13} = \cdot 043 \pm \cdot 127.$$

Sex ratio (1) and mean age (4):

$$r_{14} = - \cdot 043 \pm \cdot 127.$$

Fertility (2) and proportions of servants (3):

$$r_{23} = - \cdot 700 \pm \cdot 065.$$

Fertility (2) and mean age (4):

$$r_{24} = - \cdot 891 \pm \cdot 026.$$

Proportion of servants (3) and mean age (4):

$$r_{34} = \cdot 762 \pm \cdot 054.$$

Making proportions of servants constant for each area we have:

Sex ratio (1) and fertility (2):

$$_3r_{12} = \cdot 169 \pm \cdot 124.$$

Sex ratio (1) and mean age (4):

$$_3r_{14} = - \cdot 117 \pm \cdot 126.$$

Fertility (2) and mean age (4):

$$_3r_{24} = - \cdot 773 \pm \cdot 051.$$

Lastly eliminating fertility we have:

Sex ratio (1) and mean age (4) with proportion of servants (2) and fertility constant (3):

$$_{23}r_{14} = + \cdot 023 \pm \cdot 127.$$

Similiarly:

Sex ratio (1) and fertility (2) with mean age (4) and proportion of servants (3) constant:

$$_{34}r_{12} = \cdot 12 \pm \cdot 13$$

and sex ratio (1) and proportion of servants (3) with mean age (4) and fertility (2) constant:

$$_{24}r_{13} = \cdot 13 \pm \cdot 12.$$

The suggestion from these results, were they significant with respect to their probable error, would be that a rise in fertility, number of

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servants kept or in mean age of married women leads to an increase in the relative number of boys born.

In so far as a rise in fertility, with other factors constant, may denote a fall in pre-natal mortality and an increase in the proportion of servants under similar conditions may be a factor of an enhanced degree of pre-natal care, the first two results obtained are not inconsistent with the hypothesis that pre-natal mortality is a factor of the sex ratio of any district.

The third result is contrary to what would have been expected, for we have seen that abortions and miscarriages tend to increase with age of parent, and hence if the mean age of married women is indicative of the mean age at reproduction it should be associated with a relative increase of females and the sign of the correlation be negative. Hence the possibility of the nutritive influence of age on the ovum after fertilisation being compensated by an increase in the male-female conception ratios, seems worthy of further inquiry. But in view of the large "probable errors" of the coefficients, no certain conclusions can be drawn from this analysis.

The influence of age of parent at birth of offspring on the number of males and females born alive has been directly investigated by numerous observers from Sadler onwards and nothing very definite has been discovered.

In fact it would almost appear as if the sex ratio at birth, with respect to age of parent, is subject to certain small fluctuations, which differ at different times and in different localities. The following series of observations cannot be compared with the much more numerous series that will be found in the literature quoted. It goes somewhat further however, in so far as the birth order and age of mother have been taken in the same material, whereby partial correlations can be found. The data were obtained through the Notification of Births Act, 1908, in the County Borough of Middlesbrough and the Urban District of Barking Town. All births that occurred in these areas were visited and the necessary information obtained. An important point is the fact that all the still births and a small number of miscarriages are included, exactly what proportion of the latter it is impossible to say. The actual figures are as follows:

TABLE XV.

Sex and age of mother at birth.

Age of mother	Number of males born	Number of females born	Total	Sex ratio
15	0	1	1	1·00
16	2	3	5	·60
17	6	5	11	·45
18	19	19	38	·50
19	36	38	74	·51
20	61	58	119	·49
21	68	58	126	·46
22	77	74	151	·49
23	95	96	191	·50
24	84	100	184	·54
25	117	75	192	·39
26	95	92	187	·49
27	71	85	156	·54
28	98	81	179	·45
29	85	85	170	·50
30	101	59	160	·37
31	57	57	114	·50
32	172	81	153	·53
33	63	62	125	·50
34	64	77	141	·55
35	58	54	112	·48
36	46	60	106	·57
37	49	44	93	·47
38	44	48	92	·52
39	44	40	84	·48
40	42	30	72	·42
41	18	16	34	·47
42	24	17	41	·41
43	13	18	31	·58
44	11	11	22	·50
45	8	6	14	·43
46	5	3	8	·38
47	8	1	9	·11
48	2	0	2	·33
49	0	1	1	1·0
	1643	1556	3194	

The coefficients obtained are:

Age of mother at birth of offspring and sex ratio:

$$r = -\cdot 055 \pm \cdot 011$$

and the mean square contingency:

$$C_2 = \cdot 103 \pm \cdot 013$$

and if corrected $= \cdot 017.$

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The suggestion is that as the mothers get older there is a *slight* tendency to produce a larger number of males. Many observers, Newcomb, Geissler and others, have thought that birth order is in some way associated with sex determination. The following figures, taken from the above material, illustrate this point.

TABLE XVI.

Order of birth and sex.

Order	Male	Female	Totals
1st	310	274	584
2nd	210	265	475
3rd	208	184	392
4th	187	174	361
5th	135	126	261
6th	130	116	246
7th	94	95	189
8th	79	71	150
9th	61	53	114
10th	57	44	101
11th	38	34	72
12th	17	20	37
13th	13	8	21
14th	8	7	15
15th	7	9	16
16th	2	3	5
17th	—	—	—
18th	—	2	2
19th	1	1	2
Totals	1557	1486	3043

In this case order of birth and sex ratio:

$$r = \cdot 013 \pm \cdot 012.$$

The tendency would seem to be for the male excess of first born largely to counteract the male excess for later born. Taking now the correlations already found we have:

Age of mother at birth of offspring (1) and sequence (2):

$$r_{12} = \cdot 613.$$

Age of mother at birth of offspring (1) and sex (3):

$$r_{13} = -\cdot 055 \pm \cdot 011.$$

Sequence (2) and sex (3):

$$r_{23} = -\cdot 013 \pm \cdot 012.$$

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Should sequence be made constant, nutritive influence will be removed to some extent and age of mother at birth of offspring and its sex:

$$_2r_{13} = -\cdot 06 \pm \cdot 01.$$

That is, those born during the earlier years tend to be female. Some support is given to this conclusion, by the following figures taken from the 1901–2 and 1912 *Statistical Reports for the City of Paris.*

The six categories from the twentieth year to the fortieth year are very large, hence the ratios are reliable. All still births of more than seven months' gestation are included.

	Males per 1000 females
15 years and under	1000
15–19	1033
20–24	1049
25–29	1058
30–34	1042
35–39	1124
40–44	1016
45–49	930

There is reason to believe that the fall from the fortieth year onwards is due to the increase in the number of male conceptions that abort. Thus, turning to events happening previously to the seventh month, we find the following figures in the above report for the year 1912.

	Abortions (embryos to the 7th month of gestation)		
Age of mother	Male	Female	Totals
15–19	63	48	111
20–24	409	272	681
25–29	389	268	657
30–34	271	157	428
35–39	152	83	235
40–45	35	29	64
Totals	1319	857	2176

From these figures the correlation between age of mother and the sex of abortions was found to be

$$r = -\cdot 032 \pm \cdot 016.$$

Although the correlation is not large, still the suggestion is that the male rate for abortions increases as the age of the mother increases. This agrees with what happens after birth. Even in view of the fact that this series must necessarily be incomplete, owing to defect in record and the difficulty in determining sex previous to the second month, it is impossible to explain the previous result regarding the age of mother and the sex of living and still born children, as being due to a differential rate previous to the sixth month of gestation, for the sequence should be the opposite to that actually found. We must now consider age in another way, namely, the effect of the age of the grandparent at the birth of the parent on the relative numbers of the sexes in their families. We have the following data:

Age of grandmother at birth of mother	Number of inquiries	Males per 100 females born
20 and under	229	$100 \pm 4{\cdot}45$
21–25	350	$103 \pm 3{\cdot}60$
26–30	220	$106 \pm 4{\cdot}54$
31–35	198	$113 \pm 4{\cdot}79$
35–40	124	$102 \pm 6{\cdot}06$
41 and over	73	$132 \pm 7{\cdot}89$

Average number of births per mother = 6·1.

The data refer to families of which the duration of married life has been at least twelve years. The introduction to the parent from whom the information was obtained was through a child in its tenth year. It will be seen that the proportion of males in the family increases as the age of the grandparent at which the parent was born increases though in one instance only is the difference definitely significant. The probable errors are based on the number of families investigated, not on the gross numbers of individuals.

Conclusions.

I. The imperfections of the data analysed are such that it must be with some considerable hesitation that any decided statement is made concerning the points discussed. Still, some credence can be given to the belief that those born during the declining years of life do enjoy an enhanced fertility, which may however, by the time at which birth occurs, be actually neutralised by the low survival value of their offspring.

II. If we infer from the evidence just presented, that the pre-natal mortality affects males more than females, then since evidence adduced earlier in the paper supports the conclusions, (*a*) that infant and pre-natal mortality are highly correlated, (*b*) that infant mortality is higher in the case of elderly parturients and also in the case of parturients themselves the offspring of elderly parents, and (*c*) that the differential pre-natal rate increases as age increases, it must follow that the ratio of male to female births should diminish with the age of the parent. But our direct investigation of this point leads, if anywhere, to an opposite conclusion. Hence it must follow that age exerts a direct polarizing influence upon the sexual cell (whether before or after fertilisation cannot even be conjectured) sufficient to neutralise the factors which make for the production of an excess of females.

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