

# AN EMPIRICAL TEST OF THREE HYPOTHESES CONCERNING THE HUMAN SEX RATIO AT BIRTH IN THE UNITED STATES, 1915-1948

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## INTRODUCTION

THE balance between the sexes is an interesting and important characteristic of a population. The sex distribution is usually expressed by means of the sex ratio. It is not a ratio "in the strictest sense, but is actually the number of males per 100 females."<sup>2</sup> Many demographic phenomena are affected by the ratio of males to females, for example, the birth rate, the marriage rate, the amount and extent of migration, and the death rate. Even the social life of the community is tremendously affected by the sex distribution.<sup>3</sup>

It is well known among demographers that the human sex ratio at birth in the United States is in the neighborhood of 105.6 for the total population, 105.9 for whites, and 102.9 for Negroes. These data represent the mean sex ratio for the period 1915-1948, and were obtained from calculations in this study. In general the sex ratio at birth for the population of the United States is usually regarded as approximately 106 for whites and 103 for Negroes; for example, during the period 1939-1941<sup>4</sup>, the sex ratio at birth among the white population of one state was 106.2 and for Negroes it was

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<sup>2</sup> Hagood, Margaret Jarman: *STATISTICS FOR SOCIOLOGISTS*. New York, Reynal and Hitchcock, Inc., 1941, p. 115.

<sup>3</sup> Smith, T. Lynn: *POPULATION ANALYSIS*. New York, McGraw-Hill Book Company, Inc., 1948, p. 113.

<sup>4</sup> Smith, T. Lynn: *A Demographic Study of the American Negro. Social Forces*, March, 1945, 23, pp. 379-387; and McMahan, C. A.: *THE PEOPLE OF ATLANTA*. Athens, Georgia, University of Georgia Press, 1950, p. 18.

103.0. Thus, the proportion of males is somewhat greater for whites than for the colored population. Although for mammals in general there is usually a greater proportion of males at birth, this is not always the case as many studies have shown.<sup>5</sup>

Concerning the human sex ratio at birth there have been many popular assertions; many of them have dealt with the idea that war causes a change in the ratio and the reasons for such a change. Among the assertions commonly made are the following: (1) The sex ratio among live births tends to rise during or after a war; (2) the sex ratio among live births tends to diminish as the age of the mother increases; (3) as the order of birth increases, the sex ratio among live births tends to fall; (4) the sex ratio increases in wartime because of the greater interval between births; (5) the sex ratio rises in wartime or immediately thereafter because *nature* compensates for war casualties (from battle as well as from starvation, etc.); (6) the sex ratio at birth rises in wartime because of undernourishment of women, and presumably undernourishment produces a greater proportion of males; (7) there is a tendency for the sex ratio of live births to increase as the socio-economic status of the mother rises; and (8) the emotional excitement of war produces an increase in masculinity.

<sup>5</sup> In most mammals the sex ratio at birth is near equality but generally there is a slight excess of males, *i.e.*, the sex ratio is above 100. Sydney A. Asdell, who has done a tremendous amount of work along this line and who is considered one of the leading authorities in the field, has summarized many studies. He found more than 50 per cent males in most studies of horses, goats, guinea pigs, rabbits, dogs, cattle, and in some studies of rats and mice; less than 50 per cent males were found in pigs, sheep, some goats and some rats. For an excellent discussion see Asdell, Sydney A.: *PATTERNS OF MAMMALIAN REPRODUCTION*. Ithaca, New York, Comstock Publishing Company, Inc., 1946, pp. 128, 152, 195, 259, 271, 298, 320, 364, 379, and 395.

For several studies of horses, mules, sheep, some chickens, and some studies of cattle and guinea pigs, Lush reported the sex ratio less than 100 at birth; he reported more than 100 for goats, swine, dogs, cats, rats, mice, rabbits, as well as some studies of guinea pigs and cattle. See Lush, Jay L.: *ANIMAL BREEDING PLANS*. Ames, Iowa, The Collegiate Press, Inc., 1945, pp. 405-409.

For examples of other studies, see Rice, Victor A.: *BREEDING AND IMPROVEMENT OF FARM ANIMALS*. New York, McGraw-Hill Book Company, Inc., 1942, p. 457; Crew, Francis A. E.: *THE GENETICS OF SEXUALITY IN ANIMALS*. Cambridge, The University Press, 1927; and Warren, Carl N.: *ANIMAL SEX CONTROL*. New York, Orange Judd Publishing Company, Inc., 1940, p. 85.

Since several of these assertions will be tested in this study, it is well to state the qualifications of a good hypothesis: It is stated in simple terms, it agrees with the observed facts, it does not conflict with laws ("natural") known to be true, and it permits the application of deductive reasoning.<sup>6</sup>

*Assertions 1, 2, and 3.* The first three of the eight assertions listed above seem to qualify as meeting the test of a good hypothesis and so will constitute the main body of this paper. They will be discussed as Hypotheses I, II, and III. The remaining five assertions will be discussed and disposed of immediately.

*Assertion 4.* Savorgnan maintains that masculinity in births increases in wartime on account of the greater intervals between births, which, in turn, provide greater rest for the female reproductive system and thereby brings about the birth of a larger proportion of males.<sup>7</sup>

Since empirical data on this subject are not available to the investigator, no test is made of this hypothesis.

*Assertion 5.* "There is a very widespread belief that *nature* compensates for the loss of males in war by producing a larger proportion of males in such periods than is usual in normal times."<sup>8</sup>

Such a statement, couched in pseudo-scientific language, cannot be tested empirically. However, the discussion under "Hypothesis 1" indicates that war with its accompanying conditions does not directly affect the sex ratio at birth.

*Assertion 6.* The sex ratio at birth is higher among poorly nourished women than among well nourished women.

No test of this hypothesis is made in this study although

<sup>6</sup> Good, Carter V.; Barr, A. S.; and Scates, Douglas E.: *THE METHODOLOGY OF EDUCATIONAL RESEARCH*. New York, D. Appleton-Century Company, Inc., 1941, p. 195.

<sup>7</sup> Cited by Panunzio, Constantine: Are More Males Born in Wartime? *The Milbank Memorial Fund Quarterly*, July, 1943, 21, pp. 281-291.

<sup>8</sup> For an excellent discussion see Thompson, Warren S.: *POPULATION PROBLEMS*. New York, McGraw-Hill Book Company, Inc., 1942, pp. 48-49. One of the earliest references to the increase of boy babies in wartime was made nearly 200 years ago by the theologian Johann Sussmilch, who offered Divine intervention as the causal factor. Cited by Metropolitan Life Insurance Company: *More Boy Babies in Post-War Years. Statistical Bulletin*, April, 1939, 20, pp. 1-4.

there are many assertions elsewhere that the above is true.<sup>9</sup>

*Assertion 7.* There is a tendency for the sex ratio of live births to increase as the socio-economic status of the mother rises. Since it is well known that birth control is practiced to a greater degree in the upper classes, there is a possibility that this factor may affect the sex ratios in favor of males.

In one study of 5,466 completed families of a socially select group, it was found that the sex ratio at birth was significantly higher than that for the general population.<sup>10</sup> The investigator explained his findings by stating that social factors operated to produce a decrease of prenatal deaths. Since mortality is selective of males at all ages, this results in a higher sex ratio among live births.

Again in the present study, no attempt is made to test this hypothesis. However, in the discussion under "Hypothesis II" it will be seen that the data in Table C do not support this assertion.

*Assertion 8.* The emotional excitement of war produces an increase in masculinity at birth.

This conjecture is advanced by Huxley,<sup>11</sup> but since no data are available for testing it empirically, it will not be treated further.

#### PURPOSE OF THIS STUDY

Although there has been much speculation and several excellent studies concerning the factors related to the sex ratio at birth, apparently there has not been a recent summary of the more significant findings. This is especially true in relation to studies making use of data appearing since the birth and death registration area of the United States was completed (1933). There is, in one place or another, much reference to the subject. This paper attempts to compile in convenient and concise form

<sup>9</sup> For discussions see Landis, Paul H.: *POPULATION PROBLEMS*. New York, American Book Company, 1943, p. 369; also see the explanation by H. Ploss in Panunzio, *op. cit.*

<sup>10</sup> Winston, Sanford: Birth Control and Sex Ratio at Birth. *American Journal of Sociology*, September, 1932, 38, pp. 225-231.

<sup>11</sup> Cited by Panunzio, *op. cit.*, p. 288.

the results of the more significant studies and further, to supplement those studies by testing three of the hypotheses by means of data from the Census Bureau and the National Office of Vital Statistics.

Then it is the purpose of this study (1) to review some of the literature and to present in concise form a summary of representative studies pertaining to the human sex ratio at birth, more particularly among live births; (2) to analyze recent vital statistics in the United States in relation to "good" hypotheses suggested by a review of the literature; and (3) to present the results of the above empirical tests.

#### SCOPE AND DATA

This study is limited to the vital statistics of the birth-registration area of the United States for the period 1915-1948. Actually the period covered by most of the tables is of much shorter duration.

It will be recalled that the national birth-registration area was not established until 1915. At that time this area consisted of only ten states and the District of Columbia.<sup>12</sup> There was a gradual increase in the number of states included in the birth-registration area until 1933 when Texas entered as the last of the states to be included.<sup>13</sup> Accordingly the data used for this study are based on numbers of states varying from ten and the District of Columbia in 1915 to forty-eight states and the District of Columbia for the period 1933-1948.

That the registration of births is somewhat incomplete is generally accepted because, as late as 1946, it was estimated that 96.7 per cent of all white births and only 84.4 per cent of the nonwhite births were registered.<sup>14</sup> This is apparently a vast improvement over the early years of registration for it is a con-

<sup>12</sup> VITAL STATISTICS OF THE UNITED STATES: 1946, Part I. Washington, Government Printing Office, 1948, pp. v-vii. It should be pointed out that the Federal Government has published vital statistics since 1850 with the exception of the period 1900-1914. For the most part these data were collected by enumeration during the decennial censuses but these particular types of data were inaccurate and incomplete.

<sup>13</sup> *Ibid.*, pp. vi-vii.

<sup>14</sup> *Ibid.*, pp. xi-xii.

siderable improvement over the 1940 findings when the percentages were 94.0 and 82.0 for whites and nonwhites respectively.<sup>15</sup>

As far as this study is concerned, this incompleteness of early data should have no effect upon the ratio of registrations of males and females. At least, the writer knows no reason why one sex should be registered in greater proportions than the other in this country.<sup>16</sup>

Since vital statistics data are supposedly records of complete registrations and no sampling situation exists *per se*, it is not deemed necessary in this study to deal with tests of significance, etc.<sup>17</sup>

### THE THREE "GOOD" HYPOTHESES ANALYZED

*Hypothesis I.* The sex ratio among live births does not tend to rise during or after a war. (Although this hypothesis is stated positively in most studies, the writer preferred the negative form which he believed accorded more closely "with the observed facts.")

1. *Review of Previous Studies.* By making use of the New York Census of 1865 and the United States Census of 1870, Simon Newcomb examined the data on the sex of over 100,000 children who must have been born about the close of the Civil War and concluded that not the slightest influence of the war could be noted on the ratio of males to females.<sup>18</sup> He confined much of his examination to the South, because he felt that greater suffering and privations probably would have influenced the distribution of the sexes most in that section.

One study finds that the proportion of male births following

<sup>15</sup> *Ibid.*, p. xii.

<sup>16</sup> In census (enumerated) data, a sex ratio lower than that known to exist at birth or which could be accounted for by differential mortality is found for Negro children under 5 years of age. See Smith: *POPULATION ANALYSIS*, p. 114. Whether this same error, whatever the error may be, is carried over into registration data is not known to this investigator.

<sup>17</sup> Hagood, *op. cit.*, pp. 612-616, has an excellent discussion of a subject closely related to this.

<sup>18</sup> Newcomb, Simon: *A STATISTICAL INQUIRY INTO THE PROBABILITY OF CAUSES OF THE PRODUCTION OF SEX IN HUMAN OFFSPRING*. Washington, Carnegie Institute of Washington, 1944, p. 27.

a long war increases, and that this phenomenon has been repeatedly observed. The sex ratio in Germany around the First World War was used as an example.<sup>19</sup> There the sex ratio varied between 105.3 and 105.9 for the period 1910 to 1914; it rose gradually from 105.6 in 1914 to a high of 108.0 in 1919 and declined to 106.8 by 1923.<sup>20</sup> It was further pointed out that if the return of the soldiers caused an increase in the sex ratio, the rise to a point above normal should have been abrupt at the end of the war. Such was not the case; on the contrary, the increase continued during the war years while the soldiers were away from home.<sup>21</sup>

In comparing the sex ratio for the period 1906 to 1914 with that of 1914 to 1918 in twelve European countries, Panunzio quotes data which show that the sex ratio increased in ten of the twelve countries, remained the same in one, and declined two-tenths of one point in the other.<sup>22</sup> In this study to determine if masculinity decreased in the postwar period, that is, to make the case stand up for an increase during the war period, it was found that from a peak in 1919 the sex ratio fell to a low in 1926 in England; in 1929 in Belgium; in 1930 in France, Germany, Italy, and Scotland; and reached a low in Hungary in 1932.<sup>23</sup> These data support the thesis that war does increase the proportion of male births. However, Thompson, in a similar discussion of fifteen countries, some of which were neutral in World War I, states that "it cannot be said with any assurance that the sex ratio at birth is altered by war." To make the matter more controversial, Landis states that a greater proportion of males is born in postwar years, but concludes his discussion by stating that no explanation of this phenomenon is as yet adequate.<sup>24</sup>

In one recent work on the sex ratio in the United States dur-

<sup>19</sup> Metropolitan Life Insurance Company, *Statistical Bulletin*, April, 1939, 20, pp. 1-4.

<sup>20</sup> *Ibid.*, pp. 2-3.

<sup>21</sup> *Ibid.*, pp. 2-3.

<sup>22</sup> Panunzio, *op. cit.*, pp. 283-286.

<sup>23</sup> *Ibid.*, p. 286.

<sup>24</sup> Thompson, *op. cit.*, p. 49 and Landis, *op. cit.*, p. 269.

LIVE BIRTHS, 1915 - 1948

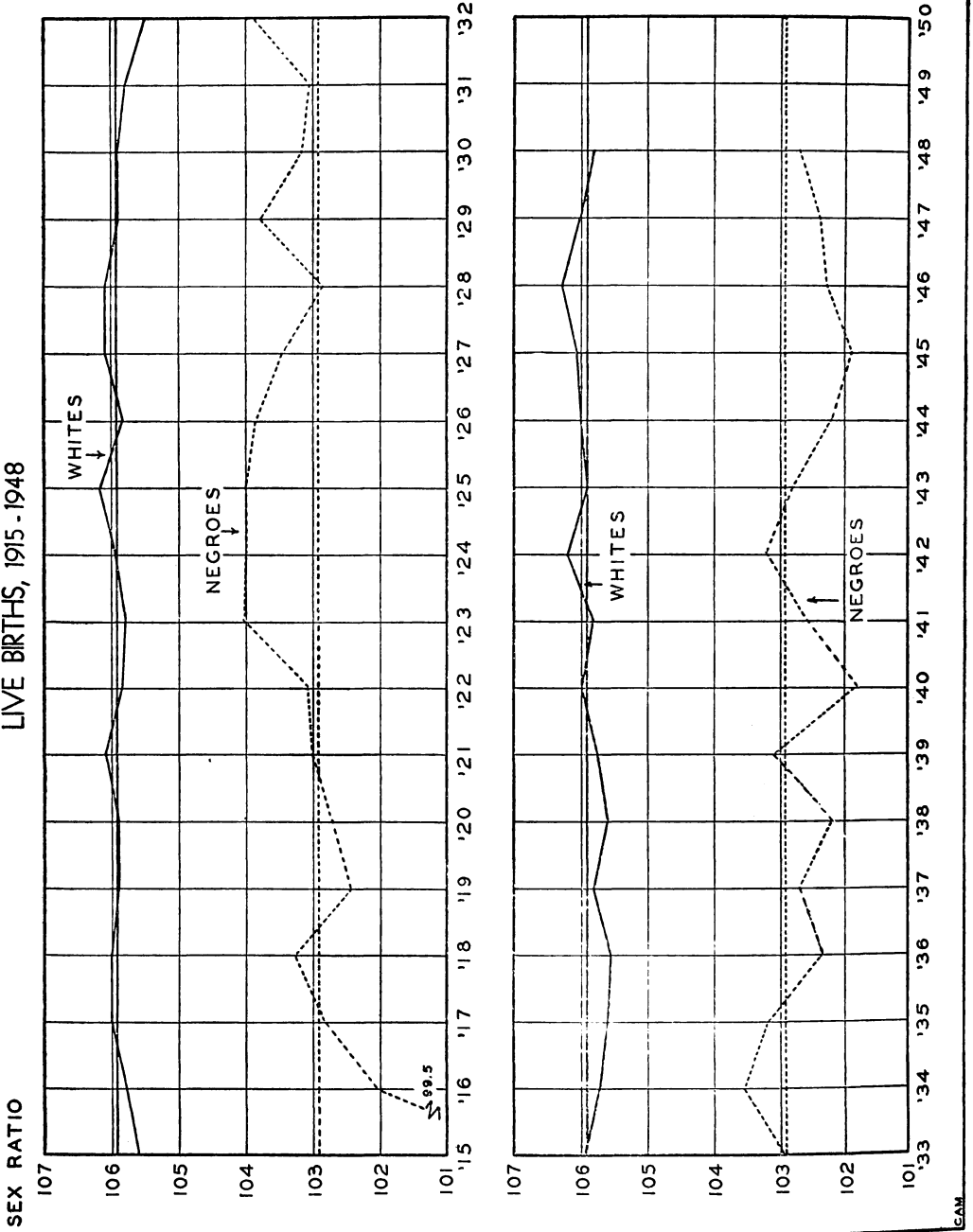


Fig. 1 Sex ratio among live births, 1915-1948

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ing and after World War II, which utilizes some of the same data used in the present study, it was concluded that there is no significant increase in the sex ratio at birth during or immediately following a war.<sup>25</sup>

2. *Empirical Test.* In order to test this hypothesis empirically for the United States, Figure 1 was constructed. The straight solid line on the chart represents the mean sex ratio among whites for the entire thirty-four-year period from 1915 to 1948. In a similar manner the straight broken line represents the mean sex ratio among Negroes for the period 1915 to 1948. This chart indicates that among white live births the sex ratio was highest in 1921, 1925, 1927, 1928, and during the period 1942-1946, although the sex ratio in 1943 was not as high as it was in 1933. The lowest sex ratios occurred in 1915, 1932, and the period from 1934 to 1939. For Negroes, the highest ratio of males to females at birth occurred in 1923-1927, 1929, 1932, and 1934. The lowest sex ratio among Negro births occurred in 1915, 1916, 1919, 1936, 1938, 1940, and 1944-1946.

Since in some cases the chart indicates "above average" sex ratios for 1917-1918 and 1942-1945, it is of interest to compare the average sex ratio for the war years with the average sex ratio for all nonwar years. (The year 1941 has not been included as a war year since the sex ratio was definitely below average.) Table 1 indicates that for all classes and for whites the sex ratio for war years was slightly above the average of

Table 1. Average sex ratios of live births for war years as compared with nonwar years, 1917-1947.

| POPULATION  | NONWAR YEARS <sup>1</sup> | WAR YEARS <sup>1</sup> |
|-------------|---------------------------|------------------------|
| ALL CLASSES | 105.6                     | 105.7                  |
| Whites      | 105.9                     | 106.0                  |
| Negroes     | 102.9                     | 102.6                  |

<sup>1</sup> War years include 1917-1918, 1942-1945 inclusive; nonwar years include 1919-1941 and 1946-1947, inclusive.

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1917-1947.

<sup>25</sup> Metropolitan Life Insurance Company, *Statistical Bulletin*, June, 1949, 30, pp. 5-7.

the nonwar years (one-tenth of one point to be exact); but for Negroes the average for nonwar years was somewhat higher than the average for the war years. In view of the rather great fluctuations and racial differentials, the data do not seem to be conclusive.

Since it will be shown later in this paper that there is a slightly greater tendency for first-born children to be male than for later born children, it is of interest at this point to compare the proportion of first births among births occurring during the period 1934-1939 with the proportion during 1942-1946. In general the latter period had higher average marriage and birth rates than the period 1934-1939.<sup>26</sup> From Table 2 it will be noted that for the total population and for whites, there was a slightly greater proportion of first births during World War II and shortly thereafter; but for Negroes the proportion of first births decreased during this period. The sex ratios by race for the period 1934-1939 are compared with those of the period 1942-1946 in Table 3. These findings suggest support for the hypothesis that if the percentage of first births is increased as average marriage and fertility rates rise, the sex ratio is likely to increase. For whites the percentage of first births increased as well as the sex ratio; while for Negroes, there was a decrease in percentage of first births and a "resulting" decline in the sex ratio.

Table 2. Percentage of first births, 1934-1939, compared with 1942-1946.

| POPULATION  | 1934-1939 | 1942-1946 |
|-------------|-----------|-----------|
| ALL CLASSES | 34.9      | 37.1      |
| White       | 35.7      | 38.3      |
| Colored     | 29.4      | 28.0      |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1934-1939 and 1942-1946.

<sup>26</sup> VITAL STATISTICS OF THE UNITED STATES, 1947, Part I. Washington Government Printing Office, 1949, pp. xviii-xix; Metropolitan Life Insurance Company. Postwar Marriage Trends. *Statistical Bulletin*, 28, pp. 1-2; and Metropolitan Life Insurance Company, Marriages Continue to Decline. *Statistical Bulletin*, December, 1949, 30, pp. 4-6.

3. *Conclusion.* Based on the sex ratio, by race and for the registration area of the United States, the data support the hypothesis that the sex ratio at birth does not consistently change as a direct influence of war either during the war years or immediately thereafter.

*Hypothesis II.* The sex ratio among live births tends to diminish as the age of the mother increases.

1. *Review of Previous Studies.* Landis states that this hypothesis is sometimes used to account for the increase in the proportion of male babies in wartime; he further states that it sounds plausible since immediately after wars there is a rapid increase in marriage rates.<sup>27</sup>

In a study of the sex ratio among total confinements of white mothers, by age, during the period 1942–1946, it was shown that the proportion of male babies was somewhat higher among young mothers and the proportion decreased (although not consistently) with advance in age of the mother.<sup>28</sup> This study continues by stating that in the United States during World War II there was no rise in the proportion of births to young mothers; in fact, the proportion of such births was a trifle less than in the years immediately preceding the war.<sup>29</sup> This last statement possibly depends upon (1) the years considered prewar and war periods; (2) whether an allowance is made for changes in age distribution; and (3)

Table 3. Sex ratios of live births by race, 1934–1939, compared with 1942–1946.

| POPULATION  | 1934–1939 | 1942–1946 |
|-------------|-----------|-----------|
| ALL CLASSES | 105.3     | 105.7     |
| White       | 105.7     | 106.1     |
| Negroes     | 102.9     | 102.5     |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1934–1939 and 1942–1946.

<sup>27</sup> Landis, *op. cit.*, p. 269.

<sup>28</sup> Metropolitan Life Insurance Company, *Statistical Bulletin*, June, 1949, 30, pp. 5–7. These findings are based, in part, on some of the same data as those used in this study.

<sup>29</sup> *Ibid.*, p. 6.

whether births to the total population are considered as a unit or by race and nativity.

Table 4 verifies the fact that there was no rise in the proportion of births to young mothers for the war period. In constructing this table it was assumed that mothers under 25 years of age were "young mothers"; that 1937-1940 was the period immediately preceding World War II; and that 1941-1945 included war years. The table indicates that a greater percentage of births occurred to young mothers before the war than during the war. As a further check, Table 5 was constructed to determine the relative change in birth rates, by age of mother, for selected war years as compared with the average birth rates of a somewhat different prewar period (1935-1939). It is obvious that the birth rates, for whites and nonwhites, increased among most of the ages during the war years in comparison to the prewar period. Noteworthy is the fact that for native whites, there was a greater relative increase of births to mothers aged 25 and over for all war years except 1942. For nonwhites, however, there was a greater relative

Table 4. Percentage of total births (mother's age known) to women under 25 years of age, by race, 1937-1947.

| PERIOD               | ALL CLASSES | WHITE | COLORED |
|----------------------|-------------|-------|---------|
| 1937                 | 44.6        | 43.0  | 55.9    |
| 1938                 | 44.7        | 43.2  | 56.0    |
| 1939                 | 44.3        | 42.6  | 56.3    |
| 1940                 | 44.2        | 42.5  | 56.6    |
| 1941                 | 44.8        | 43.1  | 56.9    |
| 1942                 | 45.4        | 43.8  | 57.2    |
| 1943                 | 43.6        | 41.9  | 56.3    |
| 1944                 | 42.0        | 40.3  | 54.2    |
| 1945                 | 39.6        | 37.8  | 52.6    |
| 1946                 | 42.0        | 40.5  | 53.3    |
| 1947                 | 44.6        | 43.2  | 55.4    |
| Average<br>1937-1940 | 44.5        | 42.8  | 56.2    |
| Average<br>1941-1945 | 43.1        | 41.4  | 55.4    |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1937-1947.

increase of births to young mothers for 1942 and 1943; after 1943 the greater relative increase was among older women. Thus the assumption that a general rise in the sex ratio results at such times because males are more common among births to young mothers does not seem to follow from a study of the data.<sup>30</sup>

Table 5. Index numbers showing the relative importance of birth rates by age of mother, for native white and nonwhite women, 1942-1945. (Average 1935-1939 = 100).

| AGE OF MOTHER | NATIVE WHITE |      |      |      |
|---------------|--------------|------|------|------|
|               | 1942         | 1943 | 1944 | 1945 |
| 15-19         | 118          | 120  | 104  | 96   |
| 20-24         | 128          | 126  | 115  | 105  |
| 25-29         | 126          | 131  | 120  | 115  |
| 30-34         | 115          | 125  | 124  | 127  |
| 35-39         | 100          | 113  | 115  | 119  |
| 40-44         | 78           | 83   | 89   | 89   |
| 15-24         | 125          | 124  | 112  | 102  |
| 25-34         | 122          | 129  | 122  | 121  |
| 35-44         | 94           | 105  | 108  | 111  |
| 15-29         | 126          | 127  | 116  | 108  |
| 30-44         | 106          | 116  | 117  | 119  |
|               | NONWHITE     |      |      |      |
| 15-19         | 120          | 123  | 114  | 114  |
| 20-24         | 116          | 120  | 118  | 113  |
| 25-29         | 108          | 114  | 118  | 119  |
| 30-34         | 109          | 114  | 117  | 116  |
| 35-39         | 102          | 112  | 118  | 123  |
| 40-44         | 91           | 95   | 95   | 91   |
| 15-24         | 118          | 121  | 116  | 113  |
| 25-34         | 108          | 114  | 118  | 118  |
| 35-44         | 99           | 108  | 111  | 114  |
| 15-29         | 115          | 119  | 117  | 115  |
| 30-44         | 104          | 111  | 114  | 115  |

SOURCE: The above calculations are based on data found in Whelpton, P. K.: FORECASTS OF THE POPULATION OF THE UNITED STATES, 1945-1975. Washington, Government Printing Office, 1947, p. 17.

<sup>30</sup> This supports the above article, *ibid.*, p. 6. Many of the above findings are somewhat in contrast to those in an earlier publication from the same source, Metropolitan Life Insurance Company: More Boy Babies in Postwar Years. *Statistical Bulletin*, April, 1939, 20, pp. 1-4.

2. *Empirical Test.* The sex ratios at birth of all classes of the population of the United States, by known age of mother, have been calculated from 1917 to 1947. An analysis of these results shows that there is not a consistent decline in the sex ratio at birth as the age of the mother increases, and for the most part no definite generalizations can be made from these data.

In order to analyze the data by race, similar calculations have been made for white and Negro live births for the same period (Tables A and B, Appendix).

*Whites.* For white live births, there is a consistent decrease in the mean sex ratio for the entire period 1917-1947, as the age of the mother increases. For individual years, however, there is no consistent decrease in the sex ratio as the age of the mother increases although there is a general trend in that direction.

*Negroes.* For Negroes the sex ratio for the total period is highest for the age group 15-19 and 20-24 and tends to fall as the age of the mother increases although there is no consistent decline. Again, as in the case of white mothers, there is no consistent trend by single years.

*Stillbirths.* In order to determine if the sex ratios among stillbirths could account for a change in the sex ratio of live births in relation to increase of the age of the mother, sex ratios of stillbirths among whites and Negroes, by known age of mother, for the period 1942-1947, have been calculated (Table C, Appendix). No consistent trend is discernible in the sex ratio of stillbirths either for whites or for Negroes.<sup>31</sup>

<sup>31</sup> It is generally known that for man mortality rates are higher for males than for females at all ages. This is true among males of many different species other than man. The interested reader should investigate Hamilton, J. B.: *The Role of Testicular Secretions as Indicated by the Effects of Castration in Man and by Studies of Pathological Conditions and the Short Lifespan Associated with Maleness. RECENT PROGRESS IN HORMONE RESEARCH, PROCEEDINGS OF THE LAURENTIAN HORMONE CONFERENCE, Vol. 3.* New York, Academic Press, Inc., 1948, p. 257. The sex ratio among all conceptions in man must run between 110 and 170. Furthermore Ciocco has found that the sex ratio among all stillbirths is about 133; the highest sex ratio is during the second month of uterogestation when it is about 433 (author's note: this may be based on too small a number of cases) and falls to 201 by the fourth month and to 135 by the ninth month. See Ciocco, A.: *The Masculinity of Stillbirths and Abor-*

*Conclusion.* Among both whites and Negroes there is a tendency for the sex ratio among live births to decrease as the age of the mother increases; however, there is no consistent trend. The consistency is greater among whites than among Negroes.

*Hypothesis III.* As order of birth increases, the sex ratio among live births tends to fall, i.e., the sex ratio among first born children is higher than among second born; the sex ratio is higher among tenth born than among twentieth born children, etc.

1. *Review of Previous Studies.* Winston, in a limited study of completed families, found that the chances of a male child's being born decreases from a ratio of about 117 for the first-born to around 105 for the fourth born.<sup>32</sup> Many studies mention the effect of order of birth on the sex ratio but few of them present substantiating evidence.

2. *Empirical test.* The sex ratios at birth, by order of birth, were calculated for the period 1942-1947 for whites and nonwhites (Tables D and E, Appendix). Although these data are for a relatively short period, some trends are indicated. For both whites and nonwhites, the sex ratio of the first-born child is higher than the average sex ratio of the second to the twenty-second child inclusive.<sup>33</sup> However, there is no consistent tendency, by single years or by averages, for the sex ratio to decrease as the order of birth increases.

3. *Conclusion.* The mean sex ratio of all children other than first-born is lower than the mean sex ratio of first-born chil-

tions in Relation to the Duration of Uterogestation and to the Stated Causes of Foetal Mortality. *Human Biology*, May, 1938, 10, p. 235.

In relation to mammals, most evidence indicates that there is a heavier foetal death rate for the male than for the female. See Winters, Laurence M.: *ANIMAL BREEDING*. New York, John Wiley and Sons, Inc., 1948, pp. 156-157; and Rice, *op. cit.*, pp. 443-444. Similar evidence is also presented by Asdell, *op. cit.*, and Warren, *op. cit.*

<sup>32</sup> Winston, Sanford: The Influence of Social Factors Upon the Sex Ratio at Birth. *American Journal of Sociology*, July, 1931, 37, pp. 1-21. Winston also discussed the relationship of war to the human sex ratio at birth.

<sup>33</sup> It must be realized that this hypothesis is in many ways a duplication of "Hypothesis II" because in general the age of the mother increases as birth order increases (that is, in the tabulations).

dren, thus indicating a slight tendency for first-born children to be male. The sex ratio does not consistently decrease, however, as the order of birth increases.

### CONCLUSIONS

The following conclusions seem to result from this study: (1) There is much misinformation concerning the factors related to the sex ratio among humans at birth; (2) many of the assertions concerning the sex ratio at birth have not been empirically demonstrated; (3) this study has demonstrated empirically that the sex ratio in the United States was not appreciably or consistently influenced by the two World Wars; (4) it has also been shown empirically that, for both whites and Negroes, there is a tendency for the sex ratio among live births to decrease as the age of the mother increases; although this trend is not consistent, it is somewhat more so for whites than for Negroes; and (5) there is a slightly greater tendency for the first-born child to be a male than for later born children; and finally (6) the evidence seems to indicate that any increase in the sex ratio to above average during World War II can be considered primarily a result of the increase in the proportion of first births rather than a result of a greater proportion of births to young mothers.<sup>34</sup>

<sup>34</sup> Furthermore, there are studies which indicate that the median age of marriage has shown a slight decline for the first half of the twentieth century; yet there has been no corresponding increase in the sex ratio at birth for the last thirty years. See Ogburn, William F., and Nimkoff, Meyer F.: *SOCIOLOGY*. New York, Houghton Mifflin Company, 1940, p. 481; Smith, T. Lynn: *op. cit.*, p. 151; and McMahan, C. A.: *op. cit.*, pp. 97-103.



## APPENDIX

Table A. Sex ratios of live births among whites, by known age of mother, 1917-1947.

| YEAR                 | SEX RATIOS BY AGE OF MOTHER |       |       |       |       |       |       |
|----------------------|-----------------------------|-------|-------|-------|-------|-------|-------|
|                      | 15-19                       | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 |
| 1917                 | 106.6                       | 105.7 | 106.3 | 106.3 | 106.2 | 105.5 | 103.4 |
| 1918                 | 106.4                       | 105.8 | 106.1 | 105.9 | 106.2 | 104.3 | 101.2 |
| 1919                 | 105.2                       | 105.6 | 106.5 | 106.2 | 104.8 | 106.2 | 105.4 |
| 1920                 | 106.0                       | 106.9 | 106.3 | 105.4 | 104.6 | 103.4 | 115.1 |
| 1921                 | 106.3                       | 106.2 | 106.0 | 106.2 | 105.7 | 105.9 | 102.3 |
| 1922                 | 106.9                       | 105.8 | 106.4 | 105.2 | 105.2 | 105.9 | 108.4 |
| 1923                 | 106.1                       | 105.7 | 106.1 | 105.3 | 106.3 | 105.1 | 101.1 |
| 1924                 | 107.1                       | 106.6 | 106.0 | 104.6 | 106.3 | 104.8 | 103.4 |
| 1925                 | 107.1                       | 106.8 | 106.6 | 105.5 | 105.2 | 104.1 | 107.1 |
| 1926                 | 106.1                       | 106.2 | 105.9 | 105.9 | 105.2 | 105.3 | 102.3 |
| 1927                 | 105.5                       | 106.3 | 106.9 | 106.1 | 105.1 | 104.5 | 100.8 |
| 1928                 | 106.0                       | 106.8 | 105.9 | 105.8 | 105.8 | 104.5 | 104.7 |
| 1929                 | 106.4                       | 106.2 | 105.8 | 105.8 | 105.4 | 105.3 | 100.9 |
| 1930                 | 105.8                       | 106.3 | 105.8 | 105.7 | 105.9 | 103.9 | 105.6 |
| 1931                 | 105.6                       | 106.2 | 105.8 | 105.6 | 105.4 | 104.5 | 104.3 |
| 1932                 | 106.7                       | 105.4 | 105.2 | 105.8 | 105.4 | 103.7 | 108.4 |
| 1933                 | 106.7                       | 106.6 | 105.7 | 105.4 | 105.0 | 105.1 | 107.2 |
| 1934                 | 105.5                       | 106.0 | 106.1 | 105.6 | 105.2 | 104.4 | 104.5 |
| 1935                 | 105.5                       | 106.0 | 105.7 | 105.8 | 104.7 | 104.8 | 103.7 |
| 1936                 | 106.2                       | 105.6 | 105.2 | 105.7 | 105.7 | 104.8 | 107.9 |
| 1937                 | 106.5                       | 106.0 | 105.4 | 105.8 | 106.0 | 104.3 | 102.8 |
| 1938                 | 105.2                       | 106.1 | 105.6 | 105.8 | 104.7 | 104.4 | 102.4 |
| 1939                 | 106.2                       | 105.8 | 105.8 | 106.1 | 104.5 | 104.9 | 103.9 |
| 1940                 | 106.9                       | 106.1 | 106.2 | 105.5 | 105.2 | 104.6 | 103.1 |
| 1941                 | 106.3                       | 105.9 | 105.8 | 105.0 | 106.0 | 105.4 | 105.1 |
| 1942                 | 107.2                       | 106.5 | 106.3 | 105.5 | 105.1 | 105.1 | 105.3 |
| 1943                 | 106.4                       | 106.0 | 106.5 | 105.3 | 104.4 | 103.8 | 105.0 |
| 1944                 | 106.5                       | 106.2 | 106.2 | 105.6 | 106.2 | 104.3 | 103.2 |
| 1945                 | 106.4                       | 106.5 | 106.3 | 105.3 | 105.9 | 105.0 | 101.3 |
| 1946                 | 106.6                       | 106.8 | 106.5 | 105.8 | 105.1 | 105.1 | 104.9 |
| 1947                 | 106.2                       | 106.2 | 105.8 | 105.7 | 105.7 | 105.0 | 108.1 |
| Average<br>1917-1947 | 106.3                       | 106.2 | 106.0 | 105.6 | 105.4 | 104.8 | 104.6 |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1917-1947.

| YEAR                 | SEX RATIOS BY AGE OF MOTHER |       |       |       |       |       |       |
|----------------------|-----------------------------|-------|-------|-------|-------|-------|-------|
|                      | 15-19                       | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 |
| 1917                 | 102.3                       | 102.4 | 102.0 | 102.1 | 105.5 | 98.1  | 106.5 |
| 1918                 | 103.2                       | 103.8 | 102.8 | 104.0 | 99.7  | 106.7 | 111.6 |
| 1919                 | 101.1                       | 101.9 | 100.8 | 103.5 | 106.7 | 103.4 | 110.5 |
| 1920                 | 103.3                       | 102.7 | 101.9 | 99.3  | 105.3 | 103.4 | 119.8 |
| 1921                 | 102.8                       | 104.3 | 102.0 | 102.5 | 105.9 | 99.0  | 106.9 |
| 1922                 | 102.3                       | 104.6 | 103.5 | 102.1 | 103.6 | 105.1 | 107.6 |
| 1923                 | 101.2                       | 105.8 | 103.6 | 105.5 | 104.5 | 102.2 | 103.5 |
| 1924                 | 103.5                       | 104.0 | 104.6 | 104.4 | 105.5 | 101.4 | 95.2  |
| 1925                 | 103.6                       | 105.2 | 104.8 | 103.9 | 105.0 | 103.0 | 100.3 |
| 1926                 | 105.7                       | 103.4 | 103.8 | 103.3 | 103.5 | 103.9 | 96.6  |
| 1927                 | 103.4                       | 103.1 | 105.2 | 104.1 | 101.4 | 102.1 | 102.9 |
| 1928                 | 102.5                       | 102.9 | 102.6 | 104.8 | 102.2 | 97.5  | 102.8 |
| 1929                 | 104.0                       | 104.7 | 103.7 | 102.1 | 104.2 | 99.9  | 97.6  |
| 1930                 | 102.9                       | 102.6 | 104.0 | 103.5 | 104.8 | 103.8 | 104.8 |
| 1931                 | 103.3                       | 103.8 | 103.6 | 102.2 | 102.5 | 102.3 | 95.1  |
| 1932                 | 103.6                       | 106.0 | 101.8 | 102.6 | 106.2 | 101.6 | 101.3 |
| 1933                 | 104.6                       | 102.9 | 102.6 | 104.3 | 102.8 | 102.8 | 102.9 |
| 1934                 | 104.7                       | 103.0 | 102.9 | 105.2 | 103.2 | 105.1 | 102.8 |
| 1935                 | 102.1                       | 103.0 | 103.3 | 105.9 | 102.1 | 101.4 | 97.0  |
| 1936                 | 103.4                       | 101.9 | 103.6 | 102.3 | 100.8 | 104.9 | 108.7 |
| 1937                 | 102.6                       | 103.0 | 102.2 | 104.1 | 101.9 | 101.9 | 96.7  |
| 1938                 | 102.8                       | 102.9 | 102.0 | 101.7 | 100.1 | 103.0 | 97.8  |
| 1939                 | 102.9                       | 103.4 | 103.4 | 103.2 | 103.3 | 94.0  | 109.5 |
| 1940                 | 102.2                       | 102.3 | 101.9 | 99.5  | 102.0 | 99.7  | 113.7 |
| 1941                 | 101.5                       | 103.1 | 102.1 | 103.5 | 102.4 | 104.8 | 98.5  |
| 1942                 | 104.5                       | 102.7 | 102.6 | 102.6 | 103.6 | 104.7 | 103.0 |
| 1943                 | 103.8                       | 101.9 | 103.7 | 102.8 | 102.4 | 101.5 | 92.1  |
| 1944                 | 101.7                       | 103.1 | 101.9 | 100.9 | 102.1 | 102.6 | 96.7  |
| 1945                 | 102.4                       | 102.0 | 102.1 | 102.8 | 98.9  | 102.6 | 91.8  |
| 1946                 | 103.1                       | 102.4 | 102.3 | 101.9 | 101.4 | 99.2  | 97.4  |
| 1947                 | 101.6                       | 103.5 | 102.3 | 102.7 | 100.6 | 101.4 | 108.8 |
| Average<br>1917-1947 | 103.0                       | 103.2 | 102.9 | 103.0 | 102.7 | 102.0 | 101.9 |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1917-1947.

Table B. Sex ratios of live births among Negroes, by known age of mother, 1917-1947.

| YEAR                 | AGE OF MOTHER |       |       |       |       |       |       |
|----------------------|---------------|-------|-------|-------|-------|-------|-------|
|                      | 15-19         | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 |
|                      | WHITE         |       |       |       |       |       |       |
| 1942                 | 127.0         | 122.5 | 120.6 | 122.1 | 121.8 | 119.1 | 131.1 |
| 1943                 | 121.6         | 120.5 | 120.2 | 124.3 | 123.6 | 128.7 | 114.1 |
| 1944                 | 127.3         | 118.7 | 116.7 | 121.1 | 121.9 | 123.1 | 114.3 |
| 1945                 | 124.7         | 115.4 | 121.9 | 115.6 | 122.4 | 122.7 | 110.5 |
| 1946                 | 122.6         | 119.4 | 122.3 | 120.7 | 124.4 | 114.6 | 115.7 |
| 1947                 | 124.1         | 120.7 | 120.4 | 117.2 | 125.0 | 116.3 | 116.7 |
| AVERAGE<br>1942-1947 | 124.5         | 119.7 | 120.3 | 120.2 | 123.6 | 120.7 | 116.8 |
|                      | NEGRO         |       |       |       |       |       |       |
| 1942                 | 134.2         | 131.5 | 131.3 | 136.3 | 135.3 | 157.7 | 134.6 |
| 1943                 | 139.2         | 140.6 | 130.3 | 125.2 | 131.5 | 138.6 | 127.0 |
| 1944                 | 134.5         | 130.1 | 127.8 | 133.7 | 121.0 | 117.3 | 114.3 |
| 1945                 | 135.3         | 116.7 | 120.9 | 124.1 | 132.4 | 141.2 | 82.5  |
| 1946                 | 125.9         | 123.2 | 121.5 | 120.2 | 122.4 | 123.4 | 115.4 |
| 1947                 | 125.8         | 123.5 | 126.7 | 118.7 | 124.8 | 116.0 | 154.8 |
| AVERAGE<br>1942-1947 | 132.6         | 127.5 | 126.4 | 126.0 | 127.6 | 131.3 | 119.7 |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1942-1947.

Table C. Sex ratios of stillbirths among whites and Negroes in the United States by known age of mother, 1942-1947.

| BIRTH ORDER   | SEX RATIOS     |       |       |       |       |       |       |
|---|----------------|-------|-------|-------|-------|-------|-------|
|   | 6-Year Average | 1947  | 1946  | 1945  | 1944  | 1943  | 1942  |
| First   | 106.7          | 106.6 | 107.2 | 106.5 | 106.7 | 106.6 | 106.9 |
| Second  | 106.1          | 105.6 | 106.3 | 106.5 | 105.9 | 106.2 | 106.1 |
| Third   | 105.6          | 105.2 | 105.5 | 105.2 | 106.3 | 105.4 | 105.8 |
| Fourth  | 105.5          | 105.3 | 105.6 | 106.0 | 105.6 | 105.3 | 105.2 |
| Fifth   | 105.0          | 106.2 | 104.4 | 106.5 | 104.1 | 103.7 | 105.4 |
| Sixth   | 104.6          | 105.1 | 104.9 | 102.3 | 105.2 | 105.1 | 105.1 |
| Seventh   | 105.1          | 105.9 | 106.1 | 105.3 | 106.2 | 104.1 | 103.0 |
| Eighth  | 104.1          | 104.5 | 103.9 | 105.6 | 103.7 | 102.0 | 104.9 |
| Ninth   | 103.9          | 101.2 | 106.1 | 103.4 | 105.0 | 103.7 | 104.0 |
| Tenth   | 105.3          | 106.1 | 105.8 | 105.8 | 102.8 | 103.5 | 108.1 |
| Eleventh  | 103.9          | 104.1 | 104.6 | 104.8 | 103.5 | 107.6 | 99.2  |
| Twelfth   | 103.8          | 104.2 | 99.3  | 103.7 | 105.2 | 101.6 | 108.8 |
| Thirteenth  | 106.5          | 103.9 | 110.2 | 99.9  | 107.4 | 105.4 | 112.4 |
| Fourteenth  | 107.3          | 106.0 | 105.1 | 104.0 | 109.2 | 115.1 | 104.5 |
| Fifteenth   | 103.0          | 115.4 | 111.1 | 101.8 | 103.8 | 87.6  | 101.0 |
| Sixteenth   | 112.4          | 136.0 | 105.2 | 116.7 | 120.2 | 105.7 | 96.2  |
| Seventeenth   | 90.7           | 77.8  | 100.0 | 83.5  | 91.2  | 97.9  | 95.2  |
| Eighteenth  | 99.0           | 120.0 | 75.5  | 94.9  | 106.8 | 109.5 | 96.2  |
| Nineteenth  | 123.3          | 105.0 | 173.3 | 86.4  | 120.0 | 152.4 | 116.7 |
| Twentieth   | 115.3          | 89.3  | 119.2 | 166.7 | 110.0 | 92.3  | 158.3 |
| Twenty-first  | 96.0           | —     | —     | 116.7 | 166.7 | 58.3  | 125.0 |
| Twenty-second   | 61.0           | —     | —     | 70.0  | 55.6  | 63.6  | 54.6  |
| AVERAGE OF<br>SECOND TO<br>TWENTY-SECOND<br>INCLUSIVE | 105.6          | 105.4 | 105.8 | 105.8 | 105.7 | 105.5 | 105.7 |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1942-1947.

Table D. Sex ratios of live births among whites, by birth order, 1942-1947.

| BIRTH ORDER   | SEX RATIOS     |       |       |       |       |       |       |
|---|----------------|-------|-------|-------|-------|-------|-------|
|   | 6-Year Average | 1947  | 1946  | 1945  | 1944  | 1943  | 1942  |
| First   | 103.0          | 102.7 | 102.8 | 102.8 | 102.9 | 103.3 | 103.7 |
| Second  | 103.2          | 103.1 | 103.2 | 102.0 | 102.8 | 103.7 | 104.4 |
| Third   | 102.5          | 103.1 | 102.9 | 103.0 | 102.2 | 102.1 | 101.6 |
| Fourth  | 102.0          | 102.0 | 102.7 | 100.0 | 100.2 | 104.2 | 103.3 |
| Fifth   | 101.2          | 101.5 | 100.0 | 102.0 | 100.9 | 100.7 | 102.1 |
| Sixth   | 102.3          | 102.2 | 103.3 | 101.2 | 101.6 | 102.1 | 103.9 |
| Seventh   | 101.9          | 100.7 | 101.5 | 102.2 | 99.5  | 105.6 | 102.4 |
| Eighth  | 102.8          | 104.2 | 103.7 | 96.8  | 101.8 | 104.1 | 107.0 |
| Ninth   | 100.9          | 101.2 | 101.6 | 102.9 | 104.6 | 95.0  | 99.7  |
| Tenth   | 100.1          | 97.1  | 97.2  | 97.3  | 105.9 | 100.0 | 104.0 |
| Eleventh  | 101.3          | 100.7 | 95.2  | 102.1 | 105.3 | 103.9 | 101.5 |
| Twelfth   | 99.6           | 101.9 | 96.5  | 100.6 | 96.4  | 97.9  | 104.5 |
| Thirteenth  | 101.0          | 99.6  | 110.7 | 102.9 | 100.4 | 98.3  | 93.4  |
| Fourteenth  | 103.7          | 100.9 | 94.3  | 96.3  | 122.4 | 102.1 | 110.9 |
| Fifteenth   | 106.0          | 103.3 | 105.7 | 102.3 | 113.0 | 92.0  | 124.5 |
| Sixteenth   | 109.0          | 86.1  | 110.0 | 111.2 | 99.2  | 154.5 | 110.4 |
| Seventeenth   | 111.1          | 94.5  | 89.9  | 112.0 | 129.9 | 144.4 | 115.6 |
| Eighteenth  | 90.9           | 68.6  | 141.4 | 94.9  | 66.7  | 103.0 | 94.6  |
| Nineteenth  | 109.7          | 121.1 | 87.0  | 105.6 | 95.0  | 153.3 | 110.5 |
| Twentieth   | 95.4           | 93.1  | 77.1  | 85.7  | 125.0 | 140.0 | 100.0 |
| Twenty-first  | 100.0          | —     | —     | 42.9  | 120.0 | 87.5  | 233.3 |
| Twenty-second   | 65.7           | —     | —     | 50.0  | 75.0  | 100.0 | 42.9  |
| AVERAGE OF<br>SECOND TO<br>TWENTY-SECOND<br>INCLUSIVE | 102.3          | 102.3 | 102.3 | 101.5 | 101.9 | 102.7 | 103.2 |

SOURCE: Annual Volumes of VITAL STATISTICS OF THE UNITED STATES from 1942-1947.

Table E. Sex ratios of live births among nonwhites, by birth order, 1942-1947.