Presently evident trends in death rates from leukemia offer no support for a theory that leukemogenic factors in the American environment have increased sharply within the last 15 years.

Trends of Mortality From Leukemia in the United States, 1921–55

ALEXANDER G. GILLIAM, M.D., and WILLIAM A. WALTER, M.D.

SOME of the deficiencies in the basic data available in the United States for studying the trend since 1921 of deaths attributed to leukemia have been cited by Sacks and Seeman (*1*). These limitations particularly involve the lack of comparability in the rubrics provided for leukemia in the several revisions of the International Lists of Causes of Death. Prior to the introduction of the fifth revision of these lists in this country in 1939, deaths charged to aleukemia were included with Hodgkin's disease. For this reason, in describing trends from 1921 to 1942, Sacks and Seeman only tabulated the "true leukemias." Cooke (*2*), however, has pointed out that in 1940 only 4.8 percent of all leukemia deaths were charged to aleukemia. These deaths yielded a crude aleukemia death rate of only 0.2 per 100,000, which should have little effect on trends whether included or not.

An additional difficulty with data for the United States, which is generally overlooked, is that all States were not included in the death registration area until 1933. In 1921 the registration States comprised only 58 percent of the land area of the country and less than 82 percent of the population. In 10 of the 14 States added to the death registration area since 1921, the standardized leukemia mortality ratios in 1949–55 were lower than the average for the United States (A. G. Gilliam and W. A. Walter, unpublished data). The effect of this changing composition of the death registration States on the trends of leukemia mortality cannot be determined. Beginning in 1933, however, the data available and presented here refer to the entire United States, and beginning in 1939 include those deaths charged to aleukemia.

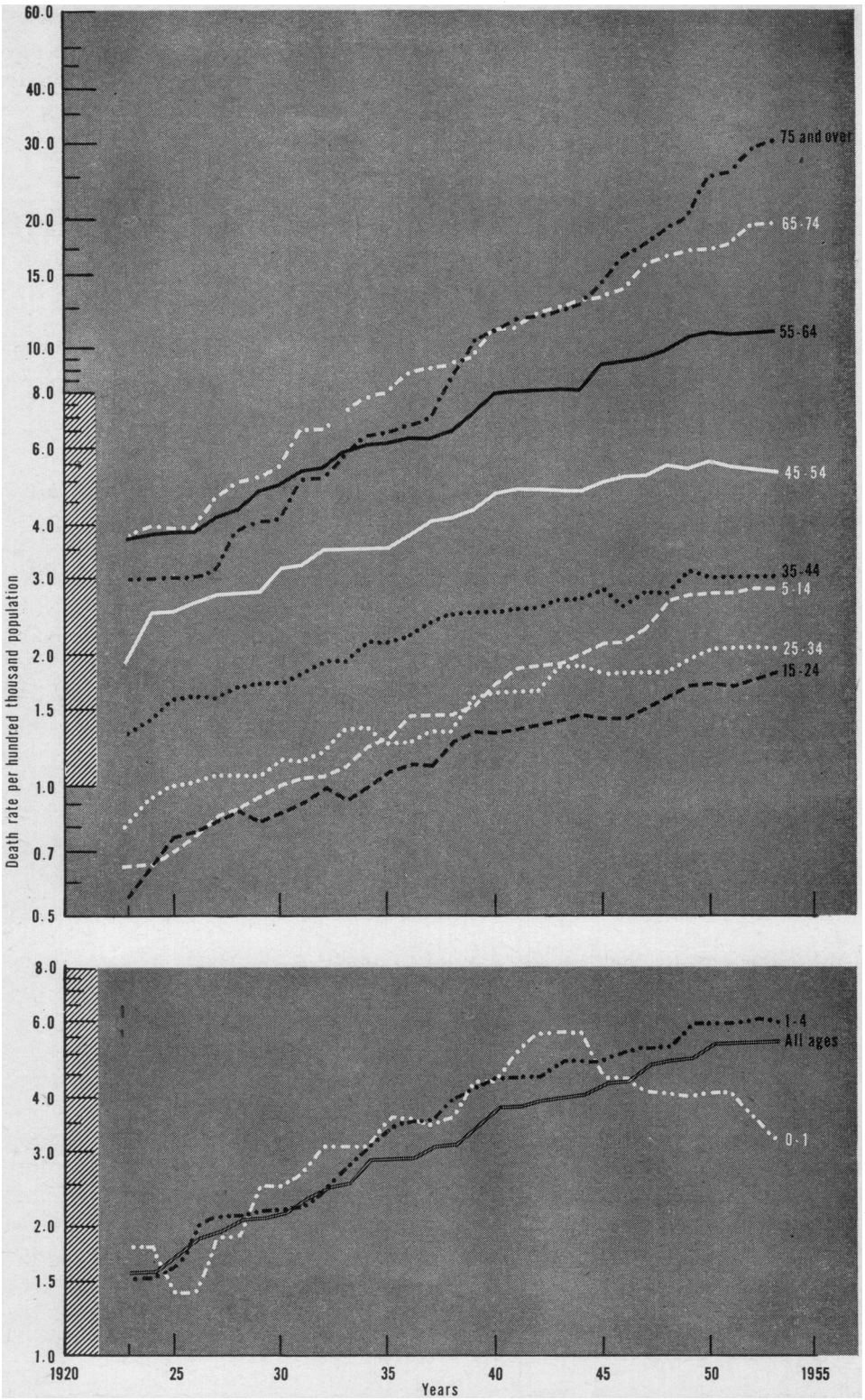
Sacks and Seeman, and Cooke, too, have pointed out that, while there has been a continuous increase in mortality from leukemia, the greatest increase has been in the older ages. In addition, Cooke has noted that in the age groups 0–4 and 0–14 the rate of increase was less between 1940 and 1949 than was observed in the previous 10 years.

To extend the observations of these authors, age-specific mortality rates for each race and sex were computed for each year 1921–55, for the registration States. The age-specific rates derived for white males and females are shown in figures 1 and 2. To achieve some degree of smoothing of annual variation, 5-year moving medians are plotted in figures 1 and 2 rather than the actual annual rates. Furthermore they are charted on a semilogarithmic scale so that changes in rate of increase may be visually evident.

With regard to the age-adjusted rates of leukemia mortality for both males and females of

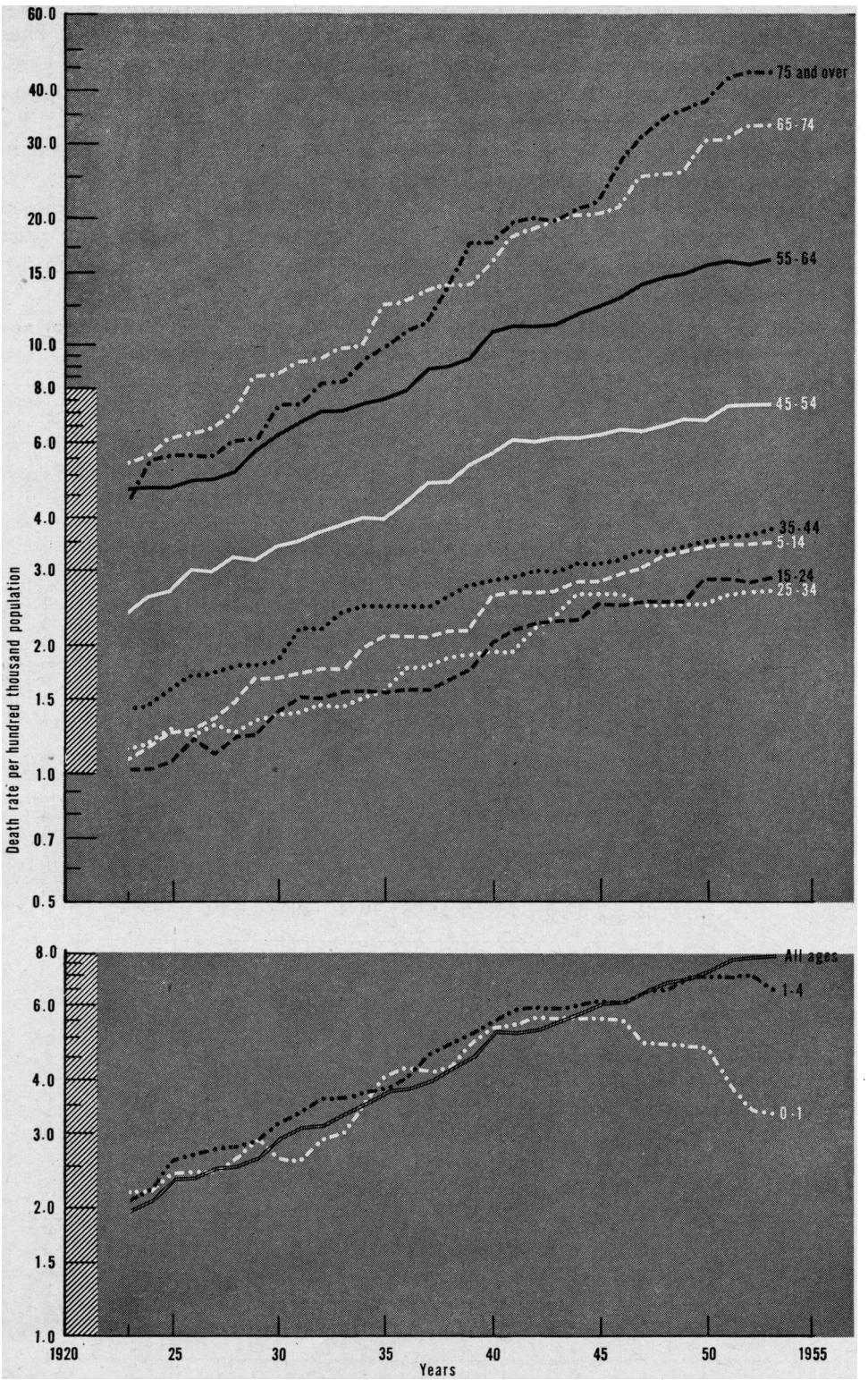
Dr. Gilliam and Dr. Walter are epidemiologists with the Field Investigations and Demonstration Branch, National Cancer Institute, National Institutes of Health, Public Health Service.

Figure 1. White females: trends of age-specific death rates for leukemia in the death registration States, 5-year moving medians, 1921–55.



NOTE: Rates for all ages adjusted to the age distribution of the population of the United States at the 1950 census. International List numbers included are: 65a, 1921–29; 72a, 1930–38; 74a,b, 1939–48, and 204, 1949–55.

Figure 2. White males: trends of age-specific death rates for leukemia in the death registration States, 5-year moving medians, 1921–55.



NOTE: See note, figure 1.

all ages, there would appear to be no change in rate of increase in the few years before and after 1933, the year in which all States were finally admitted to the death registration area. Beginning about 1940, however, there is a definite decline in the rate of increase, which would appear to be more pronounced among females than among males.

When trends for individual age groups are examined it is observed that there has been a substantial decline in leukemia death rates for both males and females under 1 year of age since about 1940. In all other age classes, with the exception of those of 75 years or older, the rates have been increasing but the magnitude of increase has been declining. The decline in rate of increase, which is very evident in the younger ages, tends to be progressively less pronounced with advance in age. For those 75 years and older there is no discernible change in rate of increase.

In addition to this decline in rate of increase, there appears to be a tendency since 1950 for actual leveling off of rates in several age

Table 1. Average annual leukemia death rates among white males and females for seven 5-year periods, 1921–55, and annual percentage change in rates [1]

Years	Age groups (years)										
	0–1	1–4	5–14	15–24	25–34	35–44	45–54	55–64	65–74	75+	All ages [2]
Male	Average annual death rate per million										
1921–25	21.6	23.0	10.8	10.2	11.4	14.0	23.8	46.6	52.4	44.6	20.4
1926–30	26.4	28.0	14.8	12.0	12.7	17.9	31.2	53.4	72.5	61.2	25.6
1931–35	33.4	35.9	17.7	15.0	14.9	23.9	37.0	73.1	100.3	87.3	33.1
1936–40	45.4	48.8	22.1	17.0	18.2	26.6	49.8	89.4	135.6	147.0	42.8
1941–45	48.4	58.3	26.9	24.7	22.8	29.6	57.3	113.7	184.9	198.4	53.8
1946–50	46.2	63.8	31.0	23.8	24.8	32.7	64.8	114.9	245.6	329.4	65.7
1951–55	31.5	65.8	35.6	27.6	25.6	36.4	71.4	155.2	320.4	475.3	77.1
Female											
1921–25	17.5	14.9	6.6	6.2	8.8	13.1	22.4	35.5	36.7	30.5	15.4
1926–30	19.5	22.0	9.0	8.5	10.9	16.8	27.4	43.6	51.4	35.6	19.9
1931–35	29.7	27.4	11.5	9.3	13.2	19.5	34.1	56.2	73.5	55.1	25.5
1936–40	38.9	39.0	14.6	12.1	14.4	23.3	41.4	66.4	92.1	87.0	31.9
1941–45	50.7	46.5	18.8	13.9	17.4	25.9	46.0	80.4	122.4	120.8	38.9
1946–50	40.2	53.0	24.2	15.1	18.4	27.6	52.0	97.9	154.9	191.5	46.5
1951–55	35.8	57.5	26.9	16.5	19.4	29.8	53.0	105.5	190.5	287.3	53.2
Male	Annual percentage change in rates										
1921–25											
1926–30	4.1	4.0	6.6	3.3	2.2	5.1	5.5	2.7	6.7	6.6	4.6
1931–35	4.8	5.1	3.6	4.6	3.2	6.0	3.5	6.5	6.7	7.4	5.3
1936–40	6.3	6.4	4.5	2.5	4.1	2.2	6.1	4.1	6.2	11.0	5.3
1941–45	1.3	3.6	4.0	7.8	4.6	2.2	2.9	4.9	6.4	6.2	4.7
1946–50	−1.0	1.8	2.9	−.7	1.7	2.0	2.5	.2	5.8	11.0	4.0
1951–55	−7.4	.6	2.2	3.0	.6	2.2	2.0	6.2	5.5	7.6	3.3
Female											
1921–25											
1926–30	2.2	8.1	6.4	6.7	4.4	5.2	4.1	4.2	7.0	3.2	5.2
1931–35	8.8	4.5	5.1	1.7	3.9	3.1	4.5	5.2	7.4	9.1	5.1
1936–40	5.5	7.3	4.9	5.5	1.8	3.6	4.0	3.4	4.6	9.6	4.6
1941–45	5.5	3.6	5.2	2.7	3.8	2.1	2.1	3.9	5.8	6.8	4.0
1946–50	−4.6	2.7	5.3	1.7	1.1	1.3	2.4	4.0	4.8	9.6	3.7
1951–55	−2.3	1.6	2.1	1.9	1.0	1.5	.4	1.5	4.2	8.4	2.7

[1] Annual percentage change in rates from one time period to the next, computed by the compound interest formula.
[2] All ages adjusted to the age distribution of the United States population at the 1950 census.

groups. The leukemia experience of the next 5 years should be sufficient to demonstrate whether this represents a temporary slackening in increase in rates or a beginning reduction similar to that already observed among infants under 1 year of age.

A plot of the leukemia death rates for nonwhites has also been prepared, but because of the irregularities due to the small numbers of deaths involved, it is impractical to illustrate them. It may be said, however, that the increase among nonwhites has been materially greater than among whites, with less evidence of a slackening in rate of increase. Such reduction in increase among nonwhites as is evident in annual rates occurred about 1948, instead of in 1940, and is less marked than among whites. In addition, the reduction in rate of increase is only apparent among males under 5 years of age and among females under 35 years.

As a further test of changes in leukemia mortality rates since 1921, average annual age-specific death rates have been computed for

Table 2. Average annual leukemia death rates among nonwhite males and females for seven 5-year periods, 1921–55, and annual percentage change in rates [1]

Years	Age groups (years)										
	0–1	1–4	5–14	15–24	25–34	35–44	45–54	55–64	65–74	75+	All ages [2]
Males	Average annual death rate per million										
1921–25	6.6	5.7	3.0	5.3	8.2	10.8	13.8	18.8	7.7	9.8	8.6
1926–30	19.3	5.9	5.3	8.6	8.4	11.5	12.7	11.0	25.7	7.8	10.1
1931–35	22.5	9.8	8.5	9.0	11.3	16.7	18.3	28.9	20.9	28.9	14.7
1936–40	18.5	12.3	9.0	10.3	14.7	21.3	33.8	46.0	32.5	33.1	20.4
1941–45	25.7	15.3	12.6	13.8	18.8	26.0	42.6	55.0	53.7	36.8	26.2
1946–50	46.3	24.0	14.1	16.6	19.2	30.7	48.4	88.3	87.9	62.5	35.0
1951–55	35.8	27.2	18.3	23.5	23.2	35.3	59.5	117.7	175.7	159.1	49.3
Females											
1921–25	2.2	5.8	3.5	4.0	4.3	6.6	12.0	8.2	14.0	9.1	6.4
1926–30	5.6	8.0	4.0	3.9	4.4	10.9	11.8	13.6	5.6	------	7.1
1931–35	15.3	7.7	4.0	4.4	10.7	11.0	17.3	17.8	6.8	11.5	9.8
1936–40	24.5	10.7	5.3	8.6	10.4	19.1	26.0	28.0	15.7	12.4	14.6
1941–45	28.6	16.6	8.5	9.0	11.1	21.6	31.3	36.1	29.7	22.4	18.6
1946–50	25.7	17.2	10.9	12.4	14.5	23.3	35.9	46.0	44.0	29.8	22.6
1951–55	28.8	24.0	12.6	11.8	16.6	30.0	57.5	69.2	78.8	77.8	32.4
Males	Annual percentage change in rates										
1921–25	------	------	------	------	------	------	------	------	------	------	------
1926–30	23.8	0.7	12.4	10.0	0.6	1.4	−1.6	−10.0	27.4	−5.0	3.1
1931–35	3.2	10.6	9.9	.9	6.2	7.7	7.5	21.2	−4.1	30.1	7.9
1936–40	−3.8	4.8	1.2	2.7	5.3	5.1	13.1	9.8	9.3	2.8	6.7
1941–45	6.8	4.4	6.9	6.0	5.0	4.0	4.7	3.6	10.6	2.1	5.2
1946–50	12.5	9.4	2.2	3.8	.5	3.4	2.6	10.0	10.4	11.2	5.9
1951–55	−5.0	2.6	5.4	7.2	3.9	2.8	4.2	5.9	14.8	20.6	7.1
Females											
1921–25	------	------	------	------	------	------	------	------	------	------	------
1926–30	21.0	6.9	2.9	−.8	.4	10.7	−.3	10.6	−16.7	------	2.2
1931–35	22.2	−.9	−.8	2.4	19.8	.2	8.0	5.5	4.0	------	6.4
1936–40	9.9	6.8	6.0	14.5	−.5	11.7	8.5	9.6	18.2	1.4	8.4
1941–45	2.4	9.3	9.8	.9	1.2	2.5	3.7	5.2	13.5	12.7	4.9
1946–50	−1.4	.7	5.1	6.6	5.6	1.5	2.8	4.9	8.2	5.8	4.0
1951–55	2.3	6.9	2.8	−.9	2.8	5.2	9.9	8.5	12.4	21.2	7.5

[1] Annual percentage change in rates from one time period to the next, computed by the compound interest formula.
[2] All ages adjusted to the age distribution of the United States population at the 1950 census.

seven 5-year periods during 1921–55, for each race and sex class. These are shown for whites in table 1 and for nonwhites in table 2. In addition, the annual percentage changes in rates from one time period to the next have been computed by the compound interest formula and are shown in the tables. The annual percentage changes in rates as given for whites in table 1 are in complete conformity with the trends of moving medians of annual rates which were shown in figures 1 and 2 and which have been described above.

For nonwhites, on the other hand, the annual percentage changes from one time period to the next, which are shown in table 2, are clearly too irregular to suggest any stabilization in rate of changes in rates for this race.

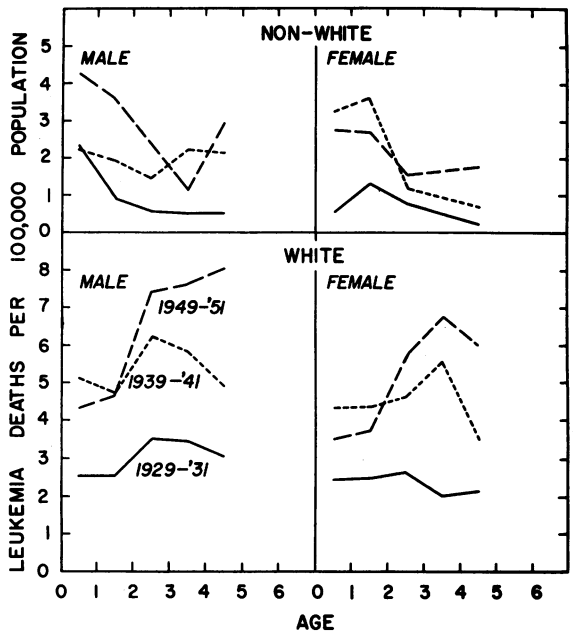
It may be added in passing that, among industrial policyholders of the Metropolitan Life Insurance Company, the total age-adjusted death rates from leukemia declined between 1951 and 1954, the last year for which rates were published (*3*). Whether or not this represents a temporary fluctuation, or a real decline in rates for this group, remains to be seen.

Persons Under 5 Years of Age

Hewitt (*4*) has extended the observation of Cooke (*2*) that leukemia tended to show a peak of occurrence in the third and fourth years of life. Walter and Gilliam (*5*) showed that this peak was present during 1949–51 for the white but not for the nonwhite population of the United States. In view of these observations, more detailed examination of mortality data for persons under 5 years of age appeared desirable. Accordingly, average annual death rates for single years under 5 were computed for 3-year periods centering around the censuses of 1930, 1940, and 1950. The results are shown in figure 3. Although the data for nonwhites are based on small numbers, there is in the three time periods a general tendency in this race for the rates to decline after the first year of life. Among white males, to the contrary, there is an opposite tendency which is present to some extent in all three time periods. Among white females, the latter general tendency is evident in the last two periods although not in the first.

Examination of mortality trends for the ages

Figure 3. Leukemia death rates for single years of age under 5 years for 1929–31, 1939–41, and 1949–51.



under 5 years during intercensal years is unprofitable because of the unavailability of reliable estimates of the populations at risk. Since 1940, however, the Bureau of the Census has published estimates (*6*) of the population for the ages under 1, 1 and 2, and 3 and 4 years. Leukemia death rates for each year, 1940 to 1955, inclusive, have been computed from these estimates, and the results for white males and females are plotted on a semilogarithmic scale in figure 4. For both sexes there is a regular decline in the rates for infants under 1 year old, which is offset in about the same degree by a rise in rates for children 3 and 4 years of age. Among females 1 and 2 years old the rates have remained at a fairly constant level, while in the males of these ages there is a tendency towards a decline in rates since about 1950.

Among the nonwhites the annual fluctuations arising from the small numbers of deaths make it impossible to form reliable conclusions about trends for these ages.

Lifetime Probability of Dying of Leukemia

Throughout the entire life span from birth onwards, the probability of dying of a disease

is a function not only of changing age-specific mortality due to that disease, but of changing survivorship from all other competing causes of death. As is well known, there have been marked fluctuations during the last 25 years, in the United States and elsewhere, with respect to expectation of life and causes of death in general. To estimate the combined effect of these general forces, together with annual changes in leukemia mortality, the lifetime probability of dying of leukemia has been computed for 6 years, distributed at 5-year intervals 1930 to 1955, inclusive, by a method from Spiegelman (7), which employs United States life tables and age-specific leukemia mortality for each year listed. The results of these computations are shown in table 3 for both races and for each sex. The percentage change in probability of dying of leukemia during each 5-year interval is also shown in the table.

In 1930 the betting odds were 185 chances in 100,000, or slightly less than 0.2 percent, that a white male would eventually die of leukemia. By 1955 this probability had risen to 684 chances in 100,000, or a little less than 0.7 percent. Changes of a similar kind, although of different degree, are noted for white females and for nonwhites of each sex.

Figure 4. Trends of leukemia death rates for white males and white females under 1, 1 and 2, and 3 and 4 yecrs of age, 1940–55.

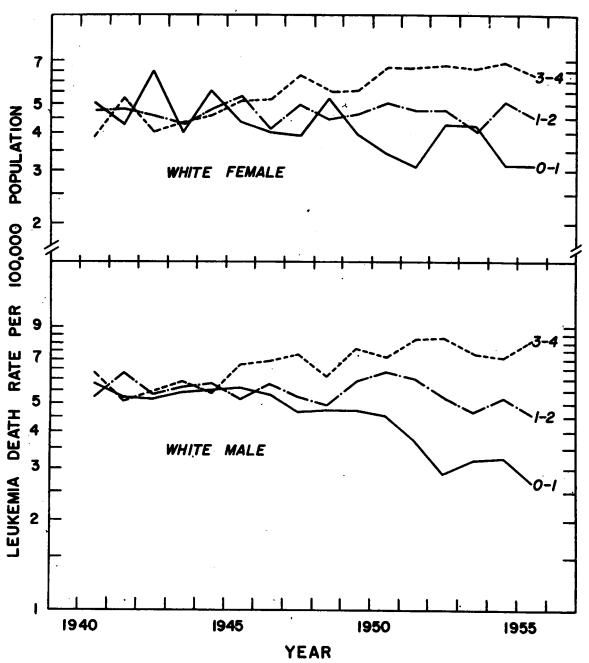


Table 3. Changes in lifetime probability [1] of dying of leukemia, from birth onward

Year	White		Nonwhite	
	Males	Females	Males	Females
	Lifetime probability of dying of leukemia			
1930	0. 00185	0. 00150	0. 00059	0. 00032
1935	. 00243	. 00198	. 00083	. 00057
1940	. 00350	. 00287	. 00149	. 00088
1945	. 00418	. 00357	. 00166	. 00118
1950	. 00579	. 00499	. 00240	. 00193
1955	. 00684	. 00576	. 00348	. 00260
	Percent increase in probability			
1930–35	31	32	41	78
1935–40	44	45	80	54
1940–45	19	24	11	34
1945–50	38	40	45	64
1950–55	18	15	45	35

[1] Computed from United States Life Tables and age-specific leukemia mortality for the indicated years, by a method from Spiegelman (7).

The percentage increase in probability of death from leukemia for each 5-year interval is shown in the lower half of table 3. The rate of increase is greater for nonwhites than for whites, but in all classes there is a distinct tendency toward a decline in rate of increase. Also, the changes in rate of increase, as estimated from lifetime probabilities, are less regular and are subject to greater fluctuation than when estimated from the annual probability of dying of leukemia, as shown in figures 1 and 2.

In view of the impossibility of determining from figure 4, with any degree of assurance, that the decline in death rates for infants under 1 year of age is entirely offset by the increase in rates for children 3 and 4 years of age, the probability of dying of leukemia during the first and second 5 years of life (birth to 5th birthday and 5th to 10th birthday) has been computed and is shown in table 4. The table shows that between 1950 and 1955 there has been a slight decline in accumulated risk of dying of leukemia in the first 5 years of life.

Table 4. Probability of dying of leukemia [1]

Year	During first 5 years of life				During second 5 years of life			
	White		Nonwhite		White		Nonwhite	
	Male	Female	Male	Female	Male	Female	Male	Female
1930	0. 00014	0. 00010	0. 00006	0. 00002	0. 00011	0. 00006	0. 00004	0. 00001
1935	. 00016	. 00015	. 00005	. 00003	. 00010	. 00008	. 00005	. 00001
1940	. 00026	. 00021	. 00011	. 00007	. 00016	. 00011	. 00008	. 00003
1945	. 00027	. 00024	. 00010	. 00008	. 00015	. 00012	. 00009	. 00004
1950	. 00030	. 00026	. 00014	. 00009	. 00019	. 00016	. 00010	. 00009
1955	. 00026	. 00023	. 00010	. 00009	. 00022	. 00014	. 00012	. 00006

[1] See footnote table 3.

Taken together with the trends of annual death rates for the ages under 1 year and 1 to 4 years (figs. 1 and 2), this strengthens the belief that this reduction may be real and not a fluctuation such as was observed in the other direction between 1945 and 1950. Regardless, however, of the certainty which might be placed in this conclusion, the table clearly shows that the risk of dying of leukemia in the first 5 years of life has at least been stabilized since 1940. During the second 5 years of life, on the other hand, there has been a perceptible, though slight, increase since 1940 in the probability of dying of leukemia.

Individual States

Unpublished tables are available from the National Office of Vital Statistics which give leukemia deaths, by age, for each State since 1935. Prior to 1942, however, deaths were assigned to the State in which death occurred rather than to the State of residence of the decedent. No information is available to determine whether or not the leukemia deaths recorded in some States prior to 1942 include any substantial proportion of nonresidents. With this reservation in mind, age- and race-adjusted death rates were computed by the indirect method for each State for three 3-year periods centering around the censuses of 1930, 1940, and 1950. The indirect method employed involved multiplication of the 1949–51 age-specific rates for the United States as a whole, for whites and for nonwhites separately, by the corresponding State populations as enumerated at the 1930, 1940, and 1950 censuses. This procedure yielded the deaths expected in each State during each period, on the basis of the 1949–51 experience of the white and nonwhite populations of the entire United States. The observed deaths, divided by those expected on this basis, yield a ratio which, when multiplied by the crude rate for the United States for 1949–51 (58.18 per million), gives the State rate adjusted for age and race.

Table 5 shows the leukemia mortality rates for each State grouped in standard geographic regions. The percentage increases in rates between 1930 and 1940, and between 1940 and 1950, are also given. Rates for the entire United States increased 64 percent between 1930 and 1940 as compared with an increase of 43 percent between 1940 and 1950. This decline in rate of increase is evident in each geographic region except New England. In this area 3 of the 6 States showed increases in the rate of increase, but the number of deaths recorded for them forms a relatively small proportion of the total deaths credited to the entire region. All other regions show a decline in percentage increase, but 12 other States do not exhibit such decline. These include nearly half of the States in the East and West South Central regions, three in the South Atlantic, and half of those in the Mountain States. In general, these all represent States having relatively small populations or relatively low leukemia mortality rates, or both.

Since the basic data available do not give the race of decedents for many of the States during 1929 to 1931, comparisons cannot be made for changes in rate of increase for each race sepa-

Table 5. Trends of leukemia mortality in the geographic regions and States of the United States [1]

Region and State	Number of deaths recorded			Average annual age- and race-adjusted death rates per million			Percent increase in rates	
	1929–31	1939–41	1949–51	1929–31	1939–41	1949–51	1930–40	1940–50
New England	**649**	**1,045**	**1,787**	**27.5**	**39.9**	**57.6**	**45.1**	**44.4**
Maine	55	86	149	21.8	31.4	48.6	44.0	54.8
New Hampshire	38	50	109	25.4	30.8	58.8	21.3	90.9
Vermont	20	35	101	17.6	30.0	79.0	70.5	163.3
Massachusetts	368	580	910	30.3	43.1	57.5	42.2	33.4
Rhode Island	53	77	106	27.9	36.3	41.7	30.1	14.9
Connecticut	115	217	412	26.2	42.8	63.6	63.4	48.6
Middle Atlantic	**1,932**	**3,616**	**5,777**	**28.0**	**46.0**	**60.9**	**64.3**	**32.4**
New York	1,118	1,973	3,084	33.7	50.8	65.3	50.7	28.5
New Jersey	243	526	911	23.4	44.6	60.5	90.6	35.7
Pennsylvania	571	1,117	1,782	22.5	39.8	54.6	76.9	37.2
East North Central	**1,663**	**3,379**	**5,577**	**24.2**	**43.2**	**58.4**	**78.5**	**35.2**
Ohio	404	834	1,489	22.0	40.4	59.1	83.6	46.3
Indiana	177	362	709	18.8	34.4	56.4	83.0	64.0
Illinois	549	1,136	1,633	27.2	49.4	59.2	81.6	19.8
Michigan	297	610	1,045	23.6	41.7	55.4	76.7	32.9
Wisconsin	236	437	701	28.6	46.3	62.6	61.9	35.2
West North Central	**1,031**	**1,851**	**2,951**	**28.1**	**45.0**	**63.5**	**60.1**	**41.1**
Minnesota	272	473	739	38.2	56.8	75.9	48.7	33.6
Iowa	217	345	546	29.7	42.9	61.0	44.4	42.2
Missouri	275	461	739	26.9	39.8	56.3	48.0	41.5
North Dakota	31	85	109	18.3	47.9	58.1	161.7	21.3
South Dakota	[2] 31	75	137	26.0	40.8	67.0	56.9	64.2
Nebraska	86	177	286	22.7	44.3	64.6	95.2	45.8
Kansas	119	235	395	22.4	42.1	62.4	87.9	48.2
South Atlantic	**680**	**1,396**	**2,822**	**19.3**	**33.2**	**51.8**	**71.5**	**56.0**
Delaware	12	36	56	18.3	47.6	59.2	45.4	24.4
Maryland	127	178	338	30.4	36.4	52.1	19.7	43.1
District of Columbia	51	118	117	41.9	70.5	55.4	68.3	−21.4
Virginia	105	216	443	18.8	33.3	52.2	77.1	56.8
West Virginia	62	152	317	14.7	31.2	56.0	112.2	79.5
North Carolina	94	240	474	14.1	30.8	48.9	118.4	58.8
South Carolina	47	104	250	14.2	27.3	53.4	92.3	95.6
Georgia	100	221	439	16.6	32.1	52.4	93.4	63.2
Florida	82	131	388	23.9	26.7	48.1	11.7	80.1
East South Central	**352**	**772**	**1,595**	**15.8**	**30.0**	**53.1**	**89.9**	**77.0**
Kentucky	94	217	440	13.9	28.1	50.8	102.2	80.8
Tennessee	99	248	515	16.0	34.0	57.7	112.5	69.7
Alabama	94	178	366	17.2	28.9	49.4	68.0	70.9
Mississippi	65	129	274	16.6	28.6	54.4	72.3	90.2
West South Central	**226**	**1,006**	**2,180**	**16.1**	**31.5**	**55.2**	**95.7**	**75.2**
Arkansas	55	105	253	13.3	22.4	48.4	68.4	116.1
Louisiana	79	175	403	18.3	33.8	61.6	84.7	82.2
Oklahoma	92	180	358	16.4	29.2	53.0	78.0	81.5
Texas [3]	-------	546	1,166	-------	34.3	55.5	-------	61.8
Mountain	**199**	**399**	**821**	**21.0**	**35.2**	**55.9**	**67.6**	**58.8**
Montana	30	73	118	21.4	45.6	63.0	113.1	38.2
Idaho	30	46	105	25.8	31.7	59.9	22.9	89.0
Wyoming	9	24	39	16.5	36.4	47.3	120.6	29.9
Colorado	68	132	234	23.8	39.3	56.3	65.1	43.3
New Mexico	6	33	86	6.0	25.7	49.9	328.3	94.2
Arizona	19	38	104	19.2	31.3	52.4	63.0	67.4
Utah	32	45	108	25.4	30.9	56.4	21.7	82.5
Nevada	5	8	27	20.7	26.0	57.9	25.6	122.7
Pacific	**727**	**1,384**	**2,794**	**31.4**	**46.1**	**61.4**	**46.8**	**33.2**
Washington	117	241	448	26.4	44.4	59.0	68.2	32.9
Oregon	99	161	283	35.6	46.8	57.8	31.5	23.5
California	511	982	2,063	32.0	46.5	62.5	45.3	34.4
United States	7,459	14,848	26,304	24.7	40.5	58.2	64.4	43.3

[1] Brief reference is made in the text to some limitations of these data.
[2] 1930 and 1931 only.
[3] Admitted to death registration States in 1933.

rately, by State. For the entire United States, however, there was a much greater percentage increase for nonwhites during both periods, being 98 percent and 62 percent, respectively, for nonwhites as compared with 64 percent and 42 percent for whites.

MacMahon (*8*), who studied the increase in leukemia mortality among the white population of each State between two periods, 1938–42 and 1949–53, was impressed with the large percentage increase exhibited in five of the Mountain States—Nevada, Utah, Arizona, Idaho, and Montana. Three, and possibly four, of these States showed a greater percentage increase in leukemia deaths between 1940 and 1950 than was observed between 1930 and 1940. Inasmuch as the number of deaths on which the increases are based is small; since these States, except Utah, lack University Medical Centers, it is probable that some of their residents died outside the State, with the result that part of their increase in mortality from leukemia after 1940 is an artifact; and since 11 other States not in this region exhibited the same type of trend, we can see no reason to single these States out for particular consideration on the basis of these data.

Mortality Among Physicians

No published data are available in the United States for a fully adequate analysis of leukemia mortality trends among physicians as a whole, or for any physician speciality group. With the exception of the report of Dublin and Spiegelman (*9*), all studies of leukemia mortality among physicians have depended upon leukemia deaths listed in the obituaries published in the Journal of the American Medical Association. Since these do not always give the cause of death, and since all physicians' deaths known to the association are not listed, it has not been possible to compute adequate mortality rates from these data. It has been feasible, nevertheless, to compute age-specific ratios of listed leukemia deaths to all deaths listed among physicians, and to compare them with ratios similarly derived for deaths recorded in the white male population as a whole. This has been accomplished, notably by Henshaw and Hawkins (*10*) and by Peller and Pick (*11*). Both studies yielded higher leukemia ratios among physicians than among the general white male population as a whole.

Ratios of this kind, even when computed on an age-specific basis, do suffer from some uncertainty as to how much of the result reflects an excess of leukemia and how much may be due to a deficit in other causes of death. At the present time, at least, such ratios would somewhat overestimate the rate of leukemia among physicians since Dickinson and Martin (*12*) have shown a deficit of 7 percent in mortality from all causes for this profession during the

Table 6. Average annual leukemia death rates for physicians compared with rates for all white males, United States, 1938–42

Age group (years)	Number of physicians [1]	Leukemia deaths, physicians, 1938–42 [2]	Average annual leukemia death rate per million		Ratio of rates: physicians / white males
			Physicians	White males	
All ages	175, 159	[3] 102	116. 5	[4] 66. 5	1. 75
20–34	42, 471	11	51. 8	18. 3	2. 83
35–44	40, 029	10	50. 0	28. 6	1. 75
45–54	31, 314	18	115. 0	53. 9	2. 13
55–64	31, 352	22	140. 3	102. 1	1. 37
65–74	22, 186	31	279. 5	156. 4	1. 79
75–84	6, 788	9	265. 2	182. 0	1. 46
85 and over	1, 019	1	196. 3	125. 9	1. 56

[1] From Dublin and Spiegelman (*9*).
[2] From Spiegelman, personal communication.
[3] Including 7 females, aged 34, 38, 40, 47, 54, 66, and 71 years.
[4] Adjusted to age distribution of physician population.

Table 7. Average annual leukemia death rates for physicians compared with rates for all white males, United States, 1949–51

Age group (years)	Number of physicians [1]	Leukemia deaths, physicians, 1949–51 [2]	Average annual leukemia death rate per million		Ratio of rates: physicians / white males
			Physicians	White males	
All ages	204, 450	85	[3] 145. 4	[3] 104. 9	1. 39
20–34	50, 566	4	26. 4	24. 3	1. 09
35–44	54, 496	6	36. 7	34. 3	1. 07
45–54	38, 270	7	61. 0	68. 5	. 89
55–64	27, 411	14	170. 2	148. 7	1. 14
65–74	21, 952	32	485. 9	277. 1	1. 75
75–84	10, 256	21	682. 5	389. 1	1. 75
85+	1, 499	1	222. 4	372. 8	. 60

[1] From Dickinson and Martin (*12*).
[2] From Dickinson and Martin, personal communication.
[3] Adjusted to the age distribution of physicians in 1940, as reported by Dublin and Spiegelman (*9*).

years 1949 to 1951. Such ratios would also overestimate the rates of leukemia mortality among physicians if leukemia deaths were more regularly listed in the obituaries than were other causes of death.

Because of the interest in leukemia among physicians, it appears desirable to place on record their death rates and their trend. This is now possible through the courtesy of M. Spiegelman of the Metropolitan Life Insurance Company and Dr. F. G. Dickinson and L. W. Martin of the Bureau of Medical Economic Research of the American Medical Association, who have supplied us with unpublished data. These data are shown in detail in table 6 for the 5-year period centering around 1940 and in table 7 for the 3-year period centering around 1950. Spiegelman identified 102 leukemia deaths (table 6) among physicians between 1938 and 1942. This is 26 percent more than the 81 deaths which Henshaw and Hawkins (*10*) found listed in physicians' obituaries during the same period.

The tables also show rates for the same periods for white males in the United States as a whole, and ratios of the age-specific leukemia mortality rates for physicians to the rates for white males. These ratios decreased with age in 1940, but increased with age in 1950. In 1940 the age-adjusted rate was 75 percent greater for physicians than for white males as a whole, while in 1950 it was only 39 percent greater. This is due to the fact that the rates among physicians increased only 25 percent in 10 years, while those for all white males of the same ages increased 58 percent. Comparison of leukemia mortality rates in tables 6 and 7 also shows that there was a decrease in leukemia mortality in the 10-year period, for physicians under 55 years of age, which was more than offset by increases for those over 55.

Summary and Discussion

Mortality attributed to leukemia in the death registration States of the United States between 1921 and 1955 has been characterized by:

1. An increase in the age-adjusted death rate for all ages, in both races and in each sex, with the rate of increase greater for nonwhites than for whites.

2. A decline since about 1940 in the rate of increase among white persons, but little tendency toward a decline among nonwhites. For the entire population the percent increase dropped from 64 percent between 1930 and 1940 to 43 percent between 1940 and 1950.

3. A regular decline since 1940 in death rates for white infants under 1 year of age.

4. An increase since 1940 in death rates for white children 3 and 4 years of age, which tends to offset the decrease exhibited among infants. For all ages under 5 years, in both

races and in each sex, however, the accumulated probability of dying from leukemia has been relatively stable since 1940, with an apparent tendency to decline among the whites since 1950.

5. A perceptible decline since 1940 in the rate of increase for all other age groups in the white race except for those 75 years of age and over. This tendency is more marked in the younger ages, and its magnitude decreases with age.

6. A smaller percentage increase between 1940 and 1950 than between 1930 and 1940, in two-thirds of the States.

7. A smaller increase between 1940 and 1950 among physicians than among white males of the same ages in the general population.

If these trends among whites persist, they will eventually result in stabilization or actual decline in the leukemia death rates for all ages. Without projection into the future, however, the trends presently evident provide no support whatsoever for a theory which postulates a sharp increase within the last 15 years in leukemogenic factors affecting the environment of Americans in general. On the contrary, the data suggest that such exposure has either become stabilized or has actually decreased during this period, if exposure to environmental factors is in fact responsible for the disease. The steady decrease in rate of increase in leukemia mortality in every age group among the white population under 75 years of age is entirely consistent with a theory of recent decrease in exposure of the general population to whatever causes operate to induce the disease.

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Haldeman Named Division Chief

Dr. Jack C. Haldeman has been appointed chief of the Division of Hospital and Medical Facilities of the Public Health Service. He succeeds Dr. Vane M. Hoge, who has been named executive director of the newly created Hospital Planning Council of Metropolitan Chicago. Dr. Hoge is retiring after 30 years with the Service.

As chief of the division with the rank of Assistant Surgeon General, Dr. Haldeman will administer the Hill-Burton program which, as its executive officer from 1946 to 1948, he helped to organize. In 1948 he became the first director of the Service's Arctic Health Research Center in Anchorage, Alaska, a post which he held until 1951. Subsequently he served as chief of the Division of General Health Services, Bureau of State Services, and for the past year he has been deputy chief of the division that he now heads.