THE EFFECT OF AGE OF MOTHER AND BIRTH ORDER ON SEX RATIO AT BIRTH

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A QUESTION of great importance in the minds of parents-to-be is whether the new arrival will be a boy or a girl. Doctors wisely attempt to sidestep predictions on this matter, although one who is hard-pressed is safer to predict a boy because experience has shown that there will be roughly 105 or 106 boy babies for each 100 girl babies. Although this is small "odds," it is on such as this that Monte Carlo has prospered.

The relative constancy of the sex ratio at birth has been widely studied and noted. From a layman's standpoint, United States data have indicated relatively little change over the years and relatively little variation with factors such as age of mother, birth order, residence, income level, war, etc. Perhaps the most noteworthy difference, and even this seems small to a layman, is that the sex ratio at birth (used hereafter as the number of boy babies per 1,000 girl babies) is about 1,060 for white persons as against 1,025 for nonwhite persons.

There are, however, *statistically significant* differences in the ratio according to age of mother and birth order, as noted by previous studies. For instance, McMahan[2] observed a "tendency for the sex ratio among live births to decrease as the age of the mother increases" and "a slightly greater tendency for the first-born child to be a male than for later born children." This paper will present the results of a detailed analysis of data for the United States covering the period 1942–1950 as to the effect of age of mother and birth order on the sex ratio at birth, considering each of these two factors independently of the other. The investigation began with 1942 because before then

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[2] McMahan, C. A.: An Empirical Test of Three Hypotheses Concerning the Human Sex Ratio at Birth in the United States, 1915–1948. Milbank Memorial Fund *Quarterly*, July 1951, XXIX, No. 3, p. 288.

data cross-classified by age of mother and birth order were not available.

Table 1 shows the sex ratio at birth for all white births in 1942–1950 (totalling some 24.2 million births after excluding

Table 1. Sex ratios of white births in 1942–1950 by age of mother and birth order.

Order of Birth	Age of Mother						
	Under 20	20–24	25–29	30–34	35–39	40 and Over	All Ages
	SEX RATIO OF BIRTHS						
1	1,068	1,067	1,068	1,064	1,060	1,075	1,067
2	1,065	1,058	1,063	1,060	1,058	1,060	1,060
3	1,057	1,053	1,056	1,049	1,054	1,053	1,053
4	1,035	1,054	1,053	1,053	1,056	1,053	1,053
5	*	1,049	1,053	1,046	1,050	1,032	1,049
6	*	1,045	1,045	1,052	1,048	1,034	1,047
7	*	1,044	1,047	1,044	1,054	1,031	1,046
8 and Higher	*	1,111	1,046	1,048	1,041	1,039	1,043
All Orders	1,067	1,062	1,061	1,055	1,053	1,046	1,060
	AS PER CENT OF PROPORTION FOR ALL AGES						
1	100.1	100.0	100.1	99.7	99.3	100.7	100.0
2	100.5	99.8	100.3	100.0	99.8	100.0	100.0
3	100.4	100.0	100.3	99.6	100.1	100.0	100.0
4	98.3	100.1	100.0	100.0	100.3	100.0	100.0
5	*	100.0	100.4	99.7	100.1	98.4	100.0
6	*	99.8	99.8	100.5	100.1	98.8	100.0
7	*	99.8	100.1	99.8	100.8	98.6	100.0
8 and Higher	*	106.5	100.3	100.5	99.8	99.6	100.0
All Orders	100.7	100.2	100.1	99.5	99.3	98.7	100.0
	AS PER CENT OF PROPORTION FOR ALL ORDERS OF BIRTH						
1	100.1	100.5	100.7	100.9	100.7	102.8	100.7
2	99.8	99.6	100.2	100.5	100.5	101.3	100.0
3	99.1	99.2	99.5	99.4	100.1	100.7	99.3
4	97.0	99.2	99.2	99.8	100.3	100.7	99.3
5	*	98.8	99.2	99.1	99.7	98.7	99.0
6	*	98.4	98.5	99.7	99.5	98.9	98.8
7	*	98.3	98.7	99.0	100.1	98.6	98.7
8 and Higher	*	104.6	98.6	99.3	98.9	99.3	98.4
All Orders	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Not computed because less than 1,000 male births.

those where birth order or age of mother was not stated) by age of mother and birth order, while Table 2 gives corresponding data for nonwhite births (totalling about 3.4 million on the same basis). For all orders of birth combined, the ratio shows

Table 2. Sex ratios of non-white births in 1942–1950 by age of mother and birth order.

Order of Birth	Age of Mother						
	Under 20	20–24	25–29	30–34	35–39	40 and Over	All Ages
	SEX RATIO OF BIRTHS						
1	1,028	1,031	1,020	1,024	981	1,065	1,027
2	1,029	1,029	1,035	1,048	1,025	984	1,031
3	1,019	1,028	1,019	1,033	1,042	1,040	1,026
4	976	1,021	1,026	1,038	1,031	985	1,024
5	1,062	1,013	1,021	1,015	1,017	1,000	1,017
6	*	1,034	1,012	1,035	1,003	1,035	1,020
7	*	1,019	1,022	1,020	1,020	938	1,022
8 and Higher	*	1,014	1,018	1,018	1,009	1,017	1,015
All Orders	1,027	1,027	1,023	1,028	1,014	1,016	1,025
	AS PER CENT OF PROPORTION FOR ALL AGES						
1	100.1	100.4	99.3	99.7	95.5	103.7	100.0
2	99.8	99.8	100.4	101.6	99.4	95.4	100.0
3	99.3	100.2	99.3	100.7	101.6	101.4	100.0
4	95.3	99.7	100.2	101.4	100.7	96.2	100.0
5	104.5	99.6	100.4	99.8	100.0	98.3	100.0
6	*	101.4	99.2	101.5	98.3	101.5	100.0
7	*	99.7	100.0	99.8	99.8	91.8	100.0
8 and Higher	*	99.9	100.3	100.3	99.4	100.2	100.0
All Orders	100.2	100.2	99.8	100.3	98.9	99.1	100.0
	AS PER CENT OF PROPORTION FOR ALL ORDERS OF BIRTH						
1	100.1	100.4	99.7	99.6	96.7	104.8	100.2
2	100.2	100.2	101.2	101.9	101.1	96.9	100.6
3	99.2	100.1	99.6	100.5	102.8	102.4	100.1
4	95.0	99.4	100.3	101.0	101.7	96.9	99.9
5	103.5	98.6	99.8	98.7	100.3	98.4	99.2
6	*	100.7	98.9	100.7	98.9	101.9	99.5
7	*	99.2	99.9	99.2	100.6	92.3	99.7
8 and Higher	*	98.7	99.5	99.0	99.5	100.1	99.0
All Orders	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Not computed because less than 1,000 male births.

a steadily decreasing trend with advancing age of mother although for nonwhite births there is some fluctuation around the generally decreasing trend. For all ages of mother combined, the ratio consistently decreases for white births and to some extent also for nonwhite births.

Accordingly, up to this point, the results of previous investigations are confirmed, but for proper analysis the ratios should be considered on a stratified or standardized basis, studying the ratios by age of mother for each birth order and, conversely, for each birth order by age of mother. In order to facilitate such analysis, the lower two sections of Tables 1 and 2 have been inserted. Considering white births, for each order no consistent trend seems evident with advancing age of mother (as per the middle section of Table 1) since the ratios fluctuate slightly above and below 100 per cent. On the other hand, considering each age of mother separately (as in the bottom section of Table 1), a decreasing sex ratio as the birth order rises is quite evident. For the nonwhite data in Table 2, the same relationships seem to be present although not quite so clear—especially in regard to first births for which the ratio seems lower than might be expected.

The preceding method of analysis might well be criticized on the basis that it is not precise but rather is based on general reasoning and observation. Accordingly, correlation analysis has been utilized to determine whether there are any significant trends. For each age group of mother, the correlation coefficient was computed, with the sex ratio as ordinates and the birth order as abscissas. The same procedure was repeated for each birth order, again taking the sex ratio as ordinates and age of mother as abscissas.

Because some of the cells were relatively small and, accordingly, wide fluctuations in the sex ratio occurred, it was decided to combine these data into somewhat fewer groups. Thus the criterion was set up that no cell would be used if it consisted of fewer than 10,000 male births. Accordingly, for white births, third and higher orders were combined for mothers under age

20, and for mothers aged 20–24 sixth and higher orders were combined. Correspondingly, for nonwhite births, the same combinations were made as to birth order and, in addition, the last two age groups were combined (so that the last group was 35 and over).

First, considering the stratification by order of birth, the following correlation coefficients were obtained as between age of mother and sex ratio at birth:

Order of Birth	*White*	*Nonwhite*
1	+.11	−.80
2	−.53	−.01
3	−.46	+.82
4	+.35	−.45
5	−.77	−.64
6	−.40	−.03
7	−.51	−.79
8 and Higher	−.97	−.36
All Orders	−.97	−.78

Although very high inverse correlation shows up for all orders of birth combined, for the birth orders taken separately there is no indication of any consistent correlation since the coefficient ranges from positive to negative (or close to zero) for both white and nonwhite births.

Next, considering the correlation between birth order and sex ratio at birth when stratification is made by age of mother, the following results were obtained:

Age of Mother	*White*	*Nonwhite*
Under 20	−.97	−.84
20–24	−.90	−.55
25–29	−.94	−.46
30–34	−.80	−.51
35–39	−.84	+.04[a]
40 and Over	−.88	[a]
All Ages	−.95	−.83

[a] Figure computed only for ages 35 and over.

Very strong evidence of inverse correlation was obtained for white births, although this is much less so for nonwhite births. Thus for white births, the coefficient never falls below – .80 for any of the age groups of mother, thus indicating that the sex ratio at birth for a given age of mother decreases as birth order increases.

Still another method of somewhat more scientific analysis involves obtaining standardized sex ratios at birth for each age group of mother. This is done by assuming that for each age group the relative distribution by birth order is the same as for all ages combined, or in other words, that all such age groups have the same distribution by birth order. Based on actual sex ratios at birth for each birth order for the particular age group

Table 3. Comparison of actual and standardized[1] sex ratios of births in 1942–1950 by age of mother and birth order.

Item	White Births			Nonwhite Births		
	Actual Ratio	Standardized Ratio[1]	Difference	Actual Ratio	Standardized Ratio[1]	Difference
	BY AGE OF MOTHER					
Under 20	1,067	1,063	+4	1,027	1,015	+12
20–24	1,062	1,061	+1	1,027	1,026	+1
25–29	1,061	1,061	0	1,023	1,023	0
30–34	1,055	1,058	−3	1,028	1,031	−3
35–39	1,053	1,057	−4	1,014	1,012	+2
40 and Over	1,046	1,061	−15	1,016	1,019	−3
	BY BIRTH ORDER					
1	1,067	1,067	0	1,027	1,024	+3
2	1,060	1,061	−1	1,031	1,031	0
3	1,053	1,054	−1	1,026	1,026	0
4	1,053	1,052	+1	1,024	1,014	+10
5	1,049	1,065	−16	1,017	1,026	−9
6	1,047	1,040	+7	1,020	1,015	+5
7	1,046	1,039	+7	1,022	1,009	+13
8 and Higher	1,043	1,059	−16	1,015	1,007	+8

[1] For each "age of mother" group, it is assumed that the relative distribution of mothers by birth order is the same as for all ages combined; then actual sex proportions at birth for each birth order for the particular "age of mother" group are weighted by this distribution to yield the standardized ratio. The same procedure (but, of course, correspondingly reversed) is used for standardized ratios for each "birth order" group.

of mothers, the aggregated standardized sex ratio of the group can be obtained.[3] In similar fashion, standardized ratios for each birth order group may be obtained under the assumption that the relative distribution of births by age of mother is the same for all birth order groups.

Table 3 compares the actual sex ratios of births with the standardized ratios. For white births, the standardized ratios show no trend for increasing age of mother, whereas the actual ratios show a significant decreasing trend; on the other hand, both the actual and standardized ratios show a definite downward trend for increasing birth order. For nonwhite births, as in the previous analysis, the same general tendencies seem to be present as for white births although not nearly so clearly evident.

In summary, the analysis made shows, for both white and nonwhite births, a definite inverse relationship between sex ratio at birth and age of mother and between sex ratio at birth and birth order when age of mother and birth order are considered independently. However, when the analysis is properly made—by stratifying birth order when considering the effect of age of mother and vice versa—new conclusions must be drawn. There is definite indication for white births that the sex ratio at birth varies inversely with birth order and to some extent this is also the case for nonwhite births. On the other hand, the apparently similar relationship of sex ratio with age of mother is due largely, if not solely, to lower orders of birth being more predominant in births to younger mothers. In other words, birth order has a definite effect upon sex ratio at birth, regardless of age of mother, whereas age of mother appears to have relatively little effect on sex ratio at birth except insofar as there is correlation between age of mother and birth order, the latter being the controlling factor.

[3] Actually, in performing the calculations, sex proportions at birth (i.e. the percentage of births that are male) must be used rather than sex ratios.