of the 2 preceding years, the number of cases was slightly above the 1933–37 median. All other areas reported a relatively low incidence. The current incidence for the country as a whole is only about 10 percent above the average (approximately 200 cases) for the years 1932, 1933, and 1934, years in which the incidence of meningitis was unusually low.

### MORTALITY, ALL CAUSES

The average death rate from all causes in large cities for the 4 weeks ending June 18, based on data received from the Bureau of the Census, was 10.8 per 1,000 inhabitants (annual basis). The average rate for the corresponding period in the 5 preceding years was 13.9. The current rate is the lowest since 1933, when a rate of 10.6 was recorded for this period.

## MORTALITY DURING PERIODS OF EXCESSIVE TEMPERATURE [1]

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CONTENTS



### INTRODUCTION

Weekly mortality from all causes in a particular locality frequently increases during the summer months to as much as four times the expected mortality for that season of the year (fig. 1.) That these sharp increases in mortality occur during weeks of exceptionally high temperature has been pointed out in a short note on mortality in the drought area in 1934 (*3*), and in a release from the Bureau of the Census which deals with mortality in 86 large cities during the heat waves of the summers of 1934 and 1936 (*8*). The peak of mortality from heat stroke in Kansas during June, July, and August of 1934 followed approximately 7 days of exceptionally high temperatures as shown by daily records of deaths and temperatures for that period (*1*).

In a study made by Shattuck and Hilferty (*9*), of deaths from excessive heat, in the expanding death registration area, 1900–28,

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[2] Appreciation is expressed to Drs. S. D. Collins and L. J. Reed for suggestions and advice in the preparation of this paper.

and in Massachusetts in particular, it was shown that (*a*) the geographic distribution of deaths from excessive heat varies from year to year; (*b*) in years of high mortality from excessive heat, death rates in urban areas are higher than in rural areas; (*c*) mortality from excessive heat is relatively high during the first year of life, low thereafter up to the age of 20, rises gradually to the age of 70, and increases sharply after 70 years; (*d*) mortality among males and females is about equal under 20 years of age and over 70 years, but between 20 and 70 years of age rates for males are about three times those for females (Massachusetts); and (*e*) "meteorological data from Massachusetts for 1901, 1911, 1917, and 1925 indicate that unusually high temperature, persisting for several days at a time, was a factor of chief importance."

In a later analysis (*10*), made by the same authors, of death certificates in Massachusetts for 1911, when deaths from heat were remarkably numerous (1,105 deaths), the following conclusions were reached: (*a*) Considering all deaths from heat,[3] whether from heat stroke or from heat exhaustion and whether recorded on the certificate as a death from heat as a primary or secondary cause, death rates from heat effects increased markedly with increase in size of city; (*b*) deaths from primary sunstroke were significantly higher in Boston than in smaller towns and rural areas, and deaths primarily due to heat exhaustion did not vary with size of city; (*c*) "the type of response shows a definite correlation with age; sunstroke is far more common than exhaustion between the ages of 20 and 59, but exhaustion predominates after 60 years of age;" (*d*) among deaths in which heat is recorded as a secondary cause, exhaustion is far more common than sunstroke; and (*e*) among the causes associated with heat as a cause of death, diseases of the circulatory system stand first by a large margin. From this fact the authors conclude "that the circulatory system suffers particularly from the effects of excessive heat, and that the correlation of deaths from excessive heat with increasing age is due to the progressive diminution of adaptability of the circulatory system to stress of this kind."

In accordance with the Manual of Joint Causes of Death (*6*), the Bureau of the Census tabulates "excessive heat" as the primary cause of death in practically all cases in which excessive heat and some other cause of death are entered on the same certificate. Nearly all of the causes included in the remainder of the group of "external causes" are preferred over heat as the primary cause. Records of primary causes of death as usually tabulated and published would therefore show

[3] Two types of response to heat effects are recognized although their basic etiology may be the same (1) cases of "sun stroke" or "heat stroke" which are characterized by high body temperature and hot dry skin, and (2) cases of "heat exhaustion" in which the temperature is practically normal, the skin moist, and the circulatory disturbances like those of shock.

practically all deaths in which heat was indicated on the death certificate as a cause.

Annual rates of mortality from excessive heat in the registration States of 1920, from 1920 to 1934 (*7*), were as follows:

| Year | Rate per 100,000 | Year | Rate per 100,000 | Year | Rate per 100,000 |
|---|---|---|---|---|---|
| 1920 | 0.31 | 1925 | 1.36 | 1930 | 1.21 |
| 1921 | 1.07 | 1926 | .63 | 1931 | 2.30 |
| 1922 | .45 | 1927 | .48 | 1932 | .51 |
| 1923 | .55 | 1928 | .57 | 1933 | .81 |
| 1924 | .41 | 1929 | .41 | 1934 | 2.64 |

In 1921, 1925, 1930, 1931, and 1934 deaths from excessive heat were obviously well above the average in that area.

In Kansas, which was in the center of the drought area of 1934, there were reported 291 deaths from excessive heat for that year, as compared with 30 in 1933 (*1*); 159 of the 291 deaths occurred during the month of July. The total number of deaths reported in Kansas during July of 1934 was 2,175, or an excess of 604 deaths over the number reported in July 1933 (1,571 deaths) (*7*). The total of 159 deaths certified as due to excessive heat for July 1934 thus amounts to only 26 percent of the 604 excess deaths from all causes during July; the other 74 percent were deaths in which unfavorable weather was probably a contributory factor but with no mention of excessive heat on the certificate; if mention had been made, the death would have been tabulated as due to excessive heat.

The heat waves of both 1934 and 1936 severely affected mortality in the North Central section of the country. Specific death rates for the States of Kansas for July 1934 (*7*) and Illinois for July 1936 (*5*) show the distribution of excess mortality among specific causes during those years (table 1). Death rates for July 1933 in Kansas and for July 1935 in Illinois are included in table 1 for comparison with the corresponding rates for July of 1934 and 1936. Exclusive of "external causes," which includes "excessive heat," the largest excesses occurred in rates for cerebral hemorrhage, diseases of the heart, and nephritis. Rates for pneumonia and diabetes also show some excess. No other single cause as tabulated in the abridged International List of Causes of Death shows an outstanding increase. The greatest actual excess mortality occurred in diseases of the heart in both Kansas in 1934 and in Illinois in 1936; and the largest percentage excess was in the rate for pneumonia for Kansas, and in diseases of the heart for Illinois in the respective years.

Since approximately 75 percent of the excess deaths during periods of extremely high temperature are not certified and not tabulated as due to "excessive heat," the excess rate for all causes is a better index of the total mortality associated with weather conditions than deaths

certified as due specifically to excessive heat. Among the various factors which make up the phenomenon of weather, temperature undoubtedly exerts the greatest influence on mortality, although humidity and wind velocity probably are a part of the unfavorable weather conditions. With respect to animal experimentation, high humidity combined with high temperature is known to increase the effects of heat (*4*).

TABLE 1.—*Monthly death rate from specific causes in Kansas for July 1933 and 1934, and in Illinois for July 1935 and 1936*

| Diagnosis | Kansas | | Illinois | | Excess in the annual rate for— | |
|---|---|---|---|---|---|---|
| | 1933 | 1934 | 1935 | 1936 | July 1934 over the rate for July 1933 in Kansas | July 1936 over the rate for July 1935 in Illinois |
| | Death rate per 100,000 population (annual basis) | | | | | |
| All causes | 988.1 | 1,369.5 | 1,013.2 | 1,414.3 | +381.4 | +401.1 |
| Tuberculosis, all forms | 41.5 | 30.2 | 55.0 | 56.9 | −11.3 | +1.9 |
| Diabetes mellitus | 15.7 | 26.4 | 23.3 | 30.9 | +10.7 | +7.6 |
| Cerebral hemorrhage and softening | 78.0 | 120.3 | 61.8 | 86.0 | +42.3 | +24.2 |
| Diseases of the heart | 210.7 | 258.2 | 247.8 | 348.9 | +47.5 | +101.1 |
| Pneumonia, all forms | 12.6 | 22.0 | 36.1 | 44.0 | +9.4 | +7.9 |
| Diarrhea and enteritis (under 2 years) | 15.1 | 17.0 | 11.3 | 9.2 | +1.9 | −2.1 |
| Nephritis | 80.5 | 118.4 | 89.6 | 113.3 | +37.9 | +23.7 |
| Puerperal state | 10.1 | 10.1 | 7.1 | 7.1 | 0 | 0 |
| Automobile accidents | 40.3 | 34.0 | 29.2 | 31.4 | −6.3 | +2.2 |
| Other external causes | 69.2 | 164.3 | 452.0 | 686.6 | +95.1 | +234.6 |
| All other causes | 414.5 | 568.6 | | | +154.1 | |

SOURCE OF THE DATA

The data for this study are from the two following sources: (*a*) Weekly Rates of Mortality from all Causes in 86 Large Cities,[4] as published in the Weekly Health Index, issued by the Bureau of the Census, 1920–37 (*11*), and (*b*) Daily Maximum Temperatures, as published in Climatological Data for the United States, by Sections, issued by the United States Weather Bureau (*2*).

In order to compare actual death rates and maximum temperatures with corresponding normals, averages have been set up which represent as nearly as possible the normal or expected rates and temperatures for corresponding weeks of the year. The normal or expected death rate for individual cities for years prior to 1930 is a 3-week moving average of the mean of the death rates for corresponding weeks of the years 1924, 1926, and 1927, and for the years 1930–37 it is a similar average for the corresponding weeks of the years 1932, 1933, and 1935. In the years on which the norm is based, little or no increase in weekly mortality rates occurred during the summer weeks (fig. 1).

[4] The 86 cities are cities of 100,000 or more population in 1930, except Waterbury, Conn. (99,902) and Schenectady, N. Y. (95,692).

The weekly mean maximum temperature is an average of the seven daily maximum temperatures. The norm of maximum temperatures for individual cities was obtained from the Weather Bureau, and is an average of daily maximum temperatures over a period of 40–60 years.[5] In a few instances in which temperature norms were not available for a particular city, the record of both the actual and normal temperatures for a nearby city have been substituted in order to make use of the total number of cities for which weekly mortality records were obtainable.[6]

MORTALITY IN A TOTAL OF 86 LARGE CITIES IN THE SUMMERS OF 1925–37

Weekly mortality rates from all causes for 86 large cities during the months of May, June, July, August, and the first part of September of the years 1925 and 1930–37 are shown in figure 1. In 5 of these 9 years there are clearly defined peaks which occurred in the weeks ended June 13, 1925, July 4, 1931, July 28, 1934, July 18, 1936, and July 17, 1937. Slight increases in mortality occurred during July in 1930 and 1932 and during the first week of August 1933. During the summer of 1935, however, and the summers of 1926–29, which are not included in figure 1, weekly rates of mortality from all causes did not show any marked deviations from normal. The week of maximum mortality occurred in July in six of the years shown in figure 1, and during the first part of June and the first part of August, respectively, in two other years (fig. 1).

A comparison of maximum summer rates with a summer normal and with a normal for January, in all cities combined, is as follows:

| Week ended— | Death rate per 1,000 population (annual basis) | |
|---|---|---|
| | Actual rate | Normal rate |
| July 4, 1931 | 12.5 | 10.2 |
| July 28, 1934 | 12.3 | 10.0 |
| July 18, 1936 | 17.0 | 10.1 |
| July 17, 1937 | 12.3 | 10.0 |
| Normal for January [1] | 12.6 | ---------- |

[1] Based on the 4 weeks ended Jan. 27, 1934, which was a year relatively free from influenza mortality.

[5] Average daily maximum temperatures for the years for which records are obtainable in individual cities are not published regularly, but were generously supplied by the Weather Bureau for this purpose.

[6] The following substitutions of temperature records were made: Boston, Mass., for Cambridge, Somerville, Lowell, and Lynn; Providence, R. I., for Fall River and New Bedford, Mass.; Hartford, Conn., for Springfield and Worcester, Mass., and Waterbury, Conn.; New Haven, Conn., for Bridgeport; New York, N. Y., for Yonkers, N. Y., and Jersey City, Newark, and Paterson, N. J.; Philadelphia, Pa., for Camden, N. J., and Wilmington, Del.; Albany, N. Y., for Schenectady; Syracuse, N. Y., for Utica; Pittsburgh, Pa., for Akron, Canton, and Youngstown, Ohio; Fort Wayne, Ind., for South Bend; Lansing, Mich., for Flint; Minneapolis, Minn., for St. Paul; Kansas City, Mo., for Kansas City, Kans.; Fort Worth, Tex., for Dallas; Seattle, Wash., for Tacoma; San Francisco, Calif., for Oakland; Los Angeles, Calif., for Long Beach.

During 3 of the 4 years the maximum summer rate was about equivalent to a normal January rate and exceeded it in 1936 by 4.4 per 1,000.

The weekly rates shown in figure 1 are weighted averages of the rates in the total number of cities, and thus the size of the death rate

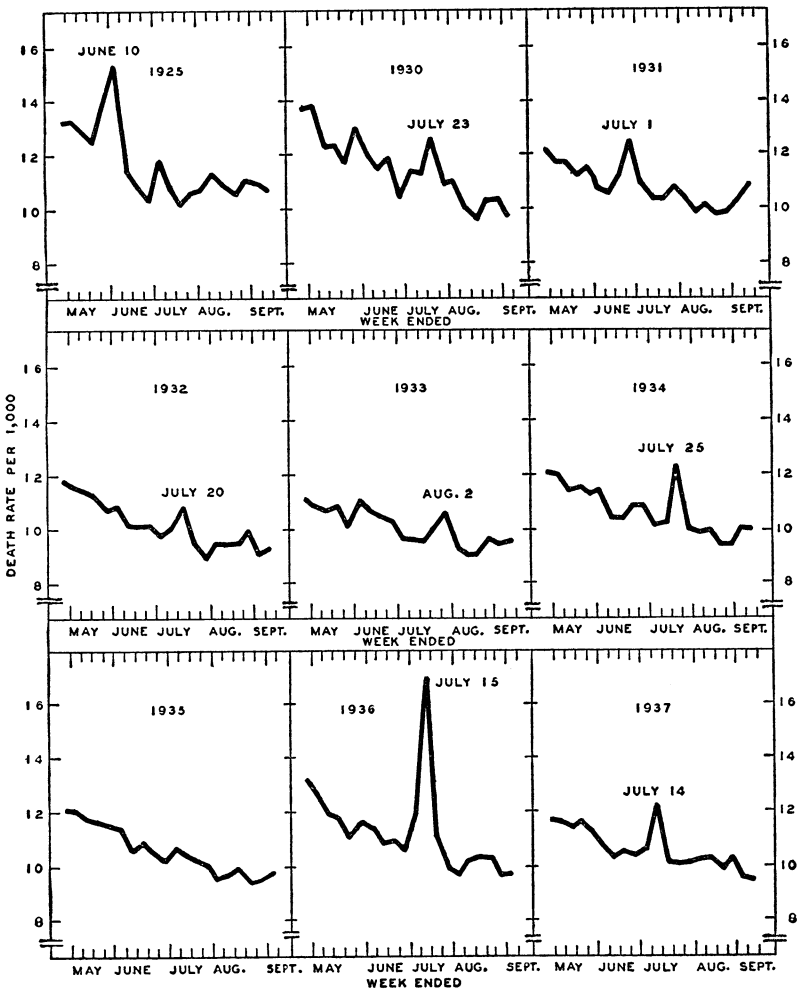


FIGURE 1.—Weekly death rate from all causes (annual basis) in about 86 large cities of the United States for 20 summer weeks of the years 1925, 1930–37. The dates are as of Wednesday of the peak weeks. (Rates from the Weekly Health Index, U. S. Bureau of the Census.)

in the peak week is influenced by the area which was most severely affected. As will be shown later, the area of high mortality was largely confined to the eastern coast cities in 1925 and 1937, and to the North Central section in 1931 and 1934. Although the rates for the affected individual cities in 1934 were greater than similar rates in

1937,[7] the rise in the curve for all cities combined is about as great in 1937 as in 1934, owing to the concentration of the population in the East, which was the area of high mortality in 1937.

### GEOGRAPHIC DISTRIBUTION OF EXCESS MORTALITY

Figure 2 is a spot map on which are located areas with marked excess mortality; it gives some idea of the severity and extent of the different periods of excess mortality. Excess mortality as represented in this figure is the sum of the excess in the annual rates for the 3 weeks which center on the peak week for all cities combined. Dots represent cities with an excess of 10 or more per 1,000; circles enclosing a cross, an excess of 5 to 9 per 1,000; and plain circles, an excess of less than 5 per 1,000. The sum of the excess for 3 weeks is used because the maximum excess does not usually occur in the same week in each section of the country. The 86 cities include 26 cities in the North Atlantic region, 35 cities in the North Central, 14 cities in the Southern, and 11 cities in the Western region.[8]

In 1925 (fig. 2, top) the 10 cities with an excess of 10 or more per 1,000 for the 3 weeks ended June 20 were all located in the North Atlantic area. In the same region 7 other cities had a 3-week excess of 5 to 9 per 1,000, and only 6 of the 23 North Atlantic cities had a 3-week excess of less than 5 per 1,000. In the North Central area eight cities also showed a 3-week excess of 5 to 9 per 1,000; with the exception of St. Paul, these eight cities were confined to the eastern part of the North Central area. Four cities in the Southern region and two in the Western had an excess of 5 to 9 per 1,000. The excess mortality in the North Atlantic cities occurred mainly during the week ended June 13, in the North Central during the week ended June 6, and in the Texas cities during the week ended June 20.

During the summer weeks of 1930, 1932, and 1933 the curve for all cities combined (fig. 1) shows only a slight excess mortality. These years have been omitted from figure 2. In 1930 there were 8 cities with an excess of 10 or more per 1,000 for the 3 weeks ended July 26,

[7] The maximum rate in the summer of 1925 was that for Trenton, N. J., 27.3 per 1,000; in 1931 for Peoria, Ill., 28.4 per 1,000; in 1934 for St. Louis, Mo., 34.0 per 1,000; in 1936 for Peoria, Ill., 46.4 per 1,000; and in 1937 for Fall River, Mass., 19.3 per 1,000.

[8] *North Atlantic:* Boston, Cambridge, Fall River, Lowell, Lynn, New Bedford, Somerville, Springfield, and Worcester, Mass.; Providence, R. I.; Bridgeport, Hartford, New Haven, and Waterbury, Conn.; Camden, Jersey City, Newark, Paterson, and Trenton, N. J.; New York and Yonkers, N. Y.; Philadelphia, Pa.; Wilmington, Del.; Baltimore, Md.; District of Columbia; and Richmond, Va.

*North Central:* Albany, Buffalo, Rochester, Schenectady, Syracuse, and Utica, N. Y.; Erie and Pittsburgh, Pa.; Akron, Canton, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown, Ohio; Evansville, Fort Wayne, Indianapolis, and South Bend, Ind.; Chicago and Peoria, Ill.; Louisville, Ky.; Detroit, Flint, and Grand Rapids, Mich.; Milwaukee, Wis.; Duluth, Minneapolis, and St. Paul, Minn.; Des Moines, Iowa; Kansas City and St. Louis, Mo.; Omaha, Nebr.; and Kansas City, Kans.

*Southern:* Knoxville, Memphis, and Nashville, Tenn.; Atlanta, Ga.; Birmingham, Ala.; Miami and Tampa, Fla.; New Orleans, La.; Oklahoma City, Okla.; and Dallas, El Paso, Fort Worth, Houston, and San Antonio, Tex.

*Western:* Denver, Colo.; Salt Lake City, Utah; Seattle, Spokane, and Tacoma, Wash.; Portland, Oreg.; and Long Beach, Los Angeles, Oakland, San Diego, and San Francisco, Calif.

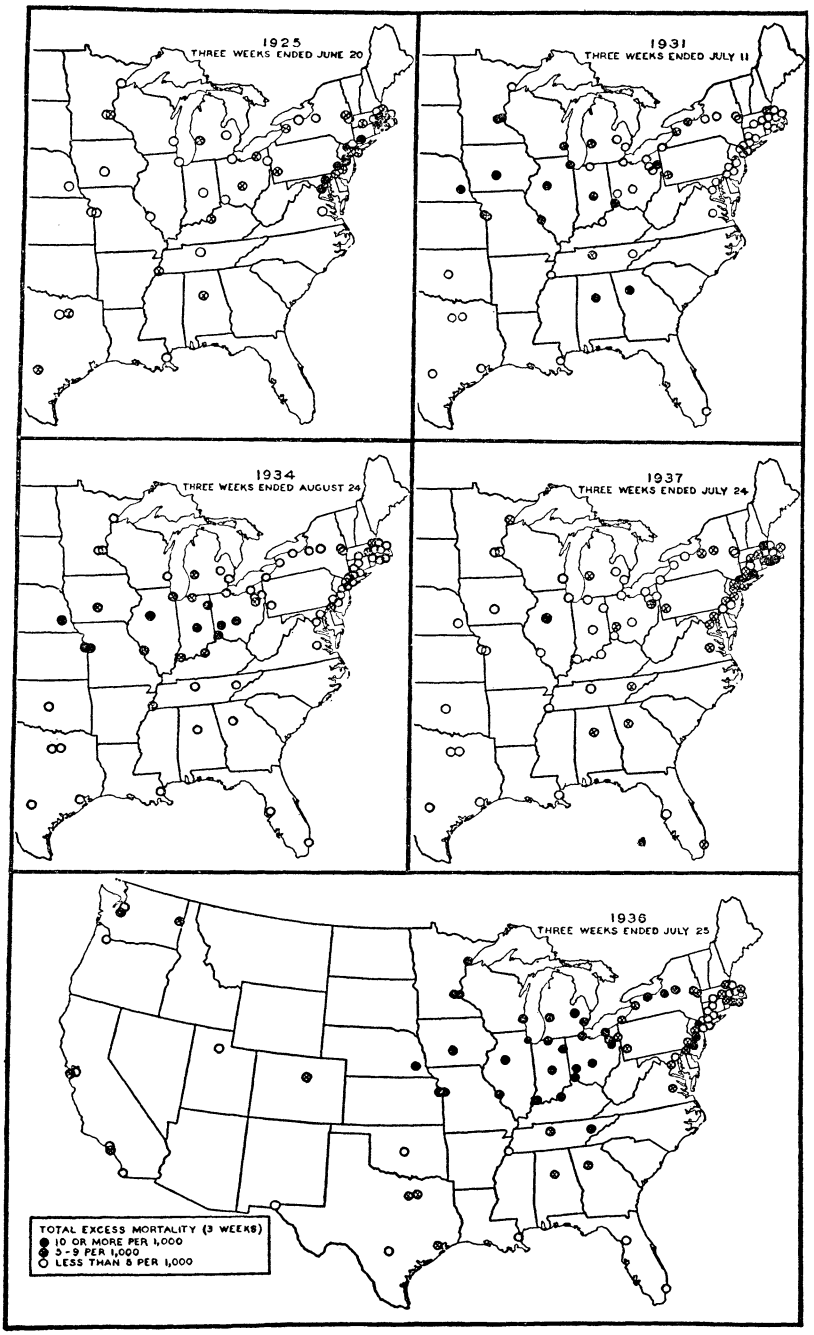


FIGURE 2.—Geographic distribution of excess mortality from all causes in large cities of the United States during 3 summer weeks ended June 20, 1925, July 11, 1931, August 24, 1934, July 25, 1936, and July 24, 1937. Total excess mortality is the sum of the excess in the annual rates for 3 weeks of each year.

namely, Trenton, N. J., Baltimore, Md., St. Louis, Mo., Omaha, Nebr., Birmingham, Ala., Memphis, Tenn., San Antonio, Tex., and San Francisco, Calif. Eight other cities in the North Atlantic, seven in the North Central, and two in the Southern area had an excess of 5 to 9 per 1,000. In neither 1932 nor 1933 did excess mortality in any city reach as high as 10 per 1,000 for the 3 weeks ended July 23 and August 5, respectively. In 1932 the area most affected included the States of Missouri, Kentucky, and Tennessee, and in 1933, Massachusetts, Connecticut, New Jersey, and Delaware.

In 1931 (fig. 2, top) 11 cities showed an excess of 10 or more per 1,000 for the 3 weeks ended July 11. Nine of these were in the North Central area and two in the Southern. Eight other cities in the North Central, two in the Southern, and three in the North Atlantic area had an excess of 5 to 9 per 1,000. The excess mortality occurred in the week ended July 4 in the western part of the North Central region, and in the week ended July 11 in the eastern part of the same region.

The 10 cities with an excess of 10 or more per 1,000 for the 3 weeks ended August 4, 1934 (fig. 2, middle) were all in the North Central area, in the States of western Ohio, central Indiana, central Illinois, Missouri, Kansas, and Nebraska. Seven other cities in eastern Ohio, northern Illinois, Michigan, Iowa, southern Illinois, and Kentucky had an excess of 5 to 9 per 1,000 for the 3-week period. Three cities in the North Atlantic, one in the Southern, and one in the Western region had an excess of 5 to 9 per 1,000. The excess mortality occurred during the week ended July 28 in practically all cities. In a few cities, notably Omaha, Nebr., and Kansas City, Mo., there was marked excess mortality in the weeks ended July 21 and July 28.

During the 3 weeks ended July 25, 1936 (fig. 2, bottom), all regions of the country experienced high mortality rates. In the North Central area 28 of the 35 cities had an excess of 10 or more per 1,000 and the other 7 had an excess of 5 to 9 per 1,000. Three cities in New Jersey had an excess of 10 or more per 1,000, and 11 others an excess of 5 to 9 per 1,000. In the Southern area one city had an excess of 10 or more, and six cities an excess of 5 to 9 per 1,000. The cities with no excess mortality were, in the main, the southern-most cities of the group. In the Western area one city had an excess of 10 or more, and four cities an excess of 5 to 9 per 1,000. The excess mortality extended over a period of 2 weeks, ended July 18, in a majority of the cities which had an excess in both the North Atlantic and North Central sections; and for 1 week, ended July 18, in the Southern and Western areas.

During the 3 weeks ended July 24, 1937 (fig. 2, middle), seven cities had an excess of 10 or more per 1,000; five of these were in the North Atlantic region and two in the North Central area. The 5 cities in the North Atlantic region were in New England and New York, but

15 other cities in this area had an excess of 5 to 9 per 1,000. In the northern part of the North Central region eight cities had an excess of more than 5 per 1,000. In the Southern and Western areas 7 cities out of 25 had some excess mortality. Excess mortality in the cities of the North Central region occurred largely in the week ended July 10, while in the North Atlantic region the excess mortality occurred mainly in the week ended July 17.

Considering the 5 years (fig. 2) in which marked excess mortality occurred during summer weeks, the maximum excess occurred in the North Central region in 3 of those years, 1931, 1934, and 1936. In the other 2 years (1925 and 1937), although the maximum excess occurred in the North Atlantic region, scattered cities in the North Central showed a decided increase in mortality. The areas with the smallest increase in mortality are in the South and West; however, the cities in the northern part of the Southern area, in Tennessee, Georgia, and Alabama, had some excess mortality in 4 of the 5 years. Although there was practically no excess mortality in the North Atlantic region during 2 of the 5 years (1931 and 1934), this area showed the maximum excess in both 1925 and 1937.

## EXCESS MORTALITY AND TEMPERATURE

Averages of actual and normal weekly mortality rates for 3 weeks in 1925, 1931, 1934, 1936, and 1937 for cities grouped into the above-mentioned four broad geographic areas are shown in table 2. Since the areas are large, differences that occur in a relatively small number of cities in a specific area tend to be averaged out. The averages, however, show a greater excess in some areas than in others for the different years. Table 2 also contains the weekly averages of daily maximum temperature for cities in the same four areas, in order to show the relationship between mortality and temperature for separate regions in different years. Average mortality rates that show a marked excess, together with average maximum temperatures for the same week and for the preceding week, are printed in bold-faced type (table 2).

Considering the 5 years shown in table 2, the largest deviations in mean temperature from normal, the highest death rates, and the largest excess mortality occurred in either the North Central or the North Atlantic regions, although the highest actual mean temperatures occurred in the Southern area. Only in 1936 was the actual weekly mean temperature in the North Central region (96°) higher than in the Southern area (93°). Although the actual temperatures are higher in the Southern area, the deviations from normal are not as great in the South as in the areas in which marked excess mortality occurred. It is, therefore, the excess in temperature rather than the actual temperature which is associated with a marked increase in weekly mor-

tality, when all sections of the country are considered. This suggests that acclimatization is a factor in response to temperature.

TABLE 2.—*Weekly death rate from all causes and weekly maximum temperature for large cities of 4 geographic sections*[1] *during 3 summer weeks of 1925, 1931, 1934, 1936, and 1937*

| | North Atlantic | | | North Central | | | South | | | West | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1925: Week ended— | | | | | | | | | | | |
| | June 6 | June 13 | June 20 | June 6 | June 13 | June 20 | June 6 | June 13 | June 20 | June 6 | June 13 | June 20 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | |
| Actual | 14.4 | **16.6** | 10.9 | 13.4 | 12.1 | 10.3 | 15.1 | 16.8 | 17.1 | 12.1 | 13.0 | 12.0 |
| Normal | 11.9 | 11.6 | 11.4 | 12.1 | 11.8 | 11.6 | 15.5 | 15.3 | 15.4 | 12.0 | 11.9 | 11.6 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | |
| Actual | **91** | **80** | 84 | 89 | 80 | 83 | 92 | 90 | 95 | 65 | 69 | 74 |
| Normal | 73 | 75 | 77 | 74 | 76 | 78 | 85 | 87 | 88 | 68 | 70 | 71 |
| Number of cities | 23 | 23 | 23 | 25 | 25 | 25 | 7 | 7 | 7 | 7 | 7 | 7 |
| | 1931: Week ended— | | | | | | | | | | | |
| | June 27 | July 4 | July 11 | June 27 | July 4 | July 11 | June 27 | July 4 | July 11 | June 27 | July 4 | July 11 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | |
| Actual | 11.4 | 10.2 | 10.4 | 11.3 | 13.7 | 10.3 | 12.5 | 14.3 | 13.7 | 10.5 | 9.6 | 11.4 |
| Normal | 11.1 | 10.9 | 10.7 | 10.2 | 10.1 | 9.8 | 12.2 | 12.6 | 12.7 | 10.6 | 10.5 | 10.5 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | |
| Actual | 80 | 83 | 80 | 85 | 91 | 82 | 93 | 95 | 93 | 78 | 79 | 80 |
| Normal | 79 | 80 | 81 | 80 | 81 | 82 | 89 | 90 | 90 | 73 | 74 | 75 |
| Number of cities | 25 | 25 | 25 | 33 | 33 | 33 | 13 | 13 | 13 | 11 | 11 | 11 |
| | 1934: Week ended— | | | | | | | | | | | |
| | July 21 | July 28 | Aug. 4 | July 21 | July 28 | Aug. 4 | July 21 | July 28 | Aug. 4 | July 21 | July 28 | Aug. 4 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | |
| Actual | 10.4 | 10.0 | 9.9 | 10.6 | 14.9 | 10.3 | 12.6 | 13.8 | 11.7 | 10.6 | 11.1 | 10.3 |
| Normal | 10.4 | 10.2 | 9.8 | 10.0 | 9.9 | 9.6 | 12.6 | 12.3 | 12.1 | 10.6 | 10.6 | 10.6 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | |
| Actual | 87 | 84 | 83 | 91 | 91 | 86 | 96 | 94 | 92 | 77 | 80 | 79 |
| Normal | 83 | 83 | 82 | 84 | 84 | 83 | 90 | 91 | 90 | 77 | 77 | 78 |
| Number of cities | 26 | 26 | 26 | 35 | 35 | 35 | 14 | 14 | 14 | 11 | 11 | 11 |

[1] See p. 1128 footnote 8 for the cities included in each geographic section; a total of 86 cities in 1934, 1936, and 1937. Mortality for the following cities is not obtainable for 1925 and 1931 and therefore they are omitted from the above averages for those years:

*North Atlantic:* Bridgeport, Hartford, and Waterbury, Conn., in 1925; Hartford, Conn., in 1931.

*North Central:* Utica, N. Y., Erie, Pa., Akron, Canton, and Dayton, Ohio; Evansville, Fort Wayne, and South Bend, Ind.; Peoria, Ill.; and Detroit, Mich., in 1925; Evansville and Fort Wayne, Ind., in 1931.

*South:* Knoxville, Tenn.; Atlanta, Ga.; Miami and Tampa, Fla.; Oklahoma City, Okla.; El Paso and Houston, Tex., in 1925; Tampa, Fla., in 1931.

*West:* Seattle, Wash.; Long Beach, Los Angeles, and San Diego, Calif., in 1925.

TABLE 2.—*Weekly death rate from all causes and weekly maximum temperature for large cities of 4 geographic sections during 3 summer weeks of 1925, 1931, 1934, 1936, and 1937*—Continued

| | North Atlantic | | | North Central | | | South | | | West | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1936: Week ended— | | | | | | | | | | | |
| | July 11 | July 18 | July 25 | July 11 | July 18 | July 25 | July 11 | July 18 | July 25 | July 11 | July 18 | July 25 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | |
| Actual | 11.9 | **12.7** | 11.1 | 13.4 | **23.2** | 11.9 | 12.9 | **15.0** | 13.3 | 12.7 | 12.5 | 11.4 |
| Normal | 10.6 | 10.4 | 10.2 | 9.9 | 10.0 | 9.9 | 12.8 | 12.6 | 12.3 | 10.6 | 10.6 | 10.6 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | |
| Actual | **89** | **85** | 79 | **96** | **95** | 85 | **93** | **93** | 92 | 76 | 81 | 82 |
| Normal | 82 | 83 | 83 | 83 | 84 | 84 | 90 | 90 | 91 | 77 | 77 | 77 |
| Number of cities | 26 | 26 | 26 | 35 | 35 | 35 | 14 | 14 | 14 | 11 | 11 | 11 |
| | 1937: Week ended— | | | | | | | | | | | |
| | July 10 | July 17 | July 24 | July 10 | July 17 | July 24 | July 10 | July 17 | July 24 | July 10 | July 17 | July 24 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | |
| Actual | 11.5 | **14.0** | 11.5 | 10.7 | 10.9 | 9.7 | 12.6 | 12.6 | 12.6 | 11.6 | 10.7 | 11.2 |
| Normal | 10.7 | 10.6 | 10.4 | 9.8 | 9.9 | 10.0 | 12.5 | 12.8 | 12.6 | 10.5 | 10.6 | 10.6 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | |
| Actual | **89** | **83** | 83 | 89 | 86 | 84 | 90 | 93 | 91 | 77 | 76 | 80 |
| Normal | 81 | 82 | 83 | 82 | 83 | 84 | 90 | 90 | 90 | 75 | 77 | 77 |
| Number of cities | 26 | 26 | 26 | 35 | 35 | 35 | 14 | 14 | 14 | 11 | 11 | 11 |

The greatest excess in mortality and also in maximum temperature (table 2) was in the North Atlantic region in 1925 and 1937, and in the North Central in 1931, 1934, and 1936. The excess in temperature extends over a 2-week period in the regions where the excess in mortality is the highest, but is usually greatest in the week preceding the week of maximum excess mortality.

In addition to the excess in the North Central region in 1936, there was a relatively smaller excess in mortality and temperature for the North Atlantic and Southern regions. Although there was some increase in temperature in 1925 in the North Central region, the average death rate was only slightly above normal. When mortality rates for individual cities were examined, however, it was found that eight of these cities had an excess of 5 to 9 per 1,000 in the annual rates for the 3 weeks ended June 20. Similarly, four cities in the Southern area in 1931 and eight cities in the North Central area in 1937 had a 3-week excess of 5 or more per 1,000 (fig. 2), although the average death rate for the total number of cities in these regions is only slightly above normal.

CORRELATION BETWEEN EXCESS MORTALITY AND EXCESS TEMPERATURE

The association between excess mortality and excess temperature for individual cities is shown in figure 3 for each of the 5 years. The entries in the correlation tables are the frequency of occurrence of cities with each combination of deviation in mortality and in temperature. The deviation in mortality is for the week of maximum mortality for all cities as shown in figure 1 for each year; the deviation in temperature is for the week prior to that for excess mortality.

It is apparent that small deviations in temperature do not show any association with changes in mortality, but that large deviations in temperature are associated with marked excess mortality, and that the higher the temperature deviation the larger the excess mortality. The correlation, however, is not linear, and therefore the correlation coefficient "$r$" could not be used. Instead, the values of "$p$" for a nine-fold table [9] have been calculated using "less than 1", "1–3", and "4 or more" as the intervals for excess mortality and "less than 4", "4–9" and "10 or more" as intervals for excess temperature. The values of "$p$" are as follows:

| Year | Number of cities | Probability ($p$) that there is no association between excess mortality and temperature |
|---|---|---|
| All 5 years | 402 | Less than 0.0000001. |
| 1925 | 62 | Less than 0.220. |
| 1931 | 82 | Less than 0.00002. |
| 1934 | 86 | Less than 0.002. |
| 1936 | 86 | Less than 0 000002. |
| 1937 | 86 | Less than 0.020. |

For the total of 5 years ($n$=402), there is a definite association between deviation in mortality and deviation in temperature. In 3 of the 5 single years also the probability that the association is due to chance only is much less than 3 in 100, which can be used as indicating a significant association. In 1937 the value of "$p$" is 0.020. In 1925 it is 0.220, or, in other words, there is no significant association between deviations in temperature and mortality. The explanation of the lack of association in 1925, as shown by the value of "$p$," lies largely in the fact that the maximum excess in temperature occurred during a single week in all cities, while the maximum excess in mortality occurred in the same week as the maximum excess in temperature in the North Central region and in the week following in the North Atlantic region.

When daily temperature records for 1925 are examined it is seen that extreme temperatures occurred in the latter part of the week ended July 6 in the North Atlantic region and in the first part of the

[9] The value of "$p$" was obtained as outlined in Pearl's Medical Biometry and Statistics, 2d edition, pp 317-322.

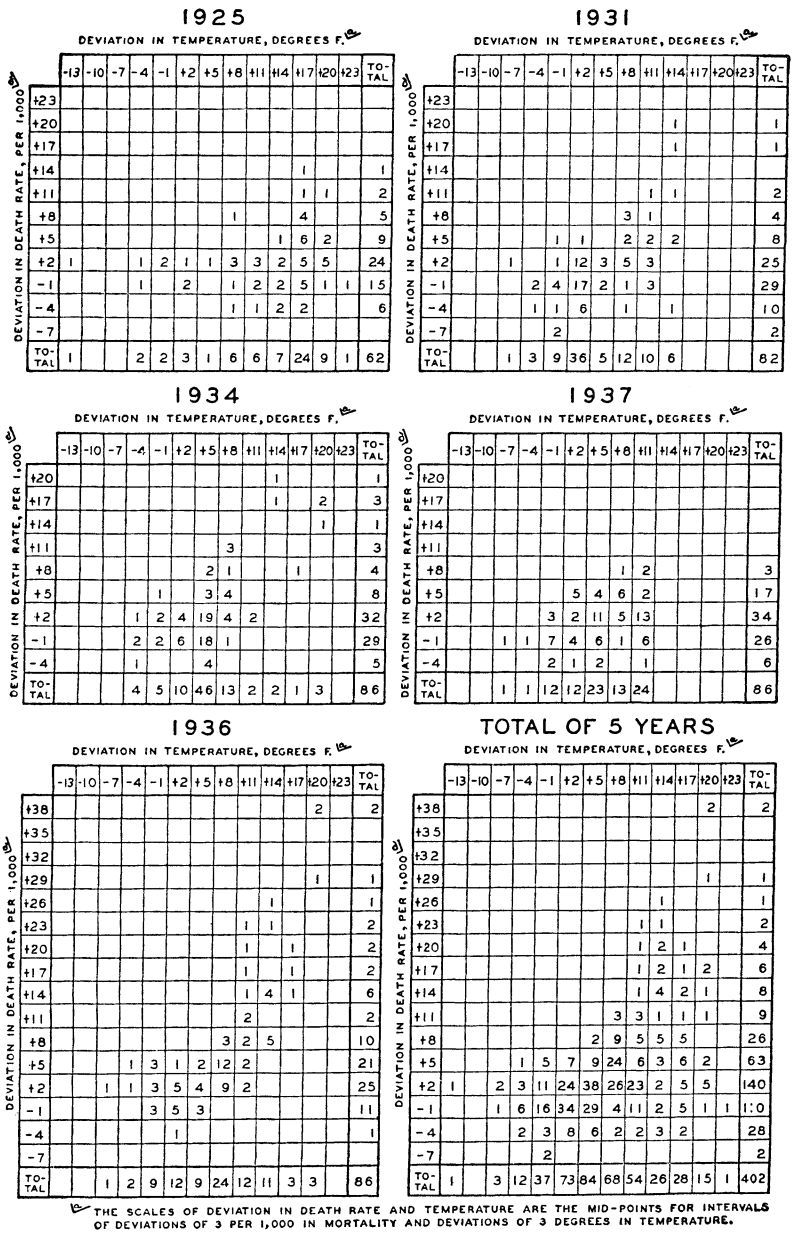


FIGURE 3.—Association between deviation from normal weekly death rate and deviation from normal weekly mean maximum temperature in 86 large cities of the United States for the week of maximum mortality during the summers of 1925, 1931, 1934, 1936, and 1937. (The week of maximum mortality was the week ended June 13, 1925, July 14, 1931, July 28, 1934, July 18, 1936 and July 17, 1937, (Fig. 1,). Deviations, in temperature are for the week prior to the week of maximum mortality.)

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same week in the North Central region. In the North Atlantic region there were 20 cities with an excess mortality of 3 or more per 1,000; in 5 of these cities the maximum excess occurred during the week ended July 6, and in 15 others it occurred during the week ended July 13. In the North Central region, eight cities had an excess of three or more per 1,000 during the week ended July 6, and three during the following week ended July 13. Similarly, in 1937 a larger proportion of the cities in the North Atlantic area had marked excess in mortality in the week following the week of maximum temperature while in the North Central area the excess mortality and excess temperature occurred during the same week. In figure 3 the deviations in temperature are for the week preceding the week of maximum mortality as determined from the rates for all cities combined.

Another fact of importance in considering the association between mortality and temperature is that consecutive days of extreme temperature have more effect upon mortality than variable temperatures. Likewise, 2 successive weeks of extreme temperature (table 2, 1936) have a very marked effect upon mortality. The daily number of deaths from "excessive heat" in Kansas (*1*) increased sharply during periods when the daily temperature was extreme and remained about constant. The number of days of continuous heat, therefore, should be taken into account in considering the effect of increased temperature on the death rate.

An attempt to set up indices which would take account of even the main facts mentioned above was abandoned because it led to indices that were too complex to have a clear meaning.

### MORTALITY AND TEMPERATURE FOR GROUPS OF CITIES IN AREAS OF EXTREMELY HIGH TEMPERATURES

Curves of average mortality and temperature for groups of cities in severely affected areas are shown in figure 4 for a period of 8 weeks in 1925, 9 weeks in 1931, 1934, and 1937, and for 12 weeks of 1936. The daily maximum, the weekly averages of the daily maximum, and the normal maximum temperatures are shown in the upper half, and the average weekly and normal death rate in the lower half of each chart. The graphs for 1925 and 1937 are based on data for the total number of cities in the North Atlantic region for which data are available, 23 and 26 cities, respectively; for 1931, 10 cities are included; for 1934, 14 cities; and for 1936, 26 cities in the North Central region.[10] For these groups of cities the maximum death rate in 1925 was 16.6; in 1931, 19.8; in 1934, 22.5; in 1936, 25.2; and in 1937, 14.0 per 1,000 (table 3), as compared with an expected rate of 11.6, 10.1, 11.0, 9.8, and 10.6 per 1,000, respectively. In 3 of the 5 years, 1931, 1934, and 1936, weekly mean temperatures were high, during both the week of

[10] See table 3, footnotes 2–6, for the cities included in each year.

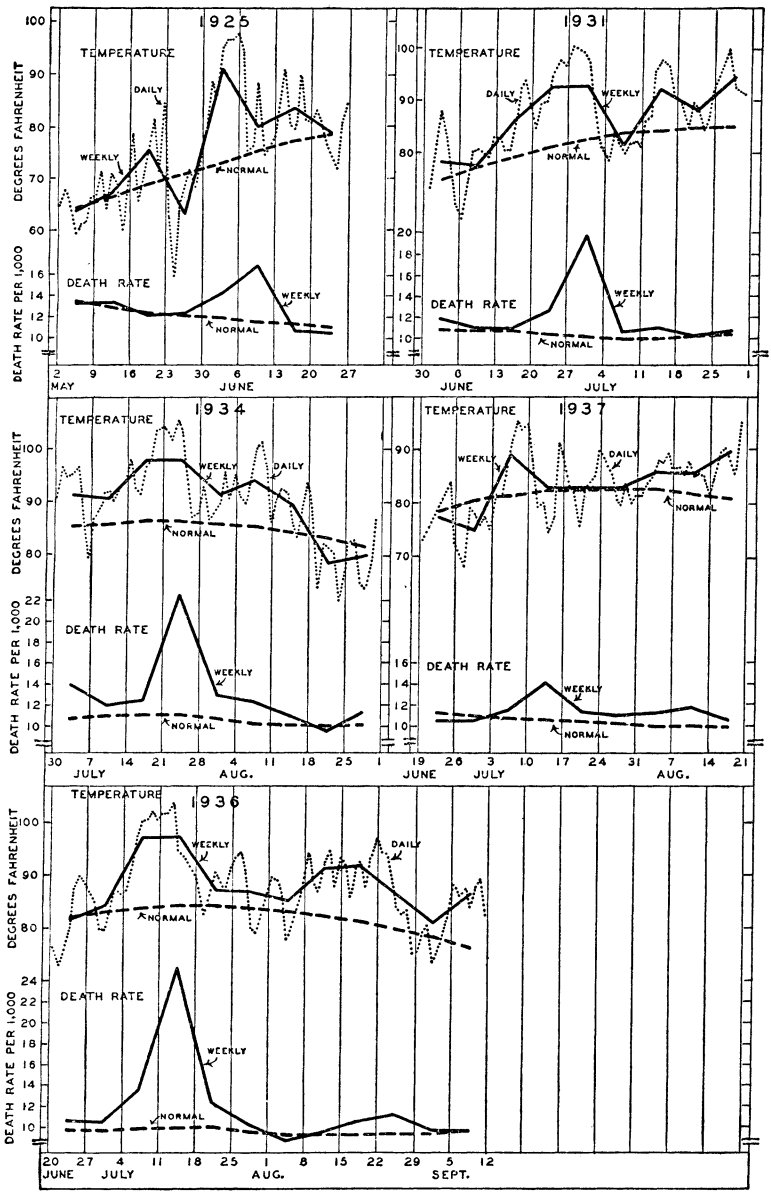


FIGURE 4.—Weekly death rate from all causes (annual basis) and daily and average weekly maximum temperature for groups of cities in areas of extreme temperature for approximately 9 summer weeks of the years 1925, 1931, 1934, 1936, and 1937. See table 3, notes 2–6, for the cities included in each year.

high mortality and the preceding week. In each year the maximum death rate was accompanied by a period of excessive temperatures, that is, an average daily maximum of 95° or more for a period of 5 days in 1925, 7 days in 1931, 8 days in 1934, 9 days in 1936, and 3 days in 1937 (table 3), which occurred in the week preceding or the week of maximum mortality. Prior to the period of excessive temperatures in each year, temperatures had been rising from subnormal over an interval of from 3 to 18 days (fig. 4).

TABLE 3.—*Weekly death rate from all causes and weekly maximum temperature for groups of cities in areas of extreme temperature, during 3 summer weeks of 1925, 1931, 1934, 1936, and 1937*

| | 1925 Week ended— | | | 1931 Week ended— | | | 1934 Week ended— | | | 1936 Week ended— | | | 1937 Week ended— | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 6 | June 13 | June 20 | June 27 | July 4 | July 11 | July 21 | July 28 | Aug. 3 | July 11 | July 18 | July 25 | July 10 | July 17 | July 24 |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | | | | | | |
| Actual | 14.4 | 16.6 | 10.9 | 12.6 | 19.8 | 10.5 | 12.3 | 22.5 | 12.8 | 13.5 | 25.2 | 12.2 | 11.5 | 14.0 | 11.5 |
| Normal | 11.9 | 11.6 | 11.4 | 10.3 | 10.1 | 9.9 | 11.0 | 11.0 | 10.6 | 9.7 | 9.8 | 9.8 | 10.7 | 10.6 | 10.4 |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | | | | | | |
| Actual | 91 | 80 | 84 | 93 | 93 | 81 | 98 | 98 | 91 | 97 | 97 | 87 | 89 | 83 | 83 |
| Normal | 73 | 75 | 77 | 81 | 83 | 84 | 86 | 86 | 86 | 84 | 84 | 84 | 81 | 82 | 83 |
| Number of days of continuous heat [1] | 5 | | | 7 | | | 8 | | | 9 | | | [1] 3 | | |
| Number of cities | [2] 23 | | | [3] 10 | | | [4] 14 | | | [5] 26 | | | [6] 26 | | |

[1] Number of continuous days with a maximum temperature of 95° or over during the week prior to and the week of maximum mortality. The total of 3 days in 1937 includes 1 daily maximum of 94°.

[2] The cities included are: Boston, Cambridge, Fall River, Lowell, Lynn, New Bedford, Somerville, Springfield, and Worcester, Mass.; Providence, R. I.; New Haven, Conn.; Camden, Jersey City, Newark, Paterson, and Trenton, N. J.; New York and Yonkers, N. Y.; Philadelphia, Pa.; Wilmington, Del.; Baltimore, Md.; District of Columbia; and Richmond, Va.

[3] Chicago and Peoria, Ill.; Milwaukee, Wis.; Minneapolis and St. Paul, Minn.; Des Moines, Iowa; Kansas City and St. Louis, Mo.; Omaha, Nebr.; and Kansas City, Kans.

[4] Cincinnati, Columbus, and Dayton, Ohio; Evansville, Fort Wayne, Indianapolis, and South Bend, Ind.; Chicago and Peoria, Ill.; Des Moines, Iowa; Kansas City and St. Louis, Mo.; Omaha, Nebr.; and Kansas City, Kans.

[5] Akron, Canton, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown, Ohio; Evansville, Fort Wayne, Indianapolis, and South Bend, Ind.; Chicago and Peoria, Ill.; Detroit, Flint, and Grand Rapids, Mich.; Milwaukee, Wis.; Duluth, Minneapolis, and St. Paul, Minn.; Des Moines, Iowa; Kansas City and St. Louis, Mo.; Omaha, Nebr.; and Kansas City, Kans.

[6] Boston, Cambridge, Fall River, Lowell, Lynn, New Bedford, Somerville, Springfield, and Worcester, Mass.; Providence, R. I.; Bridgeport, Hartford, New Haven, and Waterbury, Conn.; Camden, Jersey City, Newark, Paterson, and Trenton, N. J.; New York and Yonkers, N. Y.; Philadelphia, Pa.; Wilmington, Del.; Baltimore, Md.; District of Columbia; and Richmond, Va.

Second heat waves, which followed the main heat waves of the summer, occurred during July or August in 4 of the 5 years (1931, 1934, 1936, and 1937) in the groups of cities shown in figure 4. The second heat waves were not so severe and did not affect all of the cities of these groups. Mortality for the groups of cities increased slightly in only two of the years, 1936 and 1937 (fig. 4). Individual cities of the groups also showed lower maximum temperature and, except for Kansas City and St. Louis, Mo. (1936), fewer days of continuous high temperature during the second heat wave. Death rates during the second heat wave were not extremely high in individual

cities, considering the total number of cities as well as the selected cities shown in figure 4. The largest excess mortality in 1931 was 3.8; in 1934, 9.6; in 1936, 6.2; and in 1937, 8.4 per 1,000. In each case the largest excess occurred in a city included in the groups shown in figure 4.

MORTALITY AND TEMPERATURE FOR SELECTED CITIES IN THE SUMMER OF 1936

Graphs similar to those of figure 4 are shown in figure 5 for 10 individual cities in the North Central region for 11 weeks of 1936. Seven of the cities were in the most severely affected area, and three were in the eastern part of the North Central region, in the States of New York and Pennsylvania.

Five of the cities shown in figure 5 had a weekly mean temperature of 100° or more during the week ended July 11; 102° in Evansville, Ind., Indianapolis, Ind., and Kansas City, Mo., and 101° in St. Louis, Mo., and Minneapolis, Minn. (table 4 and fig. 5). High temperatures continued in these cities for a period of approximately 2 weeks. Except for Kansas City, Mo., the same cities also had the highest rates of mortality; the maximum rate, 40.3 per 1,000, occurred in Minneapolis, Minn. The four cities of figure 5 (Chicago, Ill., Pittsburgh, Pa., Rochester and Syracuse, N. Y.) which had less than a week of continuing high temperature also had relatively small increases in mortality. The excess, however, is definite in each of the cities.

Although the highest temperatures during 1936 occurred in Kansas City, Mo., namely, 102° and 106° for the 2 weeks ended July 18, the maximum death rate was only 18.6 as compared with an expected rate of 11.0 per 1,000 (fig. 5). The excess in Kansas City, Kans., was also relatively low, 7.7 per 1,000. During the heat wave of 1934, Kansas City, Mo., experienced the highest temperatures and the longest period of extreme temperature; the weekly mean was 108° for the week ended July 21, 1934, and there were 41 days in which the maximum temperature was 95° or more from July 1 to the middle of August. The sum of the excess in the annual rates for 3 weeks ended August 3, 1934, for Kansas City was also the highest which occurred in any of the 86 cities. In 1936 the most extreme temperatures again occurred in Kansas City, as shown in figure 5; the heat waves of 1934 and 1936 were of about equal severity in that city. The maximum mortality in 1936, however, was only 18.6 in Kansas City, Mo., as compared with 35.4 per 1,000 in St. Louis, Mo. It seems probable that the comparatively low excess mortality during 1936 in Kansas City, Mo., is associated with the fact that the heat wave of 1936 followed so soon after a heat wave of equal severity in 1934.

In four of the cities shown in figure 5 a second period of extreme temperature occurred during August, following the earlier heat wave in July. Evansville, Ind., Indianapolis, Ind., and St. Louis, Mo.,

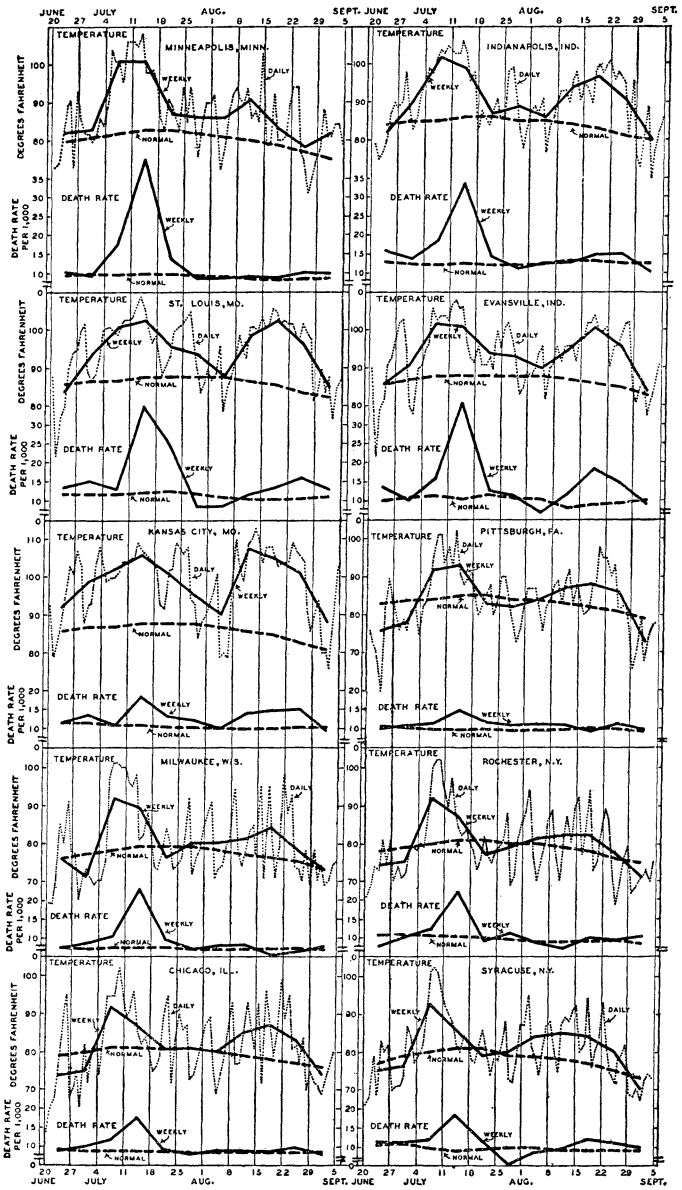


FIGURE 5.—Weekly death rate from all causes (annual basis) and daily and average weekly maximum temperature for 10 cities in an area of extreme temperature for 11 summer weeks of 1936.

(fig. 5) had temperatures in August which were only slightly lower than those which occurred in July. There is, however, a marked difference in the death rates during July and August; the excess in the weeks of maximum mortality is three to nine times as great in the earlier period (fig. 5).

TABLE 4.—*Weekly death rate from all causes and weekly maximum temperature for 10 cities in an area of extreme temperature during the summer of 1936*

| | Evansville, Ind. | Indianapolis, Ind. | Kansas City, Mo. | St. Louis, Mo. | Chicago, Ill. | Milwaukee, Wis. | Minneapolis, Minn. | Pittsburgh, Pa. | Rochester, N. Y. | Syracuse, N.Y. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Week ended July 18, 1936 | | | | | | | | | |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | |
| Actual | 36.0 | 33.5 | 18.6 | 35.4 | 17.8 | 22.9 | 40.3 | 14.9 | 22.1 | 18.1 |
| Normal | 10.5 | 12.2 | 11.0 | 12.5 | 8.8 | 7.4 | 10.0 | 9.6 | 10.4 | 8.9 |
| | Week ended July 11, 1936 | | | | | | | | | |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | |
| Actual | 102 | 102 | 102 | 101 | 92 | 92 | 101 | 92 | 92 | 93 |
| Normal | 88 | 85 | 87 | 87 | 81 | 78 | 82 | 84 | 80 | 80 |
| | Week ended July 18, 1936 | | | | | | | | | |
| Actual | 101 | 99 | 106 | 103 | 87 | 89 | 101 | 93 | 87 | 86 |
| Normal | 88 | 86 | 88 | 88 | 81 | 79 | 83 | 85 | 81 | 81 |
| Number of days of continuous heat [1] | 12 | 14 | 16 | 15 | 5 | 8 | 13 | [2] 7 | 4 | 4 |
| | Week ended Aug. 29, 1936 | | | | | | | | | |
| Death rate per 1,000 population (annual basis): | | | | | | | | | | |
| Actual | [3] 18.5 | 14.8 | 15.1 | 16.3 | 9.6 | 6.5 | 10.0 | 11.1 | 9.6 | 11.0 |
| Normal | [3] 9.0 | 12.4 | 10.4 | 10.9 | 8.4 | 7.1 | 8.5 | 9.8 | 9.3 | 8.9 |
| | Week ended Aug. 22, 1936 | | | | | | | | | |
| Weekly mean of daily maximum temperature (F°.): | | | | | | | | | | |
| Actual | 101 | 97 | [4] 108 | 103 | 87 | 84 | [4] 91 | 88 | 82 | [4] 85 |
| Normal | 86 | 83 | [4] 86 | 86 | 78 | 76 | [4] 80 | 82 | 78 | [4] 78 |
| | Week ended Aug. 29, 1936 | | | | | | | | | |
| Actual | 96 | 91 | [5] 105 | 97 | 83 | 78 | [5] 83 | 86 | 77 | [5] 84 |
| Normal | 85 | 81 | [5] 85 | 84 | 77 | 75 | [5] 79 | 81 | 76 | [5] 77 |
| Number of days of continuous heat [1] | 8 | 9 | 20 | 17 | 0 | 0 | 0 | 0 | 0 | 0 |

[1] Number of continuous days with a maximum temperature of 95° or over during 1 or 2 weeks prior to and the week of maximum mortality.
[2] The 7 days include 2 days with a maximum of 94° and 93°, respectively.
[3] Death rates are for the week ended Aug. 22.
[4] Temperatures are for the week ended Aug. 15.
[5] Temperatures are for the week ended Aug. 22.

In St. Louis, Mo., during the 2 weeks ended July 4, 1931, the weekly mean temperature was 98° for both weeks, and the maximum mortality was 28.0 per 1,000; during the 2 weeks ended July 28, 1934, the mean temperatures were 102° and 100° and the maximum mortality 34.0 per 1,000; during the 2 weeks ended July 18, 1936, the mean temperatures were 101° and 103° and the maximum mortality 35.4 per 1,000; and during the 2 weeks ended August 29, 1936, the mean temperatures were 103° and 97° and the maximum mortality only 16.3 per 1,000. In other words, although the temperatures were markedly lower in July 1931 than they were in August 1936, the excess was three times as much in the week of maximum mortality in July 1931 as during the second heat wave in August of 1936. The comparatively low excess mortality during a second heat wave in a single year may be explained by the fact of acclimatization or, since the increase in mortality occurs largely among those with chronic circulatory diseases, that the majority of such deaths are hastened in the first heat wave of the summer.

## SUMMARY

Mortality which is certified and recorded as due to "excessive heat" includes by no means all excess deaths which occur during periods of extreme temperature. During July of 1934 in Kansas, "excessive heat" accounts for only about one-quarter of the excess deaths which occurred during that month. The remainder of the excess was distributed largely among diseases of the heart, cerebral hemorrhage, nephritis, and pneumonia.

In 5 of the 13 years from 1925 to 1937 summer weekly rates of mortality in large cities rose as high as, or higher than, an average January rate. In at least 3 of the remaining 7 years smaller increases in mortality occurred.

These sharp increases in mortality occur most frequently during the month of July, but sometimes they occur in June or August. The area most often affected is roughly outlined by the States of Ohio, Indiana, Illinois, Missouri, Iowa, and Nebraska. The more northern States of Michigan, Wisconsin, and Minnesota, however, are sometimes a part of the affected area. The North Atlantic cities also frequently experience these sudden increases in mortality. The areas least frequently affected are the far South and the Pacific coast.

A comparison of weekly mortality and weekly temperature for the total of 86 cities shows a positive association between deviations from normal weekly death rates and deviations from normal weekly mean maximum temperatures for the preceding week.

Daily maximum temperatures for groups of cities and for individual cities in affected areas show that the excess in mortality is preceded

by at least several successive days of extreme temperature. Excess mortality during a second period of extreme temperature in any one year is slight when compared with the excess mortality during the first major heat wave of the summer, even when the second rise in temperature is extreme.

REFERENCES

(*1*) Brown, Earle G.: Deaths from excessive heat in Kansas, 1934. Pub. Health Rep., **50:** 546 (1935).
(*2*) Climatological data for the United States, by sections. Weather Bureau, Department of Agriculture. Government Printing Office, Washington, D. C., 1920–37.
(*3*) Collins, Selwyn D., and Gover, Mary: Maximum temperatures and increased death rates in the drought area. Pub. Health Rep., **49:** 1015 (1934).
(*4*) Hall, W. W., and Wakefield, E. G.: A study of experimental heat stroke. J. Am. Med. Assoc., **89:** 177 (1927).
(*5*) Illinois Health Messenger, State of Illinois Department of Public Health, **8:** 118 (1936).
(*6*) Manual of Joint Causes of Death, Bureau of the Census, Department of Commerce. Government Printing Office, Washington, D. C., 1933.
(*7*) Mortality Statistics, Bureau of the Census, Department of Commerce. Government Printing Office, Washington, D. C., 1920–34.
(*8*) Release, Bureau of the Census, Department of Commerce, July 25, 1936.
(*9*) Shattuck, George C., and Hilferty, Margaret M.: Sunstroke and allied conditions in the United States. Am. J. Trop. Med., **12:** 223 (1932).
(*10*) Shattuck, George C., and Hilferty, Margaret M.: Causes of death from heat in Massachusetts. New England J. Med., **209:** 319 (1933).
(*11*) Weekly Health Index, Bureau of the Census, Department of Commerce. Government Printing Office, Washington, D. C., 1920–37.

## POLIOMYELITIS: PREVALENCE SINCE 1915 AND THE PRESENT SITUATION

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Although poliomyelitis does not rank high in the lists of diseases either with reference to the annual number of cases reported or as a cause of death, and in these respects even falls below the common communicable diseases of childhood, it has become one of the most dreaded of all our epidemic infections. This fear may arise from the frequent distressing crippling effects of the disease and from the feeling of insecurity which comes from the lack of defensive measures.

Along in May or June a normal seasonal increase in the incidence of poliomyelitis occurs in the United States, and this rise brings up the question of whether it indicates that an epidemic may be expected during the following summer. As a rule, if the seasonal rise starts early and abruptly in May or June, epidemic proportions may be expected for the year. However, in the epidemic year of 1931 the sharp rise did not begin until late in June, while in 1937 and 1930, which also might be considered years of unusual prevalence, the sharp rise started in May and the respective peak weeks for the year were not reached