THE AGE-SEX COMPOSITION OF THE POPULATION RESULTING FROM NATALITY AND MORTALITY CONDITIONS

J. YERUSHALMY[1]

WHEN society began to count and record births and deaths, two interesting facts began to emerge about the two sexes. The first is that the sex distribution at birth is not equal; more boys than girls are born every year. The second is that the female, considered "the weaker sex," is able to withstand the forces of mortality better than the male; the death rates at practically all ages are higher for males than for females. That these facts were entirely unexpected may be judged from the following remark made by John Graunt in 1676 relative to the bills of mortality: "Nor could I ever yet learn (from the many I have asked and those not of the least *Sagacity*) to what purpose the distinction between *Males* and *Females* is inserted, or at all taken notice of?" (1; p. 18).

Each of these two facts has an interest of its own. Studies of the unequal distribution of the sexes at birth are closely related to the problem of sex determination. From investigations on the differential mortality by sex, it is hoped to gain a better insight into the environmental and congenital manifestations of many illnesses. However, it would appear that much may be gained if the differential mortality by sex and the differences in the sex ratio at birth are studied together. A clearer picture of the age and sex composition of the population may be obtained if all the known facts about both the natality and mortality conditions are considered.

The quantitative aspects of the future population of the United States depend at present almost entirely on the natural processes of

[1]From the Division of Statistical Research, Children's Bureau, United States Department of Labor. Grateful acknowledgment is made to Helen R. Robinson for her assistance in computations and analysis.

birth and death, since only a negligible part of the growth of the population is due to immigration. The ultimate age-sex composition of the population will depend largely on the ratio of the sexes at birth and on the age-specific mortality rates of the two sexes.[2] It is, therefore, of interest to inquire how those factors will affect the age-sex composition of the population. What will be the resulting ratio of the sexes at each age? How long will it take for the differential mortality by sex to exhaust the numerical superiority of the males at birth? How large will be the numerical superiority of the females at various ages after the 50-50 mark is reached? What is the *form* of the sex-ratio curve by age? How does that theoretical curve compare with the actual curve obtained from the census of population?

The social implications of the age-sex distribution of the population are numerous. Men still are the main producers of goods. Men, during the occupationally active ages, not only support their families during their lifetime, but have the added responsibility of providing, through savings and insurance, for those parts of the population who survive them. The age-sex composition of the population is vital for old-age and survivors' insurance plans. It is an important consideration in the problems of marriage, widowhood, and orphanhood. The curve of sex ratios by age is also of interest in the evaluation of the differential mortality by sex. The factors that may enter into this selective mortality may be partly biological and partly due to the extra hazards to the male which are mainly the result of his occupational activities. The female, on the other hand, is exposed to the extra risk which is associated with childbearing. The period of childbearing coincides with the occupationally most active period of the male. Study of the form of the age-sex curve before, during, and after the childbearing period may therefore throw additional light on the extent of the influences

[2] It should be noted that the ultimate age composition of the population depends also on the age-specific fertility rates, whereas the ratio of the sexes at each age depends only on the sex ratio at birth and on the age-specific mortality rates of the two sexes.

which these extra risks have on the mortality of the two sexes.

The theoretical age-sex distribution of the population which results from the natality and mortality conditions operating on the population in a given year may be obtained by applying, to an arbitrary number of live births, the known sex ratio at birth and the age-specific death rates for the two sexes. For example, if 51.5 per cent of the births in a locality are male, among 100,000 infants born alive at the same time, there would be 51,500 males and 48,500 females. The survivors at each age for these two groups may be determined by applying to the 51,500 males the survival rates (l_x) of the life table for males and to the 48,500 females the survival rates of the life table for females. At each age of life the resulting number of surviving males and females is thus obtained and the sex ratio at each age may then be determined.

That procedure furnishes as a by-product all the elements necessary for the construction of what might be termed a "sex-adjusted life table." The addition at each age of life of the survivors among the males and among the females furnishes the number of survivors out of the original cohort of 100,000 infants born alive. That is the survivors column (l_x) for a life table for 100,000 infants distributed by sex according to actual experience. From that column all the other functions of the life table may be obtained. The sex-adjusted life table, which in effect is a method of standardizing life tables for sex, may have a number of applications. For example, when the life-table functions are used as a basis for estimating the future population, they have to be standardized for sex.[3] Again, if the life-table functions replace the crude death rate and birth rate as vital indexes of the population, there may be occasions when it would be desirable to have a single index for both sexes.[4]

[3] Although he does not state it specifically, Karpinos (2) apparently used a sex-adjusted life table in his interesting paper on Stabilized Method of Forecasting Population. This can be seen from Table 1 of his paper where the age distribution of life-table population is given. (*See* age distribution for r=0.0).

[4] Karpinos (2) gives such functions in Table 2.

In such considerations as change of the index over a period of time, comparisons between localities, correlations with sanitary and other factors, it may be simpler to deal with one index. The sex-adjusted life table would furnish the most logical way of combining the life tables for the two sexes, since it represents the age-sex distribution which results from the natural forces operating on the population and it more nearly corresponds to actual experience than any other combination of the two life tables.

It is the object of this paper to determine and discuss the sex distribution of the population at each age, which results from natality and mortality conditions operating on the population of the United States in 1930 and to construct a sex-adjusted life table.

The Ratio of the Sexes at Each Age

The ultimate sex distribution at each age resulting from the sex ratio at birth and the age-sex-specific mortality rates will first be determined for the white population in continental United States for the year 1930. During the three-year period 1929-1931, 51.423 per cent of all white live births were male. Consequently, of 100,000 infants born alive in 1930, it may be assumed that 51,423 were males and 48,577 females. These are the first figures entered in columns 2 and 5 of Appendix Table A. The remaining figures in column 2 of this table present the survivors of the 51,423 males at the beginning of each year of life. These were obtained by applying the survival rates (l_x) as given by the Life Table of the Bureau of the Census. (3) Similarly in column 5 the number of survivors at the beginning of each year of age of the 48,577 females was obtained by applying the survival rates for females. From columns 2 and 5 all the other columns of the table were obtained. The remaining columns of the table have the following meanings:

Column 3 presents the number of males dying during each year of age (d_x). Column 6 presents similar figures for females. The figures in column 4 represent the number of years lived by the

cohort of males in each year of age (L_x), and column 7, corresponding figures for females. These last columns represent also the numbers of males and females alive during each year of age.

Comparison of columns 2 and 5 shows that there are more males than females at each year of life through age 50. Beginning with age 51 and continuing through the remainder of the life span, there are more females than males.

The masculinity rate[5] at each year of age is presented graphically in Figure 1 which shows the proportion of males alive during each year of life (column 4) out of the total survivors during the corresponding year of life (column 4 plus column 7).

It will be noted that the masculinity rates by age present a continuously decreasing curve. The rate starts at around 51.148 per cent during the first year of life and falls to as low as 36.364 per cent at age 100. The decrease is relatively small up to about age 36 at which age it becomes much more rapid. The curve intersects the 50 per cent line at age 50, indicating that there would be more males for each year of life up to that age and fewer males than females after that age.

The form of the curve is of considerable interest. Beginning with age 1 to about age 36, it is very nearly a straight line. From age 36 on it curves rapidly downward but in a very regular fashion. *A priori* one would expect a hump in the curve at the childbearing period, since it is during this period that the females are exposed to extra risks, and in fact, as will be seen later, such a hump does exist in the curve for Negroes and for whites during earlier periods. It is possible, however, that although a sharp decrease in the maternal mortality rate has not been noted until 1937, the improve-

[5] *Masculinity rate* is used in this paper to denote the ratio of males to the total population. The *sex-ratio,* as commonly used, denotes the number of males per 1,000 females. The former has many statistical advantages and will therefore be used in most cases. It was also thought more desirable to base the masculinity rates on L_x rather than on l_x because it is this figure that is more nearly comparable to census figures. The rates based on l_x, on the other hand, have the advantage that they are more clearly comparable to the usual masculinity rate "at birth."

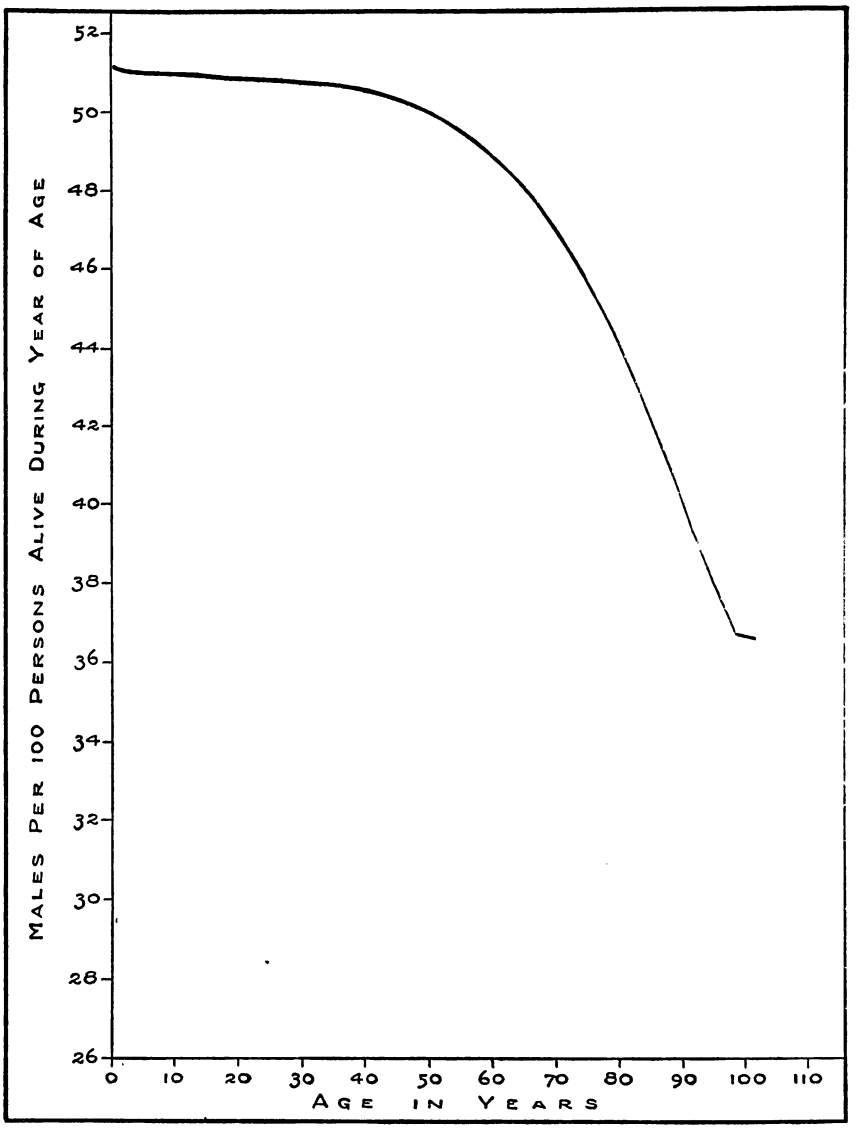

Fig. 1. Masculinity rate, by age, of survivors of 100,000 white infants, according to sex-adjusted life table: Continental United States, 1929-1931.

ment as reflected by the general mortality rate of mothers began much earlier. As a rough approximation, it appears from this curve that the extra hazard to which women are exposed during the most fertile period of their lives is counterbalanced by the extra risk

to which males are exposed as a result of their entrance into the occupationally active period. It may be tempting to try to estimate the extra risk which is due to childbearing on the basis of this curve. For example, it may be reasoned that, if it were not for that extra risk, the straight part of the masculinity curve would end not at age 36, as is shown in the figure, but at approximately age 20. Consequently an estimate of that risk may be obtained by drawing a parallel curve beginning at age 20. Although this method is obviously much too crude, it may nevertheless serve as a suggestive supplement to a more detailed and comprehensive study.

It is interesting to note the cumulative effect of the sexually selective mortality upon the distribution of the sexes. Although originally considerably more males than females entered the cohort, the higher death rates of the males at practically all ages not only resulted in the exhaustion of the numerical superiority of the males at birth but also was responsible for the fact that at the end of the life span there remain nearly two females for every male alive. In the ultimate population (stationary) resulting from the natality and mortality conditions existing in 1930 only 46 per cent of the persons aged 65 and over will be males, or there will be 117 females aged 65 and over for every 100 males of the same ages. Less than 48 per cent of the persons aged 50 and over will be male or there will be 109 females for every 100 males of these ages.

When the life span is divided into three main intervals in relation to the childbearing period the reduction in the masculinity rate is particularly noticed in the post-childbearing period. Thus, the masculinity rate for all persons under 15 years of age is 51.005, for persons 15-44 it is 50.736, and for all persons 45 years of age and over the masculinity rate is 48.341. For every 100 females in the corresponding age groups there are 104 males under 15, 103 males 15-44, and only 94 males 45 years of age and over.

The masculinity rate of the total population (all ages) will be very nearly 50 per cent (49.968 per cent). This fact is of some inter-

est because the total number of males and females of all ages (the accumulation of L_x) also represents the total number of years of life lived by all the males and all the females entering into the original cohort. This number of years of life was found to be 3,040,145 for males and 3,044,085 for females. In other words, the aggregate of males will live nearly the same number of years as the aggregate of females.

Masculinity Rates Based on the Life Tables of 1920 and of 1930-1939

It would be desirable to follow the variation with time of the curve of masculinity rates by age, in order to determine whether, during a relatively long period of time, any radical changes in the form of the curve occur. Unfortunately the registration of births and deaths has not been complete during a long enough period in a sufficiently large number of States to make that possible, so that life tables for comparable groups of the population are not available. That some changes may have occurred with passage of time is indicated in Figure 2 which presents the curves of masculinity rates by age for the years 1919-1921 (Registration States of 1920) and for the period 1930-1939 based on the preliminary life tables for that period issued by the Bureau of the Census (4). It will be noted that although the general outlines (up to age 90)[6] of these curves are very similar to those of the one for 1930 there are a number of differences between the curve for 1920 and those for 1930 and for 1930-1939. Most striking is the hump that appears in the curve for 1920 beginning shortly after age 20 and ending around age 45 (the childbearing period), whereas in the curves for 1930 and for 1930-1939 the straight line continues through age 36.

That the hump in the 1920 curve is probably due to a relatively high mortality of females aged 20-45, in that year, is substantiated

[6] No great significance can be attached to the change in the outline of the 1920 curve which occurs after age 93. The rise at the end of this curve is probably a result of inaccurate registration and enumeration at the oldest ages.

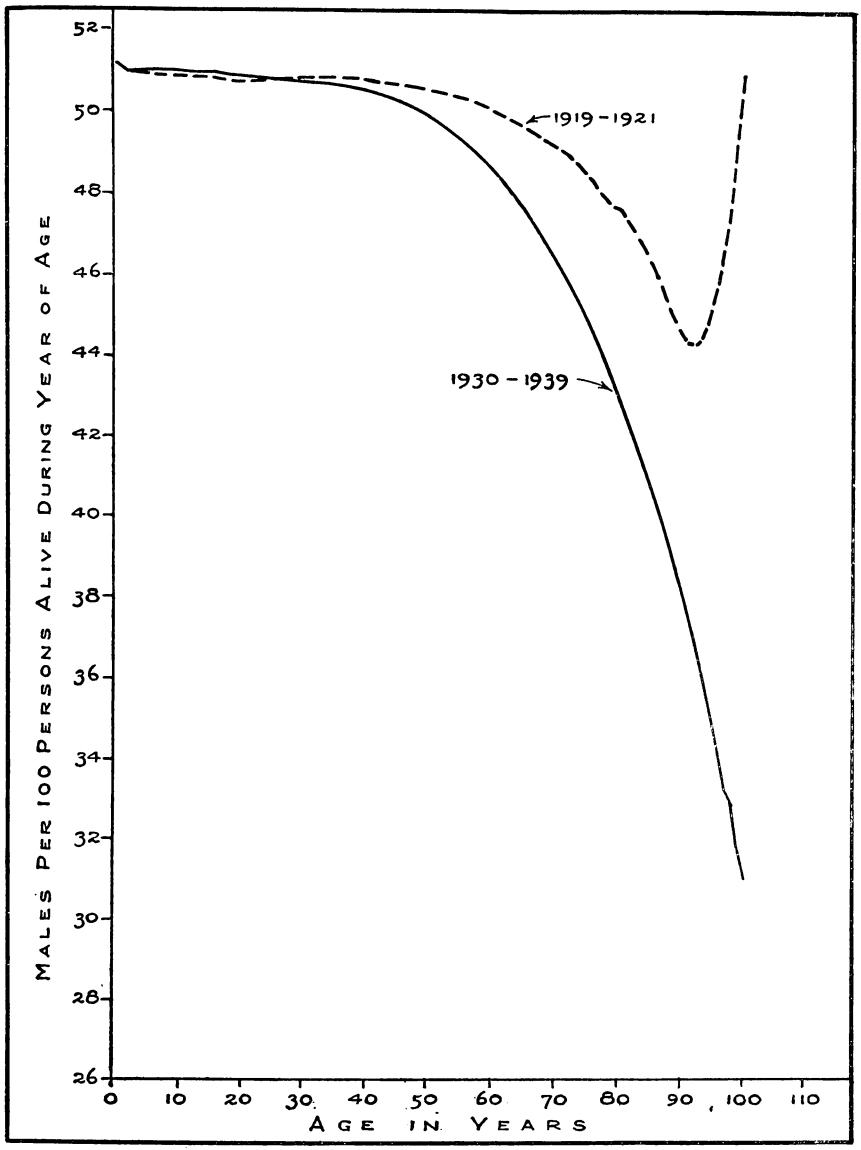

Fig. 2. Masculinity rate, by age, of survivors of 100,000 white infants, according to sex-adjusted life tables: Death Registration States of 1920 for 1919-1921 and Continental United States for 1930-1939.

by the findings of Wiehl (5). She shows that the reduction in the mortality between 1922 and 1934 was more rapid for females during the childbearing ages than for males of similar ages. In other

words, it will appear from these curves that although in the years following 1930 the extra risk to the female during the childbearing period was of a magnitude sufficient to balance the extra risk to the male, associated with his entrance into the occupationally active period; in 1920 the risk to the female during this age period was of a relatively larger magnitude. Another difference between the curves for 1920 and the subsequent curves is that in the former year the curve intersects the 50 per cent line after age 60 whereas in both the latter curves there are as many surviving males as females at age 50. This again is primarily due to the hump during the childbearing period. It is also of interest to note that toward the end of the life span the proportion of survivors who were males decreased continuously with the passage of time. Hence, of the survivors to age 90,[7] according to the 1920 life table, 44.659 per cent will be male, but the corresponding figure from the 1930 life table is 40.146, and from the 1930-1939 life table only 38.393. That fact is of interest and demonstrates that the difference between the mortality of males and females increased in the last two decades; in other words, in 1920 the mortality rate of the females was closer to that of the males than were the rates in 1940. This result agrees with that of Wiehl (5). It would be of interest to see whether this fanning out of the mortality rates of the two sexes continues in future years.

Masculinity Rates for Negroes

Figure 3 presents, by age, the curve of the masculinity rate for Negroes for 1930. As is known, the sex ratio at birth for Negroes is considerably lower than that for whites. During the period 1929-1931 the Negro masculinity rate at birth was 50.818 compared to a rate of 51.423 for whites. It is primarily for that reason that the Negro masculinity rate curve intersects the 50 per cent line at age 36 as compared with age 50 for whites. It will be noted that the

[7] Age 90, rather than the oldest age in the life table, is used here because mortality rates by sex in the later years are not reliable.

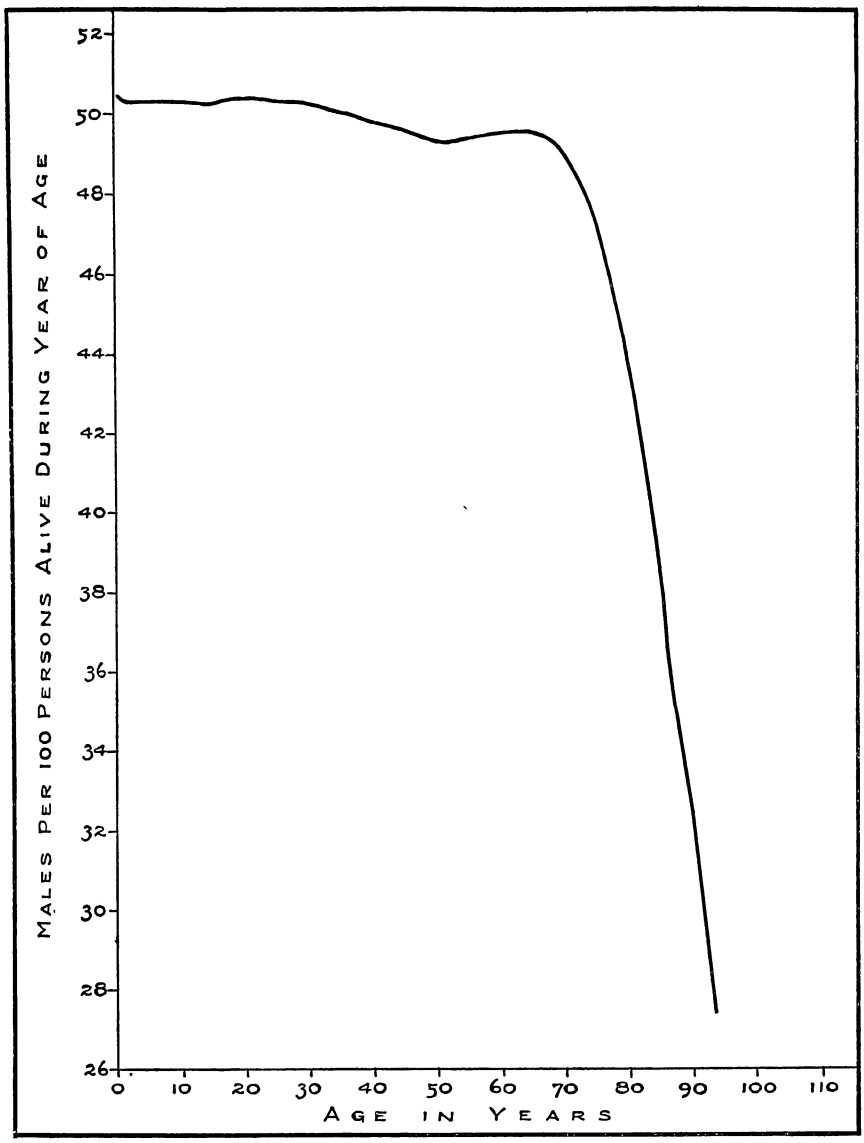

Fig. 3. Masculinity rate, by age, of survivors of 100,000 Negro infants, according to sex-adjusted life table: Continental United States, 1929-1931.

curve for Negroes is not as regular nor does it fall as rapidly (up to age 70) as that for the whites.

The curve for Negroes exhibits two humps—one beginning at age 15 and ending at age 30 which is probably due to the relatively

high extra risk associated with childbearing among Negro women. The other hump, which begins after age 50 and ends around age 70, may not be explained easily. It may be due to faulty registration of deaths or unreliable population figures. In fact, the curve for Negroes based on the 1920 life table (for the Registration States of 1920) is most irregular. It rises continuously beginning with age 3 to a maximum masculinity rate of 53.445 at age 71. It is very unlikely that such a situation actually existed since it would indicate that throughout life the mortality among the females was very much higher than that among the males. It is more probable that the life table for Negroes for 1920 was deficient in many respects.

The Relative Mortality of the Sexes

Starting with a given masculinity rate at birth the form of the masculinity curve by age depends entirely on the ratio of the mortality rates of the two sexes at each age. This ratio is not constant throughout life but exhibits a triple peak curve, as may be seen from Figure 4, which presents the ratio of the life-table mortality rates of white males to those of white females by age for 1930.

The first peak is in the first year of life, the second around puberty, and the third at middle age. In the first year of life the mortality of males is more than 25 per cent higher than that of females. The ratio of the mortality rate among males to that among females decreases sharply and at age 3 the mortality among boys is only 10 per cent higher than that among girls. Beginning at age 4 the ratio increases sharply up to age 12, when the mortality among males is higher than that among females by one-third, but a sharp decrease brings the ratio again to low levels at the ages of 20 to 30. Between the ages of 30 and 50 the ratios increase to a peak around age 50 and thereafter decrease. It is noteworthy that the curve remains above the 1.00 mark to age 100. In other words, at all ages up to the end of the life span the mortality among the males is higher than that among the females.

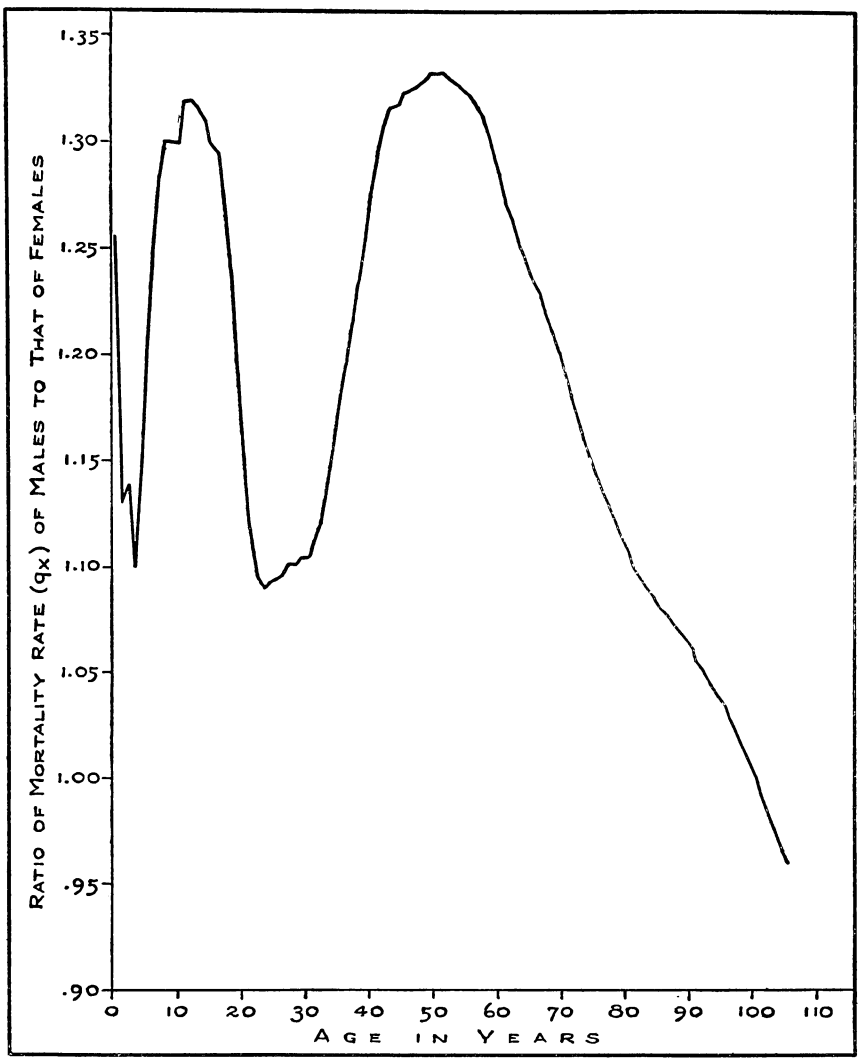

Fig. 4. Ratio of life table mortality rate (qx) of white males to that of white females at each year of age: Continental United States, 1929-1931.

Masculinity Rates of the Enumerated Population

The curves of masculinity rates by age described above may be considered theoretical, in the sense that they represent the ratio of the sexes in a theoretical population resulting from mortality conditions which were operating in one specific year. The various age

groups comprising any actual population were subjected throughout their previous lives to constantly changing mortality rates. Consequently, the age-sex composition of any actual population could not be expected to be identical with that of the theoretical population. Moreover, when the population of a given country is considered, the eventual sex composition at each age may also be greatly influenced by emigration and immigration since there is a sex differential in both. It should, however, be possible to eliminate the factor of migration by considering only the native population. In this country where emigration throughout the years has been of negligible proportions, the age-sex composition of the native population is affected only by the natural processes of birth and death. Although this population has been subjected in previous years to changing mortality rates it may nevertheless be expected that, at least in general form, its age-sex composition should not differ greatly from that described by the theoretical curves, since the higher mortality rate among the males is not a new phenomenon but appears in all recorded vital statistics. In fact, the curves of masculinity rates by age based on "generation" life tables are similar in form to those based on ordinary life tables. "Generation" life tables have recently been constructed by Dublin and Spiegelman (6). In these tables a generation of people born in a given year is traced on the basis of the mortality actually experienced from birth until 1930-1932, and on the basis of the 1930-1932 mortality rates until the entire group is accounted for by death. These life tables, therefore, attempt to reconstruct the previous vital history of a large part of the present population.

Dublin and Spiegelman have constructed "generation" life tables for England and Wales for various time periods beginning with 1876, for Massachusetts beginning with 1890, and for the white population of the original Death Registration States beginning with 1901. From these tables it was possible to construct curves of masculinity rates by age based on "generation" life tables and on life tables

which were current at the year of birth of the generation. It was found that in every case the forms of the curves were similar except that the curves based on "generation" life tables were generally steeper than those based on current life tables. This is in agreement with the observation made above that the mortality rates among the females were closer to those among the males in the past than they are today.

Allowing, therefore, for occasional fluctuations, the age-sex composition of the enumerated native population should be similar to that of the theoretical population described above. Actually, masculinity rates obtained from census figures differ markedly from the theoretical curves, as may be seen from Table 1 and Figure 5, which

Table 1. Sex distribution and masculinity rates of the enumerated native-white population by five-year age periods: Continental United States, 1930.

Age in Years	Total	Male	Female	Masculinity Rate[1]
Total	95,497,800	48,010,145	47,487,655	50.274
Under 1	1,895,302	965,226	930,076	50.927
1– 4	8,004,306	4,071,763	3,932,543	50.870
5– 9	10,834,453	5,497,255	5,337,198	50.739
10–14	10,398,546	5,265,795	5,132,751	50.640
15–19	9,786,954	4,907,316	4,879,638	50.141
20–24	8,804,163	4,346,913	4,457,250	49.373
25–29	7,552,690	3,731,794	3,820,896	49.410
30–34	6,862,936	3,408,584	3,454,352	49.667
35–39	6,551,953	3,278,767	3,273,186	50.043
40–44	5,504,331	2,771,481	2,732,850	50.351
45–49	4,757,775	2,411,909	2,345,866	50.694
50–54	4,091,686	2,092,785	1,998,901	51.147
55–59	3,264,494	1,670,570	1,593,924	51.174
60–64	2,566,416	1,305,260	1,261,156	50.859
65–69	1,882,526	944,823	937,703	50.189
70–74	1,377,436	690,036	687,400	50.096
75–79	770,082	376,565	393,517	48.899
80–84	355,911	165,846	190,065	46.598
85–89	131,839	57,036	74,803	43.262
90–94	30,499	11,720	18,779	38.427
95 and Over	5,997	2,212	3,785	36.885
Not Stated	67,505	36,489	31,016	54.054

[1] Males per 100 persons.

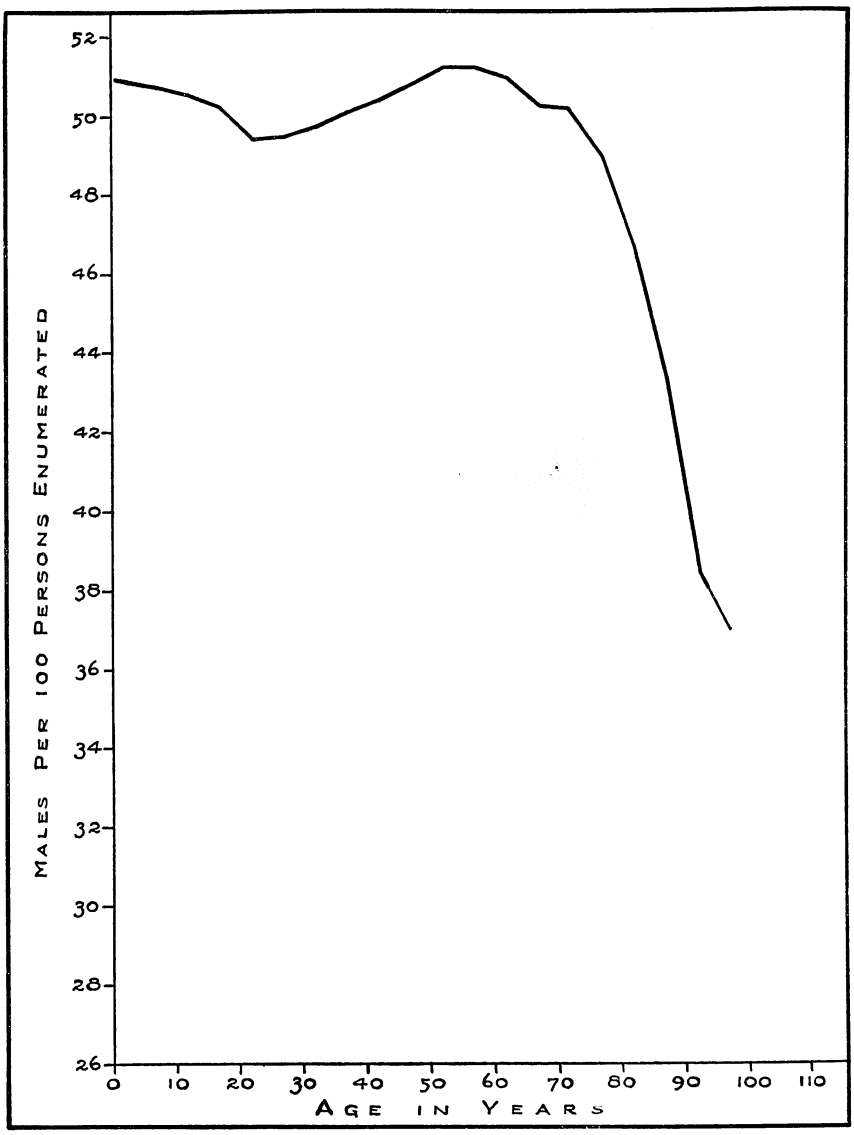

Fig. 5. Masculinity rate of the enumerated native-white population, by five-year age periods: Continental United States, 1930.

present masculinity rates in five-year age groups for the native white population of the United States as enumerated in the 1930 census.

The masculinity rate of the enumerated population starts with

50.927 for the first year of life, decreases sharply thereafter, and intersects the 50 per cent line at age 18. It falls to a low point of 49.373 at ages 20-24 and then rises, intersecting the 50 per cent line again at age 36. It continues to rise to a peak of 51.174 at ages 55-59 and from that point it falls abruptly to a low value of 36.339 at ages 95-99.

It is the relatively large jump of the masculinity rate at middle age which is difficult to explain; particularly since it rises even above the masculinity rate at birth. It is very unlikely that this curve portrays accurately the age-sex composition of the actual population. Two possible factors may have produced a population with the age-sex composition as given by the census figures. Either the ratios of the sexes at birth in previous years were very much higher than at present or the mortality rates among the females were in the past higher than those among the males. This higher mortality among the females may have operated either through a relatively long period of time or it may have been a phenomenon lasting a short period of time, such as a widespread epidemic which attacked the females more seriously than the males. The known facts do not support either of these above two hypotheses. The variations in the sex ratio at birth are at most very slight and do not indicate that it was very much higher 50 or 60 years ago than at present. As to the differential mortality by sex, it is true that in previous years the differences between the mortality rates among males and females were smaller than they are today. However, the "generation" life tables of Dublin and Spiegelman (6) show clearly that a difference in mortality between the two sexes did exist and this difference was always in favor of the females. The influenza epidemic of 1918, which is the only major catastrophe in this country that should be considered in this connection, was not selective for females and consequently could not have produced this increase in the proportion of middle-aged males.

A further indication that the age-sex composition of the actual

population is not accurately portrayed by the census figures is obtained from the distribution of the masculinity rates by age of the deaths occurring in the actual population. For, if the age-sex composition of the native population is really different from that of the theoretical population, it would be reasonable to expect a similar difference in the deaths of the two populations. However Figure 6, which presents the masculinity rates by five-year age groups of the actual deaths of the native-white population in 1930 and corresponding figures for the theoretical population, shows that they are similar in form. Both curves are triple-peaked, with the peaks occurring at practically the same ages. The actual values of the masculinity rates are also sufficiently close for the two curves to suggest that the distribution of the sexes in the populations in which these deaths occurred could not be so different as was found.

It may therefore be concluded that although natality and mortality conditions existing in the past may have had some influence in producing an age-sex distribution of the enumerated population which is different from that of the theoretical population, this influence is slight and a complete explanation of the form of the actual curve lies in other extraneous factors. These factors probably are related to faulty enumeration and may comprise any one or a combination of the following three: (a) Inaccuracies in the statement of nativity, that is, it is possible that there is a sex difference in the accuracy of statement of nativity; (b) sex differences in the completeness of enumeration at various ages; or (c) sex differences in the misstatement of age at enumeration.

Smith and Hitt (7) believe that the entire difference between the actual and theoretical curves is due to misstatement of women's ages. In fact, they use the deviation in the masculinity rates between the observed and the theoretical curves as a means of estimating at each age period the proportion of women who presumably misstated their ages. However, it seems very unlikely that misstatement of women's ages is responsible for the entire distortion, or even for

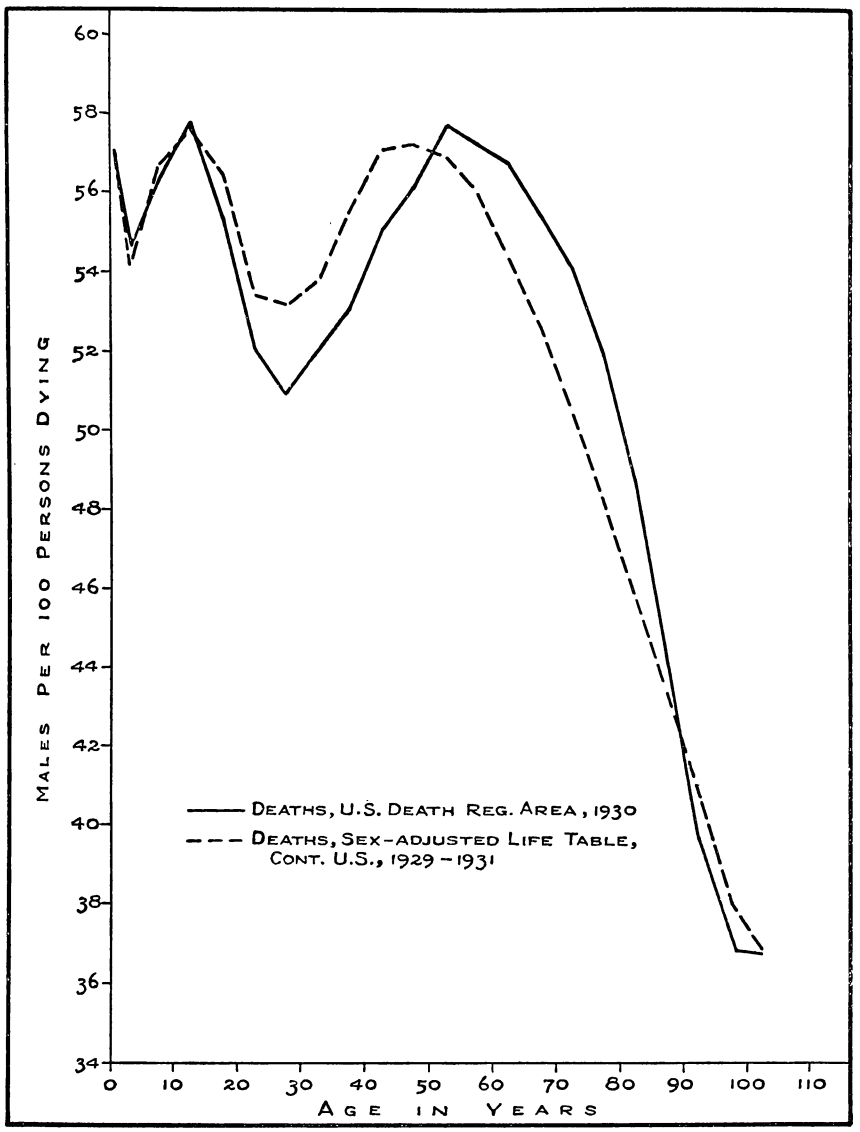

Fig. 6. Masculinity rate, by five-year age periods of native-white persons who died. Actual—United States death registration area, 1930. Theoretical—according to sex-adjusted life table: Continental United States, 1929-1931.

the major part of the distortion, in the curve of masculinity rates by age. In the first place, a considerable amount of the error introduced by misstatement of age is of a compensatory nature. In other

words, although it is true that the enumerated female population of age A is deficient because a certain number of them who should be in this age group are counted in lower age groups, this error will be compensated for, in a large measure, by a number of women who were enumerated as of age A but actually belong in higher age groups. If the explanation of Smith and Hitt is to be accepted, there must be in the population a large number of women around age 50 who are recorded as under 30. Moreover, even if the entire distortion of the curve is due to misstatement of age, the method used by Smith and Hitt to estimate the proportion of women who misstated their ages can be accepted only if the theoretical curve is based on a "generation" life table.

The most serious defect in the method, however, is the assumption that misstatement of age is limited entirely to females and that males do not engage in large-scale misstatement of age. Smith and Hitt conclude that such is the case from the fact that when the numbers of native males and females aged 5-9, 10-14, and 15-19 in 1920 are compared with the numbers aged 15-19, 20-24, and 25-29 in 1930, ". . . the decrease experienced by the female groups during this period was insignificant relative to that occurring among the corresponding males."[8] However, a continuation of this process for older age groups reveals a relatively large distortion among the males as well. For example, when the number of native males aged 25-29 in 1920 is compared with the number of native males aged 35-39 in 1930, there is a decrease of only 0.7 per cent in the ten-year period, whereas the decrease for the younger age group (ages 20-24 in 1920 and 30-34 in 1930) is 4.3 per cent. Furthermore, there is direct evidence that males are as likely to misstate their ages as are females. Densen, in a study on the accuracy of statements of age on census records, traced over 25,000 individuals in two censuses and nearly 3,000 individuals through three censuses. He studied the errors in the reporting of age by relating the reported

[8] *Op. cit.*, p. 101.

age of an individual at one census to the same individual's age as reported at a later census. He concludes that "Even when broken down by age, the distributions of differences for males and females fail to show any consistent divergence from each other." (8; p. 18). It appears, therefore, that while misstatement of ages unquestionably plays a part in producing the unnatural form of the masculinity curve of the actual population, it is probably not the only factor.

To what extent other factors such as the misstatement of nativity or the sex differential in underenumeration at different age levels contribute to the distortion of the age-sex composition of the enumerated population would be difficult to measure. In the case of nativity an attempt was made to eliminate that factor by considering only the native population of native parentage. It was found, however, that, in this case as well, there is a considerable increase in the masculinity rate at the middle ages. The entire problem must be left to students of enumeration who may have opportunities for more direct investigations. Suffice it here to state that the problem is of considerable importance, primarily in its effects on such vital indexes as fertility and mortality rates.

The Sex-Adjusted Life Table

The use of the crude death rate as a vital index of the population is becoming increasingly undesirable and misleading. The population of the United States, as is known, is aging and it may be expected that before long the crude death rate will begin to rise even if the death rates at each age continue to decline. It is therefore important to find a satisfactory substitute for the crude death rate. The tendency in the last few years has been to employ the life-table functions as the most natural vital indexes of the health of the population. With the recent development by Reed and Merrell (9) of a relatively easy method for constructing abridged life tables it may be expected that health departments will begin to use the life-table functions more effectively.

The transition from the use of crude death rates to that of life-

table functions presents the difficulty that the crude death rate in the past has been used as a single index for the two sexes, while life tables are always constructed specific for sex. This separation of the life-table functions by sex has unquestionable merit because of the large differences in the mortality experiences of the two sexes, and it is not implied here that it should be discontinued. There may, however, be occasions when it would be desirable to use, in addition to the sex-specific life tables, a table which combines the experiences of the two sexes. This may particularly be the case in the period of transition from the crude death rate to the life table since the public has become familiar with the use of a single index. If such a combined life table (for the two sexes) should be found to be useful it would appear that the most natural method of standardizing the life tables for sex is to use the sex-adjusted life tables as described above. Such a life table would then have the following meaning: Starting with 100,000 infants born alive and distributed by sex according to actual experience (that is, according to the known sex ratio at birth), the number of survivors among the males and among the females are determined from the respective sex-specific life tables. Consequently, survivors among the original cohort at each age period as well as all the other life-table functions may be determined. The construction of sex-adjusted life tables, when the sex-specific life tables are known, is relatively simple.

A sex-adjusted life table based on the natality and mortality conditions operating on the white population of the United States in 1930 is presented in Appendix Table B. Column 2 gives the number of survivors of the original cohort to each year of age and was obtained by adding columns 2 and 5 of Appendix Table A. This column is sufficient for the construction of all the remaining columns. Thus, column 3, which gives the number dying during each year of age is obtained by subtracting the consecutive corresponding figures in column 2. The remaining columns are obtained from columns 2 and 3 by the usual method.

Summary

The purpose of this paper is to present for each year of age the distribution of the sexes, which results from the ratio of the sexes at birth and the age-sex-specific mortality rates. The masculinity rates by age for the white population based on 1930 life tables follow a continuously decreasing smooth curve which is linear up to age 36, and curves downward beginning with that age. In the ultimate population there will be more males than females up to age 50, and more females than males after that age. At the end of the life span there would be nearly two females for every male alive. The curves of masculinity rates by age based on the 1920 and 1930-1939 life tables as well as for Negroes for 1930 are presented. The masculinity curve of the enumerated population is contrasted with theoretical curves and the difference between the two is discussed. A method of standardizing life-table functions for sex is presented in the form of a sex-adjusted life table.

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Appendix Table A. Male and female survivors, at each year of age, of 100,000 white births, distributed by sex according to the sex-ratio at birth, 1929-1931, subject to the life table survival rates: Continental United States, 1929-1931.

Year of Age	Males			Females		
	Of 51,423 Males Born Alive			Of 48,577 Females Born Alive		
	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age
x to x + 1	l_x	d_x	L_x	l_x	d_x	L_x
1	2	3	4	5	6	7
0– 1	51,423	3,205	48,884	48,577	2,411	46,689
1– 2	48,218	478	47,936	46,166	405	45,926
2– 3	47,740	249	47,608	45,761	209	45,650
3– 4	47,491	170	47,403	45,552	149	45,475
4– 5	47,321	147	47,245	45,403	121	45,340
5– 6	47,174	125	47,112	45,282	100	45,232
6– 7	47,049	106	46,996	45,182	83	45,140
7– 8	46,943	93	46,897	45,099	69	45,064
8– 9	46,850	80	46,810	45,030	59	45,000
9– 10	46,770	73	46,734	44,971	54	44,944
10– 11	46,697	68	46,663	44,917	51	44,891
11– 12	46,629	70	46,594	44,866	50	44,841
12– 13	46,559	73	46,523	44,816	54	44,789
13– 14	46,486	79	46,447	44,762	58	44,733
14– 15	46,407	88	46,363	44,704	65	44,671
15– 16	46,319	98	46,270	44,639	73	44,602
16– 17	46,221	112	46,165	44,566	83	44,525
17– 18	46,109	123	46,047	44,483	92	44,437
18– 19	45,986	131	45,920	44,391	103	44,340
19– 20	45,855	138	45,786	44,288	113	44,232
20– 21	45,717	145	45,644	44,175	122	44,114
21– 22	45,572	154	45,495	44,053	133	43,987
22– 23	45,418	161	45,337	43,920	141	43,850
23– 24	45,257	163	45,176	43,779	145	43,706
24– 25	45,094	165	45,011	43,634	146	43,561
25– 26	44,929	167	44,846	43,488	147	43,414
26– 27	44,762	167	44,679	43,341	148	43,267
27– 28	44,595	171	44,510	43,193	150	43,118
28– 29	44,424	173	44,337	43,043	152	42,967
29– 30	44,251	178	44,162	42,891	157	42,812
30– 31	44,073	182	43,982	42,734	159	42,654
31– 32	43,891	187	43,797	42,575	163	42,494
32– 33	43,704	193	43,608	42,412	167	42,328
33– 34	43,511	202	43,410	42,245	172	42,159
34– 35	43,309	210	43,204	42,073	176	41,985

Appendix Table A. (Continued)

Year of Age	Males			Females		
	Of 51,423 Males Born Alive			Of 48,577 Females Born Alive		
	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age
x to x + 1	l_x	d_x	L_x	l_x	d_x	L_x
1	2	3	4	5	6	7
35– 36	43,099	220	42,989	41,897	182	41,806
36– 37	42,879	230	42,764	41,715	186	41,622
37– 38	42,649	240	42,529	41,529	192	41,433
38– 39	42,409	253	42,283	41,337	200	41,237
39– 40	42,156	268	42,022	41,137	208	41,033
40– 41	41,888	285	41,746	40,929	218	40,820
41– 42	41,603	302	41,452	40,711	228	40,597
42– 43	41,301	320	41,141	40,483	240	40,363
43– 44	40,981	338	40,812	40,243	252	40,117
44– 45	40,643	356	40,465	39,991	265	39,859
45– 46	40,287	374	40,100	39,726	279	39,586
46– 47	39,913	394	39,716	39,447	294	39,300
47– 48	39,519	416	39,311	39,153	311	38,997
48– 49	39,103	439	38,884	38,842	328	38,678
49– 50	38,664	463	38,433	38,514	346	38,341
50– 51	38,201	488	37,957	38,168	366	37,985
51– 52	37,713	515	37,456	37,802	388	37,608
52– 53	37,198	543	36,927	37,414	410	37,209
53– 54	36,655	574	36,368	37,004	436	36,786
54– 55	36,081	609	35,776	36,568	465	36,336
55– 56	35,472	645	35,150	36,103	497	35,854
56– 57	34,827	685	34,485	35,606	530	35,341
57– 58	34,142	725	33,780	35,076	568	34,792
58– 59	33,417	765	33,035	34,508	606	34,205
59– 60	32,652	804	32,250	33,902	645	33,580
60– 61	31,848	842	31,427	33,257	686	32,914
61– 62	31,006	880	30,566	32,571	727	32,208
62– 63	30,126	919	29,666	31,844	771	31,459
63– 64	29,207	963	28,726	31,073	817	30,664
64– 65	28,244	1,008	27,740	30,256	867	29,822
65– 66	27,236	1,053	26,710	29,389	919	28,929
66– 67	26,183	1,098	25,634	28,470	973	27,984
67– 68	25,085	1,144	24,513	27,497	1,027	26,983
68– 69	23,941	1,185	23,349	26,470	1,082	25,929
69– 70	22,756	1,220	22,146	25,388	1,133	24,822

Appendix Table A. (Continued)

Year of Age	Males			Females		
	Of 51,423 Males Born Alive			Of 48,577 Females Born Alive		
	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Alive During Year of Age
x to x + 1	l_x	d_x	L_x	l_x	d_x	L_x
1	2	3	4	5	6	7
70– 71	21,536	1,248	20,912	24,255	1,180	23,665
71– 72	20,288	1,269	19,654	23,075	1,222	22,464
72– 73	19,019	1,282	18,378	21,853	1,259	21,224
73– 74	17,737	1,289	17,093	20,594	1,290	19,949
74– 75	16,448	1,293	15,802	19,304	1,319	18,644
75– 76	15,155	1,292	14,509	17,985	1,342	17,314
76– 77	13,863	1,286	13,220	16,643	1,359	15,964
77– 78	12,577	1,271	11,942	15,284	1,369	14,599
78– 79	11,306	1,245	10,684	13,915	1,367	13,231
79– 80	10,061	1,205	9,459	12,548	1,350	11,873
80– 81	8,856	1,151	8,281	11,198	1,314	10,541
81– 82	7,705	1,082	7,164	9,884	1,262	9,253
82– 83	6,623	1,001	6,122	8,622	1,192	8,026
83– 84	5,622	912	5,166	7,430	1,106	6,877
84– 85	4,710	816	4,302	6,324	1,011	5,818
85– 86	3,894	720	3,534	5,313	908	4,859
86– 87	3,174	622	2,863	4,405	802	4,004
87– 88	2,552	531	2,286	3,603	697	3,255
88– 89	2,021	443	1,800	2,906	597	2,607
89– 90	1,578	366	1,395	2,309	502	2,058
90– 91	1,212	298	1,063	1,807	419	1,597
91– 92	914	238	795	1,388	342	1,217
92– 93	676	186	583	1,046	275	909
93– 94	490	144	418	771	217	662
94– 95	346	109	292	554	167	470
95– 96	237	79	198	387	125	324
96– 97	158	57	130	262	91	216
97– 98	101	38	82	171	64	139
98– 99	63	26	50	107	43	86
99–100	37	16	29	64	28	50
100–101	21	10	16	36	17	28
101–102	11	5	8	19	10	14
102–103	6	3	4	9	5	7
103–104	3	2	2	4	2	3
104–105	1	1	1	2	2	1

Appendix Table B. Sex-adjusted life table for the white population: Continental United States, 1929-1931.

Year of Age	Of 100,000 Infants Born Alive		Mortality Rate	Total Number of Years Lived by Each Generation of 100,000 Infants		Complete Expectation of Life
	Number Alive at Beginning of Year of Age	Number Dying During Year of Age	Number Dying per 1,000 Alive at Beginning of Year	In Year of Age	In Year of Age and all Later Years	Average Number of Years of Life Remaining at Beginning of Year of Age
x to x+1	l_x	d_x	$1{,}000q_x$	L_x	T_x	e_x
1	2	3	4	5	6	7
0- 1	100,000	5,616	56.16	95,573	6,084,230	60.84
1- 2	94,384	883	9.36	93,862	5,988,657	63.45
2- 3	93,501	458	4.90	93,258	5,894,795	63.05
3- 4	93,043	319	3.43	92,878	5,801,537	62.35
4- 5	92,724	268	2.89	92,585	5,708,659	61.57
5- 6	92,456	225	2.43	92,344	5,616,074	60.74
6- 7	92,231	189	2.05	92,136	5,523,730	59.89
7- 8	92,042	162	1.76	91,961	5,431,594	59.01
8- 9	91,880	139	1.51	91,810	5,339,633	58.12
9-10	91,741	127	1.38	91,678	5,247,823	57.20
10-11	91,614	119	1.30	91,554	5,156,145	56.28
11-12	91,495	120	1.31	91,435	5,064,591	55.35
12-13	91,375	127	1.39	91,312	4,973,156	54.43
13-14	91,248	137	1.50	91,180	4,881,844	53.50
14-15	91,111	153	1.68	91,034	4,790,664	52.58
15-16	90,958	171	1.88	90,872	4,699,630	51.67
16-17	90,787	195	2.15	90,690	4,608,758	50.76
17-18	90,592	215	2.37	90,484	4,518,068	49.87
18-19	90,377	234	2.59	90,260	4,427,584	48.99
19-20	90,143	251	2.78	90,018	4,337,324	48.12
20-21	89,892	267	2.97	89,758	4,247,306	47.25
25-26	88,417	314	3.55	88,260	3,801,425	42.99
30-31	86,807	341	3.93	86,636	3,363,313	38.74
35-36	84,996	402	4.73	84,795	2,933,692	34.52
40-41	82,817	503	6.07	82,566	2,513,974	30.36
45-46	80,013	653	8.16	79,686	2,106,602	26.33
50-51	76,369	854	11.18	75,942	1,715,256	22.46
55-56	71,575	1,142	15.96	71,004	1,344,848	18.79
60-61	65,105	1,528	23.47	64,341	1,002,376	15.40
65-66	56,625	1,972	34.83	55,639	697,184	12.31
70-71	45,791	2,428	53.02	44,577	440,185	9.61
75-76	33,140	2,634	79.48	31,823	242,400	7.31
80-81	20,054	2,465	122.92	18,822	109,605	5.47
85-86	9,207	1,628	176.82	8,393	38,055	4.13
90-91	3,019	717	237.50	2,660	9,394	3.11
95-96	624	204	326.92	522	1,388	2.22
100-101	57	27	473.68	44	84	1.47