

MORTALITY AND SOCIO-ENVIRONMENTAL FACTORS

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THE association between physical environment and certain diseases was the foundation on which the public health program was built. Through the application of sanitary measures, through control of animal and insect vectors and of food contamination, and through protection of the individual against infectious organisms by immunization, public health brought about tremendous reductions in mortality. Continued progress in the battle to give more and more of the people the opportunity to live out the span of life attained by the healthiest or most fortunate members of society requires persistent study of the conditions which contribute to premature death. Sydenstricker (1), in *HEALTH AND ENVIRONMENT*, wrote "failure to survive in the early years of life may be ascribed chiefly to accidents of environment, to conditions of living and to ignorance, . . . in later years of life failure to survive is due chiefly to organic breakdowns." Successful control of environment, improved medical care, and advances in medical science have brought death rates in childhood to a level that is lower than the less optimistic dared to expect a few years ago, and very marked reductions in mortality of young adults. But in late middle life the decrease has been relatively small. Today, therefore, we are concerned with the problem of improving and widening our approach to the prevention or postponement of mortality and especially to the postponement of "organic breakdown." The effect of environmental factors on adult health is not well understood and there is need for more investigation of the possible relationship between early breakdown from the so-called degenerative diseases and such factors as mode of work, level of income and of education with their many related conditions, such as housing, nutrition, social and recreational activities, and concentration of populations.

The ideal method for studying effects of a specific environ-

¹ From the Milbank Memorial Fund, New York.

mental factor on mortality is to compare groups which differ with respect to that factor but are alike in other major respects. This is almost never possible. In fact, only rarely are mortality rates available for population groups that can be classified according to some one or two well-defined indices of environment. At present, therefore, our evidence concerning the effect of socio-environmental factors on mortality is based largely on deductions from variations in mortality by sex and age and for various causes in populations living in different sections of the country, under various degrees of urbanization, and, for persons living in large cities, variations among different sections of a city. These populations can be described as to some other characteristics such as proportions engaged in different types of occupations, the average income and educational status, but mortality rates specific for such breakdowns are not available. Obviously, such indirect evidence is only suggestive and subject to rather general inferences. Data of this type for the United States have been discussed in two books—one *HEALTH AND ENVIRONMENT* by Sydenstricker (1) and the other *LENGTH OF LIFE* by Dublin and Lotka (2), and in many articles. I shall not attempt to summarize these previous studies but shall limit myself to presenting some of the latest mortality data of this type.

Extensive data on mortality for whites and for nonwhites in the United States are available and the differences in mortality for these groups reflect very largely the results of the lower socio-economic levels of living of the Negroes, although some differences in mortality may possibly be due to racial characteristics. At least the evidence is clear that mortality of the Negroes is susceptible to reduction, and in the period from 1921 to 1940 the average annual per cent of decline in age-adjusted death rates for nonwhites (in 1940, 96 per cent of nonwhites were Negroes) was 1.59 compared with 1.43 for whites (3). Presumably the same factors are chiefly responsible for the improvement in mortality in both groups. The age-adjusted death rate for nonwhites in 1940 was 16.25 per 1,000, which is 60

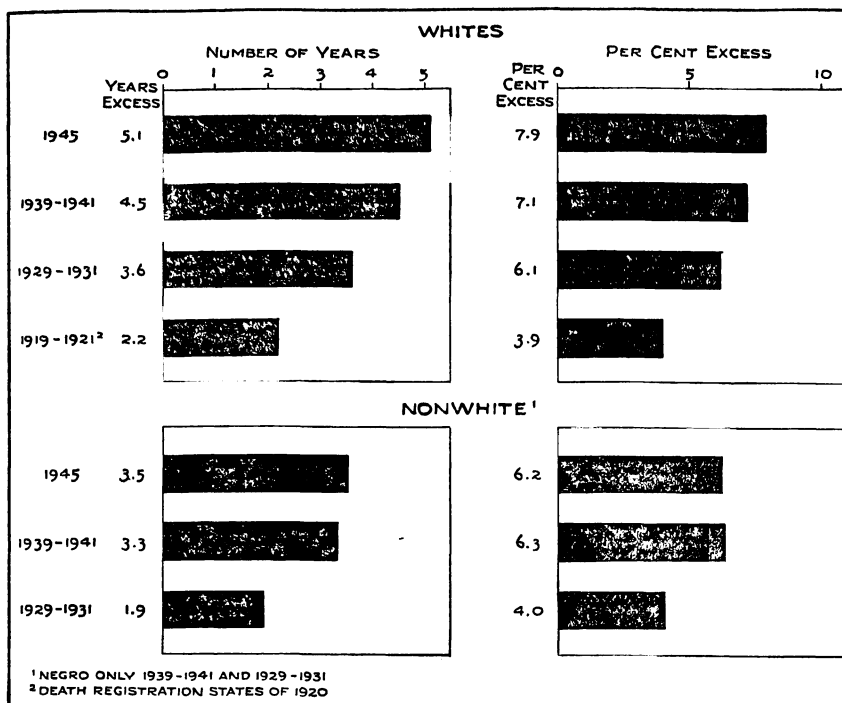


Fig. 1. Excess in expectation of life at birth for females as compared with males in the United States. Excess is shown in number of years and per cent for whites and nonwhites.

per cent higher than the rate of 10.16 for whites. It is not necessary to present evidence that the colored population on the average has a lower economic status than the white population, has poorer housing, less education, and has a generally less favorable standard of living. It is significant that from 1940 to 1945, when Negroes as well as whites had higher incomes than ever before, the mortality decline for Negroes was definitely accelerated. Life tables for 1945 (4) and for 1939-1941 (5) show that the expectation of life at birth increased 3.8 years for Negro males and 4.1 for Negro females. This increase in five years for males is 80 per cent of that for the previous ten-year period, and for females it is 68 per cent.

Differences in mortality trends for sex and age groups, as well as for whites and nonwhites are suggestive of the influence of environmental factors on mortality. The differences between

the number of years of life expectancy at birth for males and females over the past twenty-five years are shown in Figure 1. The excess life expectancy for white females as compared to males increased from 2.2 years for the period 1919–1921 to 5.1 years in 1945, and this is an increase in the percentage excess from 3.9 to 7.9 per cent. For nonwhites the excess life expectancy for females is less than for whites but it too has been increasing.

The greater increase in life expectancy for women than for men is due almost entirely to a more favorable trend in mortality at adult ages. The decrease in life-table mortality at specific ages in the fifteen-year period between 1929–1931 and 1945 is shown in Figure 2 for the white and nonwhite populations. The mortality rates on which this chart is based are the percentages of persons alive at a given age in the life-table population dying before reaching an older specific age. In the upper section of the chart, the percentage decrease in mortality for each of five fifteen-year age periods between birth and age 75 years has been plotted.

Under 15 years of age, the decrease in mortality by sex differs only slightly for both whites and nonwhites. But after age 15 years, the greater percentage decrease in mortality among females is very striking, especially for the white population. Between ages 15 to 30 years, the death rate for white females in 1945 was 59 per cent lower than in 1929–1931 and for white males, the rate declined 44 per cent in the same period; similarly at ages 45 to 60 years, the reduction in mortality was 28 and 10 per cent for females and males, respectively. Thus, the widening difference in expectation of life between males and females is the result of factors operative in adult life, both for Negroes and whites.

It is of interest that in this fifteen-year period the maximum percentage reduction in mortality occurred between ages 15 and 30 years for each sex and color group, although for white males the difference between this age group and the age group under 15 years is negligible. This relatively high reduction in early

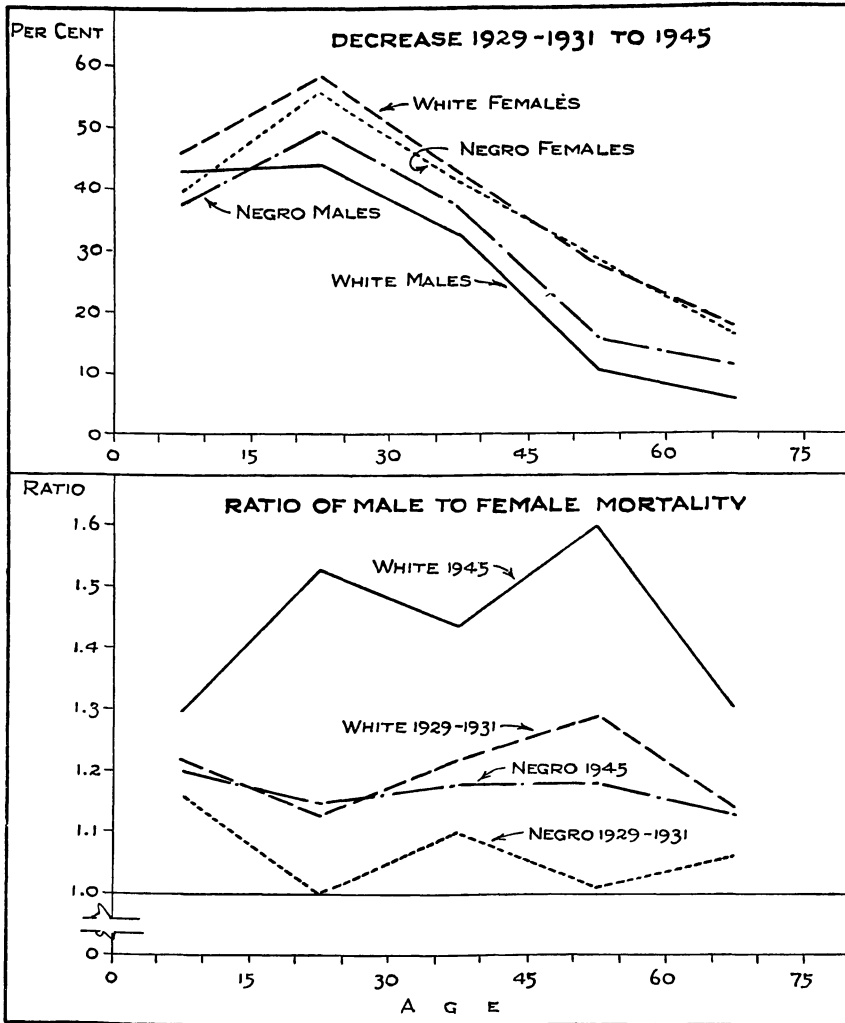


Fig. 2. Per cent decrease in percentage of life-table population dying in five fifteen-year age intervals between birth and age 75 years between 1929-1931 and 1945; and ratios of male to female percentages dying in these age intervals at each period.

adult life represents a marked increase in the rate of decline at this age period. For example, comparison of life-table mortality for Death Registration States of 1900 for the ten-year period 1901-1910 with that for the Death Registration States of 1920 for the ten years from 1920-1929 (6) shows that in the twenty-year interval between these life tables, mortality for

whites at ages 15 to 30 years decreased 33 and 30 per cent for males and females, respectively, compared with 44 and 58 per cent in the recent period from 1930 to 1945. At ages under 15 years, in the earlier twenty-year interval the decline in mortality was 43 and 46 per cent for males and females and, therefore, much greater than at ages 15 to 30 years during that period, whereas in the recent period, the percentage reduction under 15 years was less than at ages 15 to 30 years. Thus, the factors contributing to an improved mortality have become more effective in preventing deaths of young adults than previously, but white females have benefited much more than white males.

The result of the disproportionate decline in female and male mortality is shown by the ratios of male to female mortality for specific age groups in 1945 and in 1929-1931, which are plotted in the lower half of Figure 2. For every age group the excess male mortality has increased for both whites and nonwhites. For nonwhites, variation in the excess according to age is not large, but for whites the excess male mortality in 1945 was 30 per cent under 15 years of age, rose to 53 per cent at 15-30 years, declined slightly for the next 15 year age group, and increased again to 60 per cent at ages 45 to 60, after which it dropped to 30 per cent. This large excess mortality for adult males as compared with females represents one of our major health problems. Other data relating to it will be discussed later, but it may be said here that the causes are unknown.

GEOGRAPHIC VARIATION IN MORTALITY

Geographic variations in mortality for the white population are shown in Figure 3 which ranks the age-adjusted mortality² of residents of each state in 1940 in one of five classes: (1)

² The age-adjusted death rates were computed for each state from age-specific rates given in VITAL STATISTICS RATES IN THE UNITED STATES, 1900-1940, Table 11, except that the infant mortality rate based on registered births and deaths under 1 year was substituted for the death rate under 1 year given in Table 11. Rates are adjusted to the age distribution of the population of the United States according to the 1940 Census. The age-adjusted rates used here differ very slightly from those in AGE-ADJUSTED DEATH RATES IN THE UNITED STATES, 1900-1940, Table 7 (3).

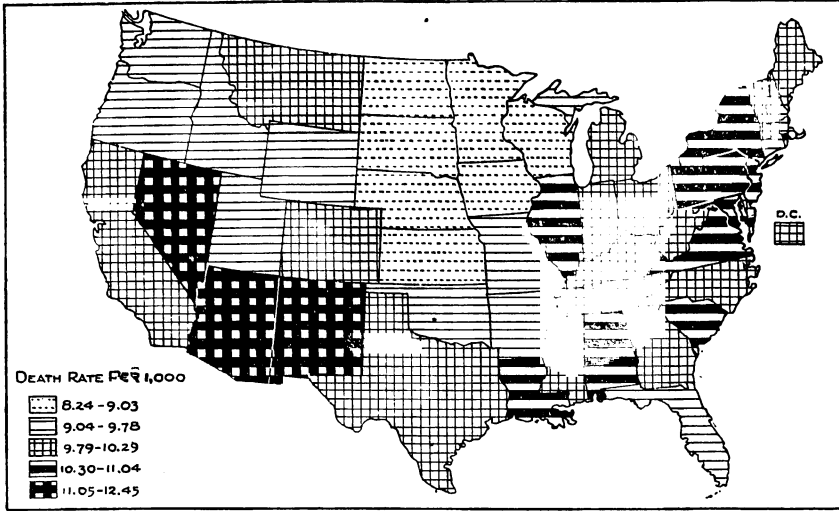


Fig. 3. Geographic variation in age-adjusted death rates in 1940 for white population. States are grouped by percentage deviation from the median rate for forty-nine states. See page 340.

more than 10 per cent below the median rate for the forty-eight state and the District of Columbia; (2) 2.6 to 10 per cent below; (3) not more than 2.5 per cent above or below the median rate; (4) 2.6 to 10.0 higher; and (5) more than 10 per cent higher. There is a marked regional distribution of low and high death rates though there are some exceptions. There are seven states in the group with minimum rates; all are in the West North Central division, except Wisconsin which is adjacent to them but conventionally classified in the East North Central division. All but two of the states with rates more than 2.5 per cent *below* the median are in the West, the exceptions being Connecticut and Florida. The highest mortality, more than 10 per cent above average, is found for only three states, New Mexico, Arizona, and Nevada. These are states affected by special conditions, two of them having long been a mecca for health seekers, especially those with tuberculosis and other respiratory ailments. The eleven states with moderately high death rates include the Middle Atlantic States, Rhode Island in New England, the northern part of the South Atlantic division, plus South Carolina, Louisiana in the South Central area,

and Illinois. This geographic distribution of mortality does not suggest climate as an important or primary factor. Although the lowest rates are concentrated in the northern plains states, the highest rates, except for the three in the southwest, are in states with widely differing climates, for example, Pennsylvania and Louisiana, or Rhode Island and South Carolina. It is apparent that the most favorable death rates are in the western agricultural states; the least favorable are chiefly in the highly urban and industrialized states.

In order to eliminate the effect of differing percentages of the population that were urban and rural on the mortality rates of the states, a death rate adjusted to equal proportions of urban and rural populations was computed for each state.³ In Table 1, the states are listed according to their rank or order on the basis of the actual age-adjusted death rates and the rank of each state on the basis of the urban-rural adjusted rates also is shown. The West North Central states continue to show the most favorable rates. The major shifts are that the relative position of a number of East North Central and North Atlantic states is improved, notably the rank of Illinois, Ohio, New Jersey, New York, and Massachusetts; and the relative position of several Southern states and several Mountain states becomes less favorable, notably Arkansas, Wyoming, Idaho, Mississippi, Kentucky, and West Virginia. As a result of these changes, a larger number of Southern states have rates more than 2.5 per cent above the median rate than is shown by Figure 3, but New York, New Jersey, and Pennsylvania remain in this category. The broad pattern of geographic variation is not altered sufficiently by equalizing the urban-rural weighting in the total rates to indicate that urbanization *per se* is a major factor in the geographic variation.

For nonwhites the geographic distribution of mortality in

³ The age-adjusted death rate for the urban population (cities of 2,500 population or more) of each state was weighted by the urban percentage for the United States in 1940 and the rural death rate in each state was weighted by the rural percentage for the United States. The urban and rural percentages for the United States in 1940 are 56.5 and 43.5 per cent, respectively. Age-adjusted urban and rural rates were taken from Table 7 of reference 3.

STATE	AGE- ADJUSTED	URBAN- RURAL ADJUSTED	STATE	AGE- ADJUSTED	URBAN- RURAL ADJUSTED
South Dakota	1	6	Maine	25	26
Nebraska	2	2	Ohio	26	17
North Dakota	3	8	Mississippi	27	37
Iowa	4	3	Massachusetts	28	20
Minnesota	5	1	Indiana	29	22
Kansas	6	4	West Virginia	30	39
Wisconsin	7	5	Delaware	31	23
Oklahoma	8	13	Kentucky	32	43
Arkansas	9	30	Georgia	33	38
Oregon	10	10	Texas	34	33
Florida	11	7	Vermont	35	35
Missouri	12	11	Illinois	36	21
Wyoming	13	24	Rhode Island	37	25
Connecticut	14	9	Alabama	38	40
Utah	15	12	Virginia	39	36
Idaho	16	34	New Jersey	40	32
Washington	17	14	New York	41	31
New Hampshire	18	15	Louisiana	42	44
Michigan	19	16	South Carolina	43	45
Montana	20	28	Maryland	44	42
North Carolina	21	27	Pennsylvania	45	41
California	22	19	New Mexico	46	46
Colorado	23	18	Arizona	47	48
Tennessee	24	29	Nevada	48	47

Table 1. Rank order from lowest to highest death rates for each state, 1940, according to age-adjusted rates for the white population and to urban-rural adjusted rates.

thirty-two states and the District of Columbia is shown in Figure 4 (rates are for Negroes only in Arizona, California, Oklahoma, and Nebraska). The states are grouped according to the percentage deviation from the median rate as in the case of whites, and it should be pointed out that the lowest rates for nonwhites is 12.5, the same as the highest rate for whites. For the nonwhite population, rates range from 12.5 to 19.4 and fewer states (six of the thirty-three states compared with nineteen of the forty-nine for whites) approximate the median. The lowest nonwhite rates are in the North and South West Central states, California and Massachusetts. Several states for which the white rates were relatively high had average or lower nonwhite rates as, for example, New York, Louisiana,

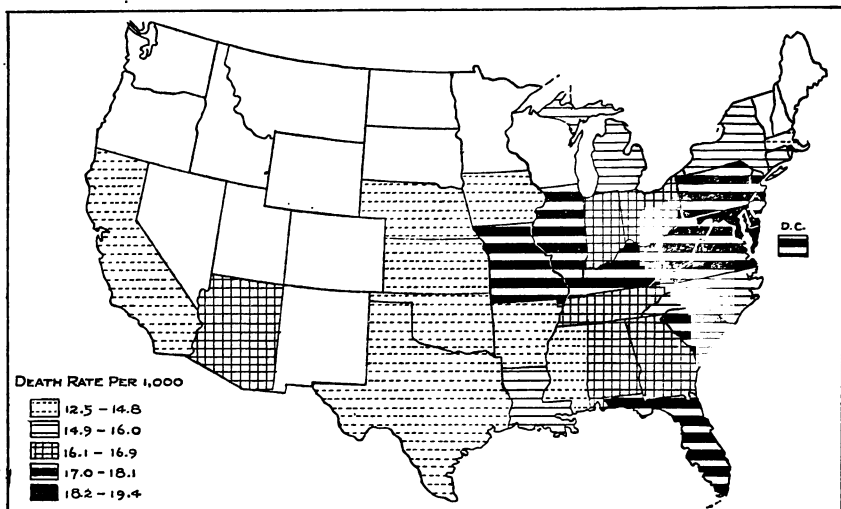


Fig. 4. Geographic variation in age-adjusted death rates in 1940 for non-white population of thirty-two states and the District of Columbia. States are grouped by percentage deviation from the median rate. See page 340.

and Alabama. There is somewhat the same tendency for high rates to occur in the industrial East and average rates to prevail in the North and South Central states.

URBAN AND RURAL MORTALITY

It has long been known that, in general, urban populations have higher mortality rates than rural populations. Much of the public health program has been directed to the control and elimination of unfavorable conditions in cities, and in the early part of this century urban mortality rates declined sharply. But in the past twenty-five years it has not been possible to follow urban and rural trends in mortality because urban and rural rates were affected by the increasing use of urban hospitals by rural residents. In 1937, the National Office of Vital Statistics began the tabulation of deaths according to place of usual residence of the decedents and data are now available for somewhat detailed comparisons of mortality in cities and in rural areas. It is of interest to examine the nature of the urban-rural differences in recent mortality of the United States.

For the United States as a whole and for three broad regions, life tables on mortality during 1939 in cities with 100,000 population or more in 1930, in communities having a population of 2,500 to 100,000, and in rural areas have been published by the National Office of Vital Statistics (7). These life tables and death rates for specific states in 1940 will be used to describe recent urban-rural differences. The movement of the population since the 1940 Census has been so great that more recent urban and rural rates are not very reliable.

In Table 2, expectation of life at birth in the United States for the year 1939 is compared for rural areas and the two urban populations. White females had nearly the same expectation of life at birth in large and small cities; in the country they had an advantage of only a little over one year. For white males also there was little difference by size of city, but at birth rural males had 2.7 years more life expectation than males in small cities and 2.5 years more than those in large cities. These urban-rural differences are much less the differences shown by life tables for the Original Registration States (8) at the beginning of this century (Table 2). In the period 1900-1902, the expectation of life at birth for rural males exceeded that for urban males by 10 years, and for rural females the excess was 7.5 years.

A further point to be noted is that, although the expectation

Table 2. Average expectation of life at birth for urban and rural populations of the United States.

YEAR AND URBAN-RURAL CLASS	WHITE		NONWHITE	
	Male	Female	Male	Female
<i>1939—Total United States:</i>				
Cities 100,000 or More	61.6	66.3	51.0	54.6
Other Urban	61.4	66.2	46.9	51.1
Rural	64.1	67.5	55.2	57.2
<i>Original Registration States:</i>				
<i>1909-1911</i>				
Cities 10,000 or More	47.32	51.39		
Rural	55.06	57.35		
<i>1900-1902</i>				
Cities 8,000 or More	43.97	47.90		
Rural	54.03	55.41		

of life has increased greatly for both urban and rural populations, the urban increase has been greater for both males and females.

Trends in sex differences in expectation of life for urban and rural populations are of interest in view of the widening differential already noted. The expectation of life for females exceeds that for males both in urban and rural populations and at all three periods shown in Table 2. For the urban population, females had an average expectation of life four years longer than males had at both earlier periods and the difference increased only slightly (about three-fourths of a year) in 1939. For the rural population, the female expectation of life exceeded that of males by only 1.4 years in 1900-1902, but it has steadily increased and in 1939 the excess was 3.4 years.

Although the population of the Original Registration States is not strictly comparable with that of the total United States, it seems probable that two general conclusions are justified: first, that the urban-rural differential in mortality has been declining due to a more rapid improvement in urban mortality; and second, that the *increase* in the differential between male and female mortality is greater for rural populations than for urban although the absolute difference is greater for urban populations.

For nonwhites, the expectation of life at birth for rural males and females exceeded that in both large and small cities by a much greater amount than that found for whites. Under-registration of Negro rural deaths probably is a factor in this large excess but could account for only a part of it. Negroes had a definitely longer expectation of life in large cities than in small cities in contrast to the slight difference for whites.

A higher urban than rural mortality is characteristic of the white populations in nearly all states. Comparison of the age-adjusted urban and rural rates for states (3) in 1940 shows that the urban rate was higher in every state except in Massachusetts where the two rates were equal, and in California and New York where the urban rate was 0.1 per 1,000 less than the rural, and in New Jersey where the urban rate was 0.6

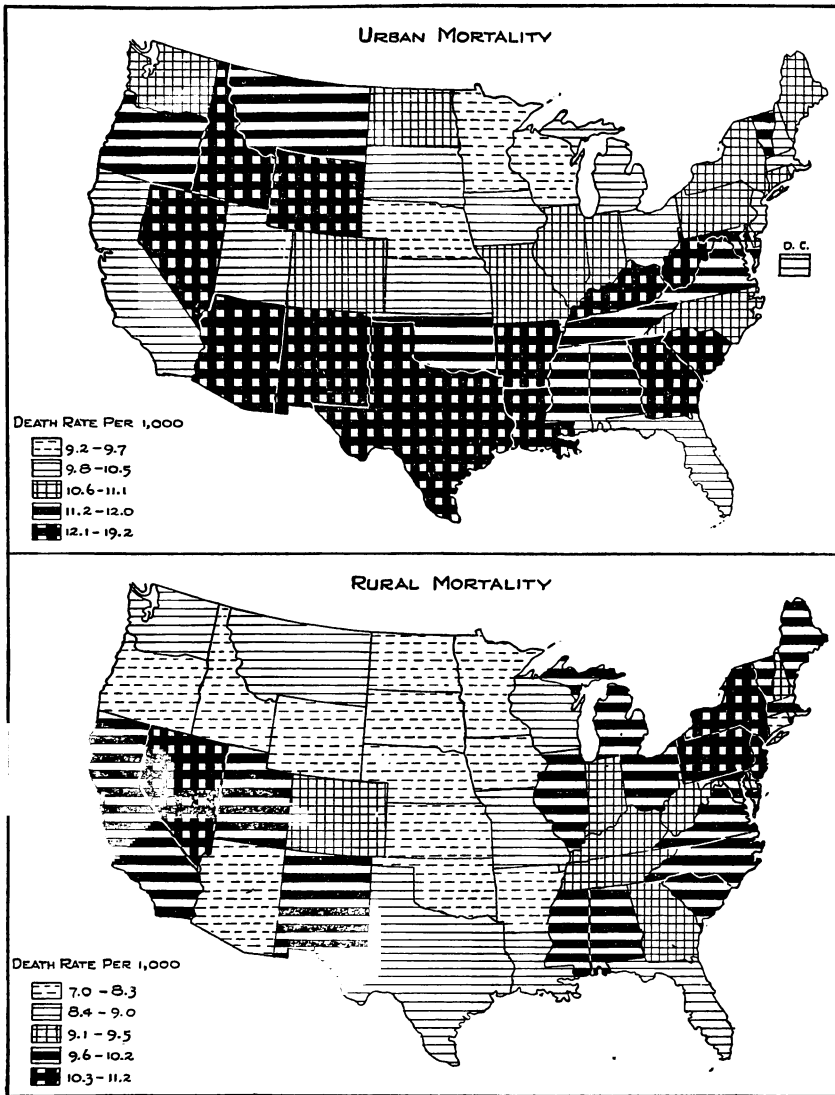


Fig. 5. Geographic variation in age-adjusted death rates in 1940 for the white population of urban and rural areas. Urban includes cities of 2,500 population or more.

lower. However, the states differ widely as to both urban and rural mortality and the pattern of variation is different.

The geographic variation of urban and of rural mortality for the white population of each state in 1940 is shown in Figure 5. States are grouped into five classes according to the percentage

deviation above or below the median rate,⁴ as previously described. The urban mortality, shown in the upper half of Figure 5, has a marked geographic pattern. All states in the North which are east of the Mountain region had average or lower rates, except Vermont. Only three states, Wisconsin, Minnesota, and Nebraska, had rates more than 10 per cent below the median rate. All states in the South, except Delaware, the District of Columbia, Florida, and North Carolina, had rates more than 2.5 per cent above the median urban rate, and seven of them had rates more than 10 per cent above the median. In the Mountain and Pacific area, states varied widely as to their urban mortality.

The geographic variation of rural mortality shown in the lower half of Figure 5 follows an east and west division rather than the north and south division of urban mortality. Higher than average rural rates are found in most of the states east of the Mississippi River and only four states west of the Mississippi (New Mexico, Utah, Nevada, and California) are in this category. Thus, rural death rates are more consistently high in the industrial states than are the urban death rates. The latter are relatively low in a considerable number of industrial states.

In order to study the possible relation of mortality to some of the characteristics of populations of individual states, correlation coefficients for death rates and a few selected indices were computed. Some of these correlations are sufficiently suggestive of the influence of certain factors on mortality to be helpful in interpreting some of the mortality variations. It must be emphasized that a significant correlation does not demonstrate a causal relation and must be interpreted with great caution.

The rural populations in different states vary tremendously in the percentage that is classified as nonfarm. The range is from 27 per cent in Mississippi to 83 per cent in Connecticut, Rhode Island, and New Jersey. If the rural death rate for the

⁴ Urban rates are for all places of 2,500 population or more, and the age-adjusted rates are taken from Table 7 of reference 3. Age-adjusted rural rates were computed for each state as described in footnote 2.

forty-eight states is correlated with the per cent of rural population that was nonfarm, a coefficient of $+ .476$ ($P < .001$) is obtained and it is highly significant. In other words, the greater the proportion of rural population that was nonfarm, the higher the rural death rate. A similar correlation for the non-white population in the twenty-eight states in which nonwhites were over 90 per cent Negroes gave a coefficient of $+ .623$ ($P < .001$). In the states west of the Mississippi, where low rural death rates were noted, the rural population is predominantly farm; in the east, especially northeast, the rural population is heavily weighted with nonfarm or small village populations and the mortality was relatively high. Since villages of less than 2,500 population apparently have a less favorable death rate than farm populations, even this degree of concentration of population seems to be unfavorable. However, an additional influence that may affect death rates of rural populations in the highly urban industrial states is the trend toward suburban living. Large numbers of persons live outside city limits and comprise a "fringe population" which finds employment in a nearby city or industrial area and in most respects is similar to the urban populations.

It is well known that the rural populations in various sections of the country differ greatly in their level of living or their socio-economic standards. For farm operators, an index of level of living based on money value of crops and several other items has been published by the Bureau of Agricultural Economics (9). On the assumption that the prosperity of farm communities closely parallels that of the farmers in the areas, this index of farm living was correlated with the white rural death rate for the thirty states in which the farm population was at least 45 per cent of the total rural population. The coefficient is $-.383$, only moderately high but statistically significant. When the correlation of the proportion of nonfarm families with the death rates in these thirty states is held constant, the coefficient for standard of living and the death rate is raised to $-.625$. Thus we have the suggestion of a second factor associated with

the death rates observed for rural populations, namely, the level of living for farm operators. So many conditions of living are associated with income that the specific factors of most importance in this relationship are not easily identified, but there are data to show that housing conditions, sanitary conveniences, medical care, and diets are less adequate in rural areas with low economic resources.

The white *urban* death rates (age adjusted) for forty-five states (Arizona, New Mexico, and Nevada excluded) were correlated with the average wage per male white worker who in 1940 received wages taxable for Federal Old Age and Survivors Insurance (10). The coefficient is $-.452$ ($P < .01$) and is statistically significant. This is high enough to suggest a moderate inverse relationship between wage levels and mortality. However, the wage level is highly correlated with the population per physician and per public health nurse in the state and is also associated with the quality of housing and of diet, and with indices of educational and cultural levels. Wages are the means by which the standard of living is modified, and carefully controlled investigations are required for an evaluation of the effect of separate socio-environmental factors on mortality.

MORTALITY BY AGE IN URBAN AND RURAL AREAS

Age-specific mortality by urbanization in the three broad regions of the United States may be analyzed by using life-table mortality for 1939 from the report mentioned above (7). The regions for which urban and rural experience may be compared are: (1) the North which includes the New England states, Middle Atlantic states, East and West North Central states; (2) the South which includes the South Atlantic division, East and West South Central states; and (3) the West, or Mountain and Pacific Coast states. For each region and urban class, the percentages of the life-table population dying within each of five age intervals were computed for each sex and a mortality rate for both sexes obtained by averaging the male and female rates.

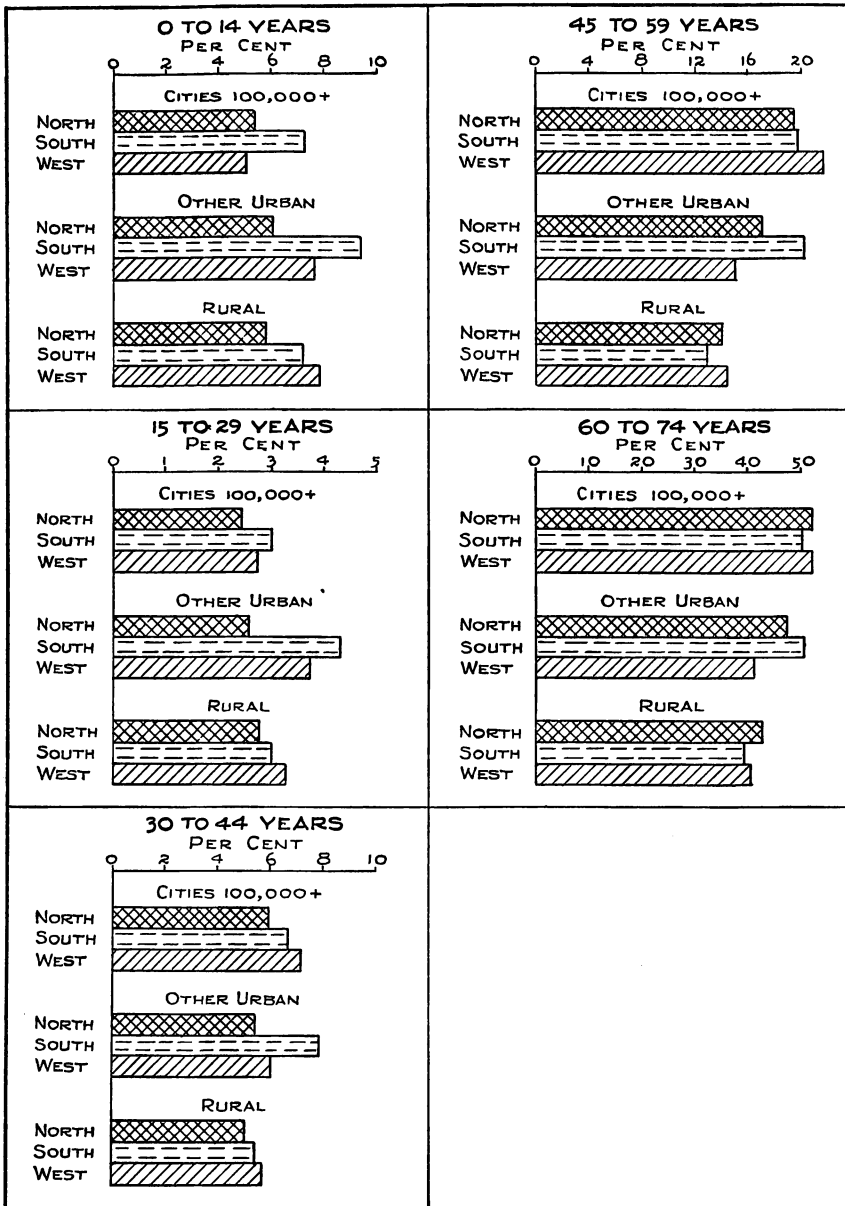


Fig. 6. Percentages of life-table population dying in specific fifteen-year age intervals compared for three regions of the United States for the white population of cities of 100,000 population or more, cities of 2,500 to 100,000 population, and of rural areas, 1939. Per cent dying is average of per cents for males and females.

Regional Comparison by Urban-Rural Class and Age. The

percentages of persons dying within a specified age interval in each of the two urban classes and in rural areas are compared for the three regions in Figure 6. The scale for percentages at each age period has been changed so that an equal distance between length of bars represents roughly equal percentage variation. The regional differences by urban class are not consistent for the various age periods and the three urban-rural classes do not show the same variation. The suggested pattern of variation may be summarized as follows:

1. Mortality is lowest in the North at each of the three fifteen-year age intervals from birth to age 45 years in rural areas, in small cities, and in cities of 100,000 population or more, with the exception that in large cities of the West mortality at ages 0 to 15 years is very slightly lower.

2. In the small cities, mortality is highest in the South at all five age periods and the largest regional differences are shown for this urban class. In large cities the highest mortality under age 30 is also in the South, but from 30 to 75 years mortality in the West is highest.

3. Rural mortality is highest in the West up to age 45 years, and thereafter the differences are small with minimum rates in the South.

4. The maximum regional variations are found for mortality in childhood and young adult ages.

Table 3. Age-specific death rates¹ per 1,000 population in 1940 in cities of 100,000 population or over and in rural areas of selected states² in four geographic areas.

GEOGRAPHIC AREA	CITIES 100,000 OR MORE			RURAL		
	Under 15 Years	15-44 Years	45-64 Years	Under 15 Years	15-44 Years	45-64 Years
North East	3.20	2.82	17.40	4.03	2.76	13.33
West North Central	2.80	2.17	12.70	2.94	1.95	9.01
South East	3.81	2.94	16.43	4.58	2.82	11.66
Pacific	3.17	2.87	15.44	3.69	2.94	12.61

¹ Rates for specific age groups were adjusted by age as follows: "Under 15 years" was adjusted for under 1 year, 1-4 years, and 5-14 years; "15-44 years" and "45-64 years" were adjusted for 10 year age groups. There was no adjustment for sex.

² For states included see page 353.

Since the North includes the West North Central states which have the lowest urban and rural mortality, the question arises whether the favorable mortality in the North is due to these states. In order to obtain some evidence on this point, Table 3 was prepared. For large cities and for rural communities, it compares the average death rates in 1940 of three age groups in selected states of four geographic areas. The areas and states included are: North East—Pennsylvania, Ohio, and Illinois; West North Central—Iowa, Minnesota, and Nebraska; South East—Alabama, Georgia, Tennessee, and Virginia; Pacific Coast—California, Oregon, and Washington. Rates for these West North Central states are much lower than those in any of the other areas for each age group both in the large cities and rural populations. Among the other three areas, differences in the death rates are less than those shown by the life-table mortality in 1939 for the three regions. However, in the large cities of the South East, mortality under 15 years of age was definitely higher than in the North East or the Pacific area, as was shown by the life-table mortality for the South. The only noteworthy shift in the relative position of geographic areas based on these selected states as compared with the larger regions is for the mortality under 15 years of age in the rural areas of the Pacific states which is lower than in either the North East or South East states, whereas the West region had the highest rate. Thus, although the lower mortality in the North is due to some extent to the low death rates in West North Central states, industrial states in the North East also have a favorable mortality among children and young adults.

Comparison of Urban-Rural Mortality Within Regions. Variation of mortality within regions according to degree of urbanization for specific sex and age groups is shown in Figure 7. Rural mortality for each age group has been taken as 1.00 and the ratio of mortality in each urban class to the rural rate has been plotted in Figure 7.

The age curve for ratios of mortality in large cities to that in rural areas is quite similar for all three regions. In the

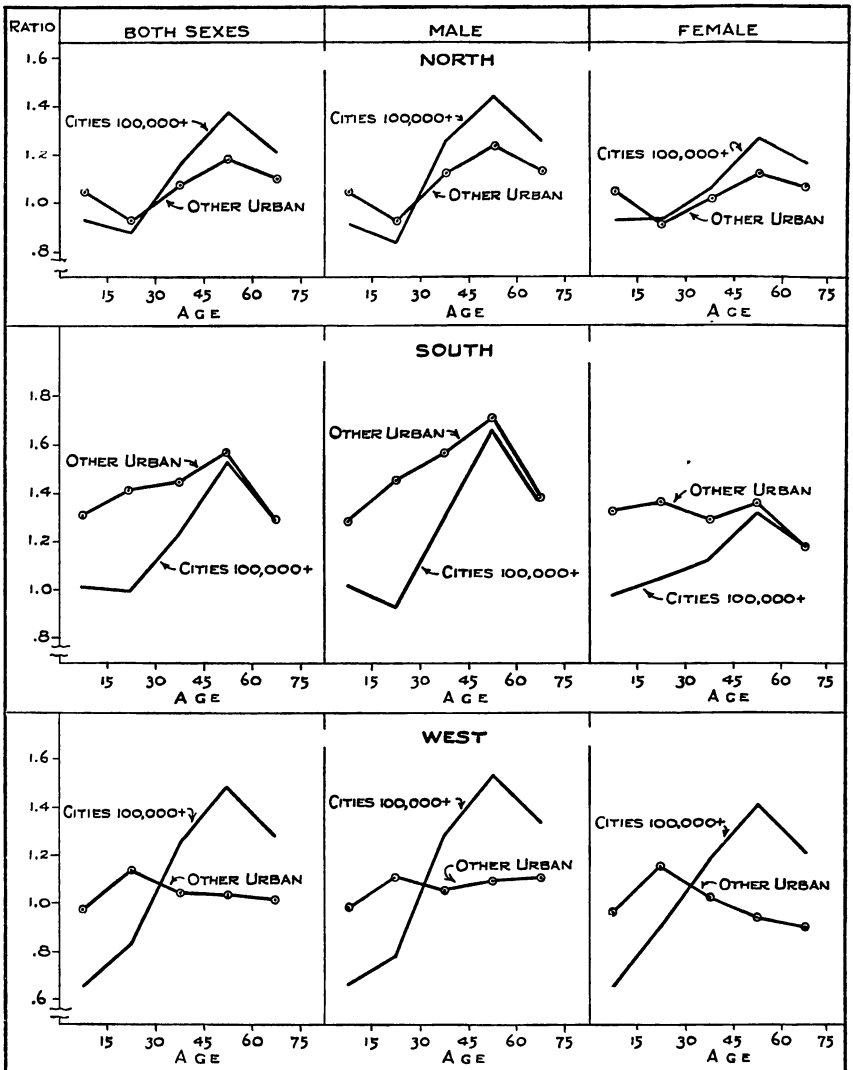


Fig. 7. Ratio of mortality in cities to rural mortality for the white population of three regions of the United States, 1939. Mortality is based on percentages of life-table population dying in fifteen-year age intervals, average of male and female per cents.

North and West, mortality at the two fifteen-year intervals under 30 years is lower than in rural areas, and in the South the rates are about equal. At all older age groups, the mortality is much higher in the large cities than in rural areas. The difference reaches a maximum at ages 45 to 60 years, and at this

age period the rate for large cities exceeds the rural rate by 38 per cent in the North, 49 per cent in the West, and 53 per cent in the South. The ratio curves by age for males and females separately are similar, but the mortality for males in large cities exceeds the rural mortality by greater percentages than does the mortality for females.

The mortality in small cities relative to rural mortality does not follow the age pattern shown by large cities and differs from region to region. In the North the mortality for the "other urban" class differs from rural mortality less than that of large cities at every age period. It is higher than the rural mortality at every age except 15 to 30 years, and the maximum difference occurs at ages 45 to 60 years with an excess of 19 per cent. In the West, mortality in small cities was slightly higher than in rural areas except under 15 years of age; the maximum difference of 14 per cent is for ages 15 to 30 years and at other age periods, including childhood, the difference varied from only 2 to 5 per cent. In the South, mortality in small cities was from 29 to 57 per cent above the rural mortality at the five age periods and was also much higher than in large cities for the three age groups from birth to 45 years.

In summary, this life-table mortality for 1939 indicates that urban conditions were associated with an unfavorable mortality for adults above 30 years of age and the unfavorable effects are more striking in the large cities except in the South where small cities had the higher mortality. On the other hand, it is interesting that large cities afforded the most favorable conditions for children and young adults, except in the South, and there the large city and rural mortality was equal.

These urban-rural differences in mortality for young people are evidence of the more effective control of diseases of childhood in cities than in the country. This is strikingly brought out if the corresponding comparison of proportions dying between birth and age 15 years is made for the years 1909-1911, using the life tables for urban and rural populations of the Original Registration States (8). In these years, 36 per cent

more persons died in cities between birth and 15 years of age than in rural areas. In 1939, only small cities in the South had any similar excess urban mortality in childhood.

For adults, conditions associated with urban life are nearly as unfavorable today compared with rural life as they were in 1910, although, of course, both urban and rural mortality have declined. For the United States, between age 45 to 60 years, life-table mortality in large cities in 1939 was 43 per cent higher than in rural areas compared with 54 per cent higher urban mortality in 1910. In the South, the urban excess was as high as in 1910. Since adult mortality has become our major health problem, the factors involved in high mortality for urban populations merit intensive study.

Sex Differences for Urban and Rural Mortality. It has been shown that the difference between male and female mortality has been increasing. It is of interest, therefore, to compare the sex ratios for life-table mortality in the three regions according to urbanization. The percentages by which male mortality exceeded female mortality are shown for the five fifteen-year age intervals in Figure 8. Variations in sex differences which seem relevant to this discussion may be briefly described as follows:

1. Under 15 years of age the percentage excess for male mortality varies little among regions or for urban-rural classes, the excess being from 21 to 29 per cent, although there were large differences in mortality by region and urbanization.

2. In both urban classes of all three regions the maximum excess mortality for males was at ages 45 to 60 years, which is the age group at which the greatest differences between urban and rural mortality is found within each region, except for small cities in the West.

3. At ages 60 to 75 years the excess mortality for males drops sharply, and it was less than in childhood except in the urban classes of the South and West.

4. Within each region the excess mortality for adult males in the rural area was less than in either urban class at each age interval except 15 to 30 years.

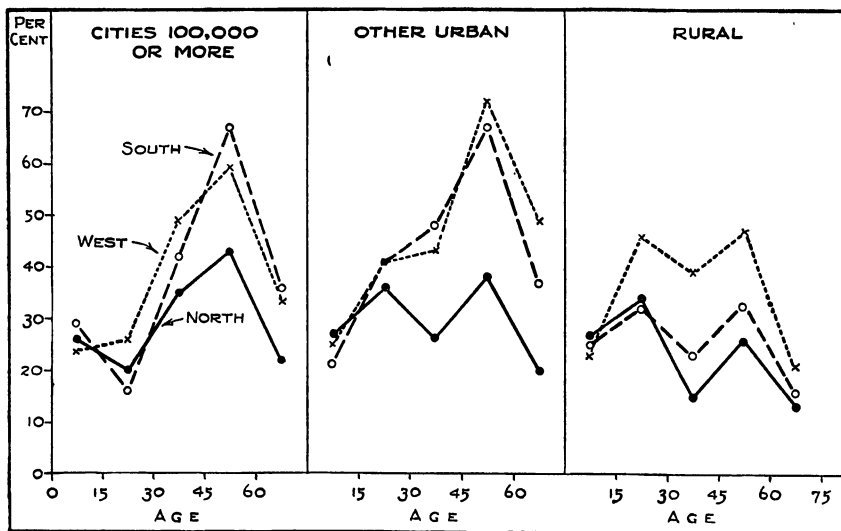


Fig. 8. Percentage excess in percentage of males in the life-table population dying in fifteen-year age intervals over percentage of females dying in the same age interval for urban and rural populations of the United States in three regions, 1939.

5. For each urban-rural class the excess mortality for males after age 29 years was least in the North.

In general, the specific regional, urban, and age classes which show a high sex-ratio for mortality are those which had relatively high death rates. In adult life, high mortality is associated with conditions which are more unfavorable to men than to women; or, stated in another way, the complex of factors which have brought about a marked decline in mortality has been more effective in postponing death for females than for males. In childhood and early adult life, the sexes have shared more equally in the decrease in mortality. It seems apparent that urban conditions are especially unfavorable to males and this suggests that factors associated with occupation or working conditions, and perhaps the strain of earning the living, may be involved.

Correlation coefficients were computed to test the association between the sex-ratio for mortality of the total white population of each state and several indices descriptive of the population for which data were available. There was no sig-

nificant correlation between the sex-ratio and an economic index for states based on a weighted average of wages per worker and rural farm operator level of living;⁵ and no significant correlation between the sex-ratio and per cent of males engaged in manufacturing and mining. A fairly high positive correlation (+.456, $P < .01$) was obtained for the sex-ratio and the percentage *increase* in the urban population between 1920 and 1940. One can only speculate as to the interpretation of this association, but it is certainly suggestive that recent, rapid growth of cities has brought with it unfavorable mortality experience for males. Whether the new urban workers are those most affected is unknown.

Since urbanization is consistently associated with high sex-ratios for adult mortality, it seems safe to conclude that the steadily rising percentage of the total population that lives in cities is one factor in the increasing excess mortality of males as compared with females. On the other hand, there is evidence that the excess mortality for males has *increased* both in urban and rural areas. In Table 4, the percentage excess in life-table mortality in 1909-1911 for rural and urban males in the Original

Table 4. Ratio of the per cent of white males in the life-table population dying within a specified age interval to the per cent of white females dying in the same age interval for urban and rural population in 1909-1911¹ and in 1939.

AGE INTERVAL	1939—NORTH REGION		1909-1911 ¹	1939 RURAL NORTH	1909-1911 RURAL ¹
	Cities 100,000 or More	Cities 2,500- 100,000	Cities 10,000 or More		
<i>Years</i>					
0-14	1.26	1.27	1.15	1.27	1.17
15-29	1.20	1.34	1.13	1.36	1.03
30-44	1.35	1.15	1.28	1.26	1.04
45-59	1.22	1.26	1.25	1.38	1.09
60-74	1.43	1.13	1.12	1.20	1.07

¹ Original Death Registration States.

⁵ For each state the average wage per worker (10) and the index of farm level of living (9) was weighted by the per cent of total population in the state which was classified as nonfarm and farm, respectively.

Death Registration States is compared with similar data for 1939 in the North.⁶ For each age interval the excess mortality for males was greater in 1939 than in 1909–1911 both for cities and rural communities. Therefore, the increase in the excess mortality for males in the total population cannot be explained entirely on the basis of the increase in the percentage of population that is urban.

CAUSE OF DEATH

There is time for only a brief reference to specific causes of death but a comparison of death rates for a few causes in different geographic areas affords some significant information on the relative level of control of preventable diseases and on the importance of the degenerative diseases in the task of postponing death among the adult population. For the comparisons of death rates from specific causes, average rates were computed for a few states in four geographic areas, as described on page 353, for each sex in the urban and rural population. Rates were adjusted for differences in the age distribution of the population by the indirect method.⁷ The mortality from specific causes is shown in Table 5 and in Figures 9 and 10.

Relatively high rates in the South East area for both urban and rural populations are shown in Table 5 for infant and maternal mortality, typhoid fever, malaria, communicable diseases of childhood, and pellagra. Mortality from these causes is preventable in large part, and this high mortality in the South East is indicative of inadequate health services

⁶ This region is more comparable with the Original Registration States than the total United States, but sex-ratios in 1939 were even higher for the United States than for the North region.

⁷ The indirect method used to adjust for age was as follows: (1) the total population by age for each specific subdivision (sex, urban or rural, geographic area) was obtained; (2) the population in each age group for a particular subdivision was multiplied by the age-specific death rate for the United States for the specific cause of death; (3) the products (expected number of deaths for a specific age group) were summed to obtain the number of deaths, all ages, that would be expected if the United States rate applied and this total was divided by the total population for the particular subdivision to obtain the expected death rate; (4) the ratio of the United States rate to the computed expected rate was obtained, and (5) the actual rate for the particular subdivision was multiplied by the ratio to obtain the age-adjusted rate.

and low standards of living. In the other three geographic areas, urban mortality from this list of causes was fairly similar, with the exception of pellagra mortality in the Pacific Coast states which was three and a half times that in the North East and West North Central area, although less than one-seventh of the urban death rate in the South East. Rural mortality was more variable than urban mortality from these causes. The North East states had less favorable rural death rates than either the West Central states or the Pacific Coast states for infant and maternal mortality, but for communicable diseases, mortality was similar in the North East and Pacific Coast states and higher than in the rural West North Central states. Only in the West North Central states was the rural death rate from these causes consistently as low or lower than the urban rates.

Table 5. Infant and maternal mortality and crude death rate per 100,000 population from selected causes for urban and rural populations of representative states¹ of four geographic areas, 1940.

CAUSE OF DEATH AND URBAN-RURAL CLASS	NORTH EAST	SOUTH EAST	WEST NORTH CENTRAL	PACIFIC COAST
<i>Infant Deaths—Per 1,000 Live Births</i>				
Urban	37.2	45.4	38.4	35.6
Rural	45.4	52.4	31.2	39.4
<i>Puerperal Deaths—Per 1,000 Live Births</i>				
Urban	3.0	3.5	3.3	2.8
Rural	3.0	4.1	2.4	2.3
<i>Typhoid Fever</i>				
Urban	.48	1.1	.51	.47
Rural	.82	1.5	.25	.80
<i>Scarlet Fever, Whooping Cough, Diphtheria</i>				
Urban	2.0	4.3	2.2	2.2
Rural	3.4	6.5	2.1	3.2
<i>Malaria</i>				
Urban	.09	1.2	0	.08
Rural	.09	2.3	.05	.03
<i>Pellagra</i>				
Urban	.14	3.8	.14	.52
Rural	.20	5.0	.14	.46

¹ States included are: North East—Illinois, Ohio, Pennsylvania; South East—Alabama, Georgia, Tennessee, Virginia; West North Central—Iowa, Minnesota, Nebraska; Pacific Coast—California, Oregon, Washington.

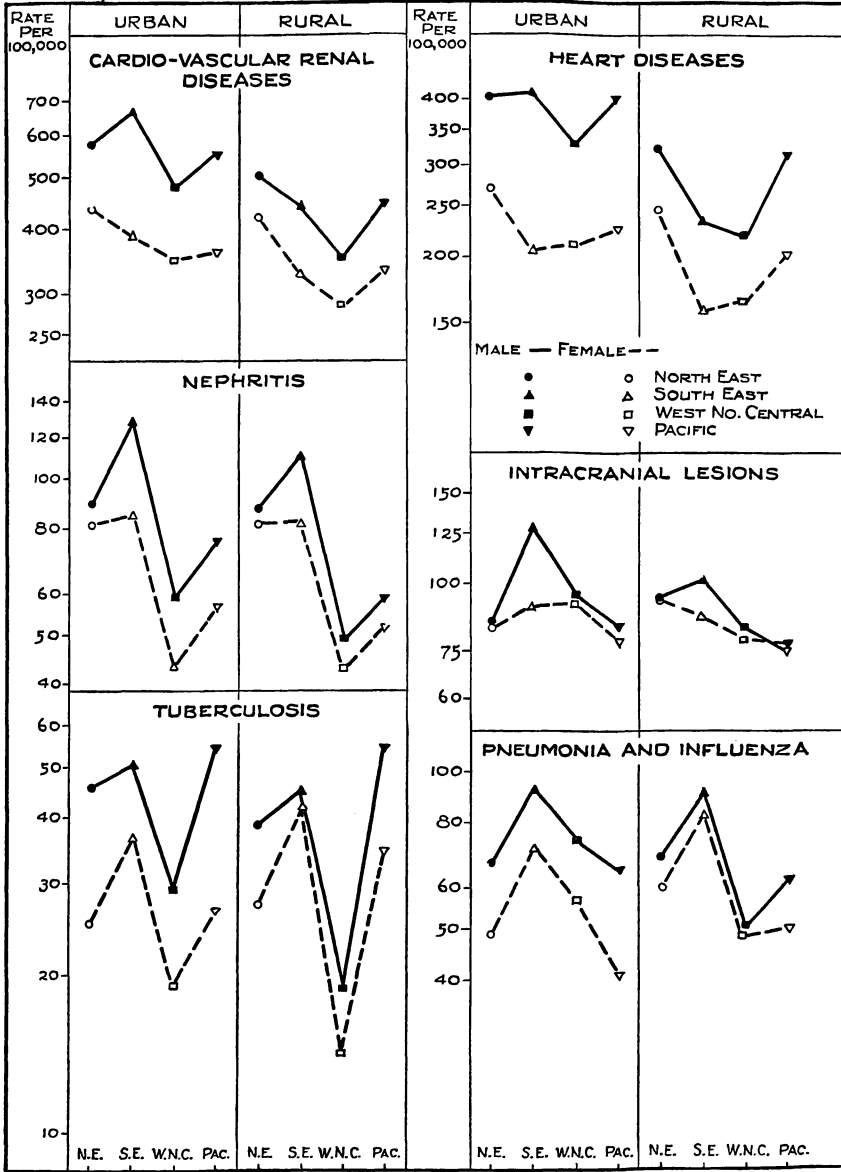


Fig. 9. Death rates in 1940 from several major causes of death for males and females in urban and rural areas of selected states in four geographic areas (see table 5, footnote). Death rates are adjusted for age by the indirect method. See footnote 7. Vertical scale is logarithmic.

Mortality from the major causes of death among adults is shown in Figures 9 and 10. In these charts the vertical scale

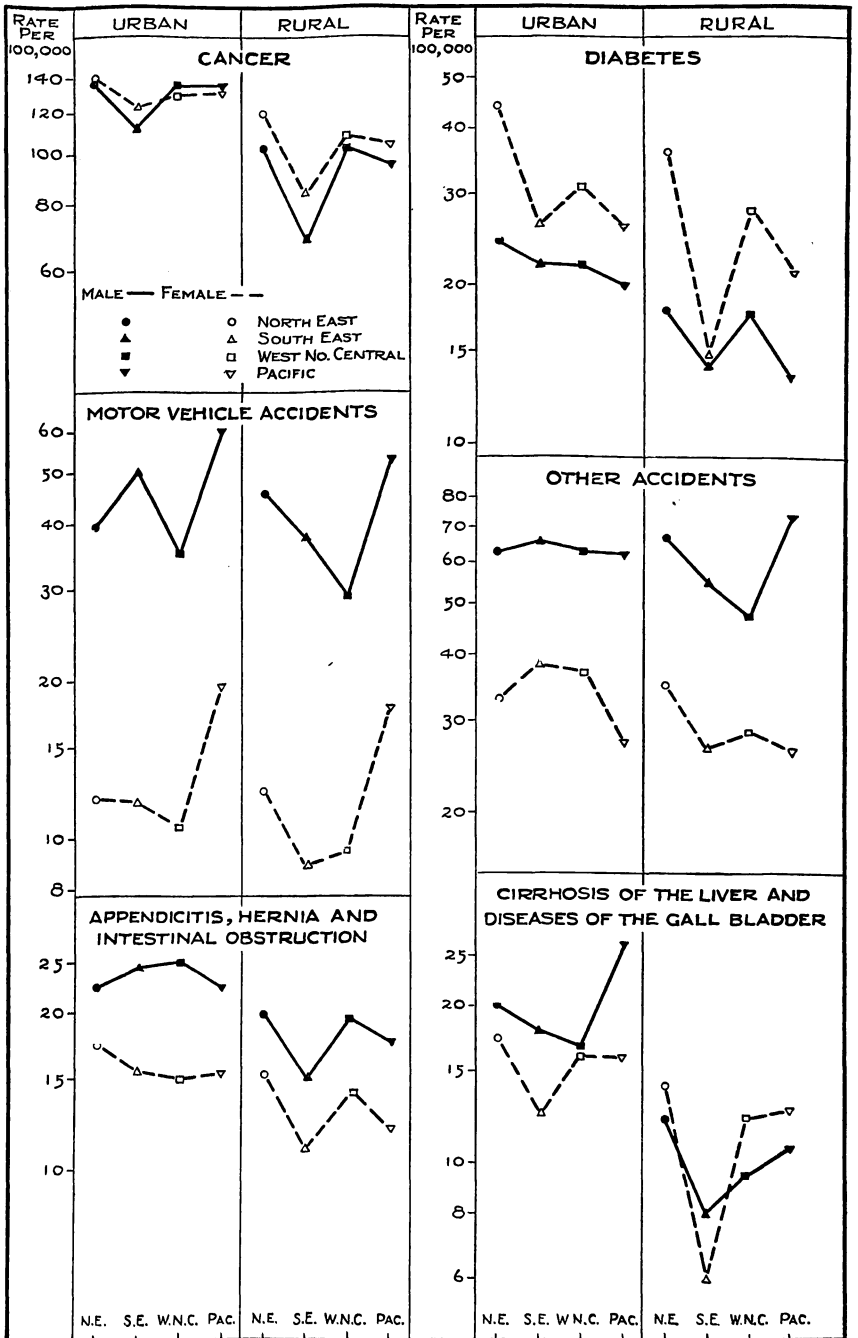


Fig. 10. Death rates in 1940 from several major causes of death for males and females in urban and rural areas of selected states in four geographic areas (see table 5, footnote). Death rates are adjusted for age by the indirect method. See footnote 7. Vertical scale is logarithmic.

(rate scale) is logarithmic and equal vertical distances between points represent equal percentage differences.

For nearly every cause, or group of causes, the death rate for males is higher than that for females, both for urban and rural populations of each geographic area. The differences in the rates by sex are usually greater in urban than in rural areas. Diseases which show the most marked excess mortality for males are the cardiovascular renal diseases, especially heart diseases, tuberculosis, pneumonia and influenza, diseases of the intestines, including appendicitis, hernia, and obstruction. Accidental deaths, especially those due to motor vehicles, show a greater percentage difference in mortality by sex than any of the diseases, both in urban and rural areas, and the actual differences in rates for the two sexes for accidental deaths from motor vehicles and other accidents are exceeded only by the cardiovascular renal diseases.

Higher mortality among females is found for diabetes in urban and rural populations of each of the four geographic areas. Cancer mortality also is somewhat greater for females than males in the rural population of each area, and in the urban population of the North East and South East states but not of the West North Central and Pacific states. The mortality from cirrhosis of the liver and diseases of the gall bladder combined is higher among females in rural sections of each area, except the South East, but is higher for males in urban sections. However, cirrhosis of the liver, separately, causes more deaths among males and gall bladder diseases cause more deaths among females.

Marked geographic differences are shown for most of these causes. Variations of special interest are: (1) the high male urban death rate from cardiovascular diseases in the South East states where total urban mortality has been shown to be relatively high; (2) a maximum death rate from influenza and pneumonia among both males and females in urban and rural areas of the South East; (3) the high tuberculosis rate for males and females in the South East states and in the

Pacific states, especially among males; and (4) the high accident rate for the Pacific Coast states.

Little is known concerning the effect of social or environmental factors on these causes, except tuberculosis and pneumonia. These two diseases are infectious and a relation to low standards of living, crowding, density of population, and some other conditions has been shown by special studies. The causes of accidents are being intensively studied as a basis for their prevention. Until quite recently the relation of environmental factors to the degenerative diseases has not received much attention. Their epidemiology, in the broadest sense, needs to be studied but the usual published mortality data can afford little more than some clues to be followed up by special investigations.

CONCLUSION

This discussion has considered only the broad pattern of recent mortality variations in this country. Mortality within limited sections of large cities, *i.e.*, for census tracts or groupings of such tracts, also has been most helpful in showing the association of poor living conditions with high death rates, and data of this type will be discussed by another speaker. Variations in mortality for different occupational groups also will be presented in another paper.

Some general conclusions that may be drawn from the data presented in the foregoing discussion are as follows:

1. Reductions in mortality have been greatest for children and young adults in large urban centers, where medical and public health services have had the greatest development and are most available.
2. Preventable mortality among children is relatively high in rural communities of most sections of the United States and is high in the smaller cities of the South.
3. In middle life, urban males have a marked excess mortality as compared with females, and the difference has been increasing. Although the excess mortality for rural males is less, it has been increasing also.

4. Geographic and urban-rural variations in adult mortality and in the differences in the sex-ratio for adult mortality suggest the importance of socio-environmental factors.

5. The causes of premature breakdown in middle life, especially for males, needs to be studied more intensively.

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