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VITAL and HEALTH STATISTICS
ANALYTICAL STUDIES

Changes in Mortality Trends: England and Wales

1931-1961

A study of trends in the death rates in England and Wales analyzed by sex, age, and cause of death as part of a survey of trends in the United States and other countries.

Washington, D.C. November 1965

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
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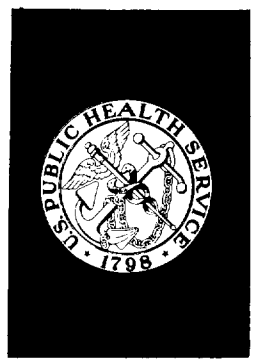

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CONTENTS

THIS REPORT is the third in a series of analytical studies from the Office of Health Statistics Analysis designed to ascertain causes underlying the change in mortality trend observed in the United States and in a number of countries in recent years.

These studies are part of a program of the Office to encourage observation and interpretation of national trends by contracts with responsible investigators in various countries, in order to provide clues for comparison with findings in the United States and other countries.

This analytical study of mortality trends in England and Wales examines the effects of certain economic, social, and medical changes on mortality and discusses the prospects for future changes in mortality.

When allowances are made for artifacts of diagnosis and coding, a clear pattern can be seen of declining mortality from infectious and respiratory diseases, little change for neoplastic diseases and violence, and gradual increase for vascular diseases. In England and Wales the average age of the population is still increasing so that the death rate will rise in the future unless major changes occur in the prevention and cure of coronary artery disease. Except for reduction in cigarette smoking there is no major advance in medicine or public health in prospect that is likely to alter the main trend in mortality, which has shown no improvement in the last few years.

The methodology, findings, and conclusions are those of the investigator.

SYMBOLS

Data not available	---
Category not applicable	...
Quantity zero	-
Quantity more than 0 but less than 0.05	0.0
Figure does not meet standards of reliability or precision	*

CHANGES IN MORTALITY TRENDS: ENGLAND AND WALES

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INTRODUCTION

In a previous report from the National Center for Health Statistics (Series 3, No. 1) it was shown that there had been a recent change in the mortality trends for the United States as a result of which the crude death rate had been more or less stationary for the decade 1950 to 1960. In view of the medical and social changes in the postwar years this failure of the crude death rate to improve was surprising, and the report (Series 3, No. 1) was a detailed analysis of the reasons which lay behind this trend. It was concluded that the recent changes in the trend in the United States could not be attributed to the aging of the population or to artifacts in calculating the mortality rate but stemmed from two other factors. The first was that the reduction of mortality due to infectious diseases had been so successful that there was little possibility of further improvement, and the second was that the diseases which were now prominent among the population of the United States were chronic degenerative diseases for which there had been no great improvement in mortality trends in the past and none were likely in the near future. The rate of change of these trends in the chronic diseases is such that it would retard the downward course of the total death rate.

That report also made a comparison between the rates in the United States with those of other countries in Europe, South America, and Asia; and many of these countries showed similar trends. The improvement in certain countries such as Chile and Japan were very marked indeed; whereas those in Norway, Sweden, Denmark, and the Netherlands were roughly similar to those experienced in the United States. In England and Wales, however, the crude mortality rate had remained constant for over 30 years despite very large advances in social and medical care. It is the purpose of this report to analyze in much greater detail the trends that underline these figures in England and Wales.

MORTALITY TRENDS IN ENGLAND AND WALES, 1841-1961

It is possible to examine trends of comparable mortality data in England and Wales for a longer period than in almost any other country except Sweden and to examine whether similar trends have appeared in the past.

Civil registration of Births, Deaths, and Marriages was introduced by the Act of Parliament, 6th and 7th, William IV, Cap 86 in the year 1836. When this act was passed, representatives of the medical profession agreed

[1]Mortality rates by age and sex for each of the main causes of death for the individual years 1931 through 1961 may be obtained from Dr. H. Campbell, Welsh National School of Medicine, The Parade, Cardiff. The fee is $3.00.

to pledge themselves "To give in every instance that may fall under our care an authentic name of the fatal disease, to procure a better registration of the causes of death, being convinced that such an improved Registration cannot fail to lead to a more accurate statistical account of the prevalence of particular diseases."

The work of registration began in July 1837, and the new Registrar General appointed Dr. William Farr as abstractor "To prepare an accurate statistical account of mortality in England and Wales." There were preliminary reports for the years 1838-40, but the first detailed analysis of mortality was published in 1841 which was a censal year, and similar reports have continued to appear annually. These earlier reports shocked the conscience of society, and their effect on political life was considerable. They provided the ammunition for many of the social reformers of the early Victorian period. Within 5 years several acts were passed regulating employment in factories and mines and the conditions in public health and industrial hygiene, but there was no improvement in the mortality rate for at least 30 years.

The period 1841-1961 (table A and fig. 1) may be divided into four eras, each covering approximately one generation of 30 years.

In the generation from 1841-71, which coincided with the active professional career of Dr. Farr, mortality remained relatively constant at about 22 deaths per 1,000 persons; and even when the rates are standardized for changes in the age structure of the population, there is no evidence of any improvement. It would appear that the concentration of population in large industrial cities more than counterbalanced the advances in medical sci-

Table A. Death rates per 1,000 population and standardized mortality ratios (1950-52 standard) by sex: England and Wales, 1841-1960

Year	Both sexes	Male	Female	Both sexes	Male	Female
	Death rate per 1,000 population			Standardized mortality ratio		
1956-60	11.6	12.3	10.9	91	94	89
1951-55	11.7	12.5	10.9	97	98	95
1946-50	11.8	12.8	10.9	101	99	102
1941-45	12.8	15.1	11.1	112	110	113
1936-40	12.5	13.5	11.6	128	123	132
1931-35	12.0	12.7	11.4	134	127	141
1926-30	12.1	12.9	11.4	145	137	153
1921-25	12.1	12.9	11.4	157	147	166
1916-20	14.4	16.5	12.8	190	180	199
1911-15	14.3	15.4	13.3	205	195	215
1906-10	14.7	15.6	13.8	221	208	234
1901-05	16.0	17.1	15.0	249	234	264
1896-1900	17.7	18.8	16.6	279	262	297
1891-95	18.7	19.8	17.7	296	275	318
1886-90	18.9	20.0	17.8	300	278	322
1881-85	19.4	20.5	18.3	308	284	333
1876-80	20.8	22.1	19.5	328	302	354
1871-75	22.0	23.3	20.7	342	314	371
1866-70	22.4	23.7	21.2	349	318	380
1861-65	22.6	23.7	21.5	353	320	387
1856-60	21.8	22.6	21.0	341	306	377
1851-55	22.7	23.5	21.8	356	321	392
1846-50	23.3	24.1	22.6	369	331	409
1841-45	21.4	22.1	20.6	344	307	381

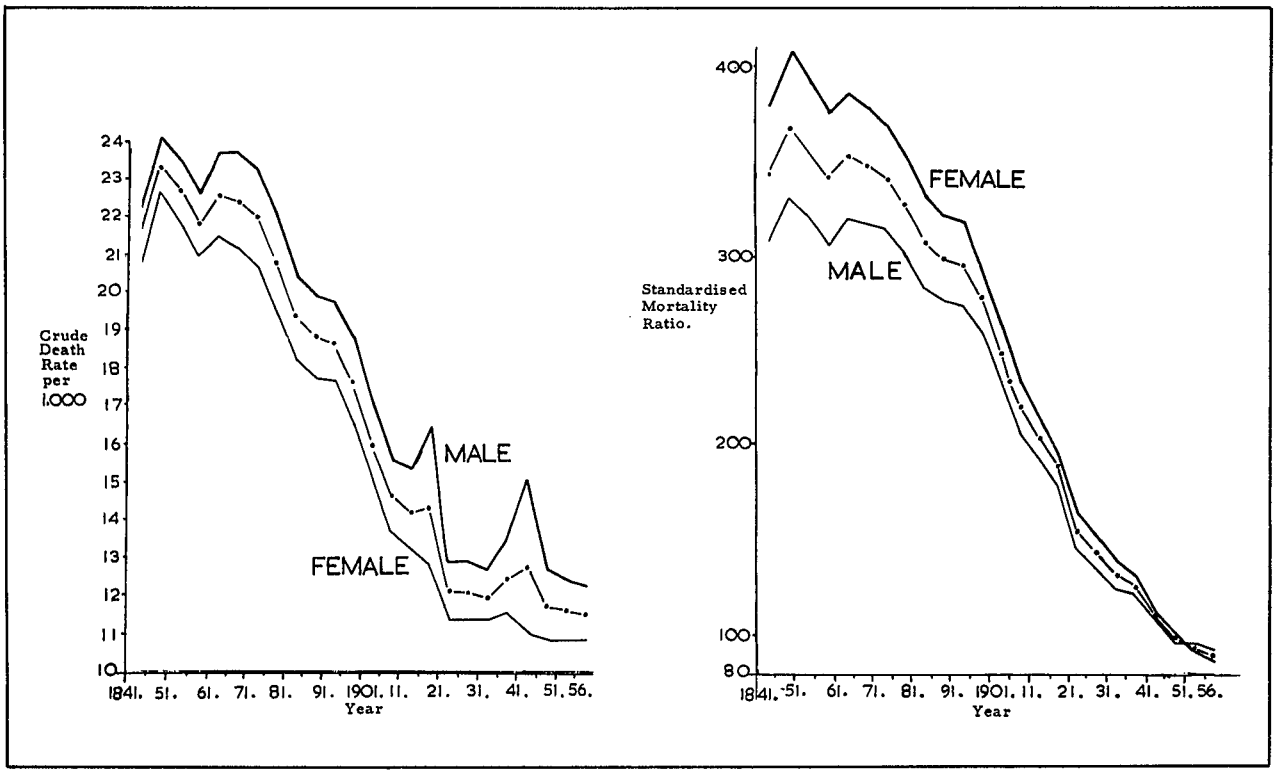

Figure 1. Death rates per 1,000 population and standardized mortality ratios (1950-52 Standard), 1841-1960.

ence and that the early attempts at public health legislation were not entirely effective.

Between 1871 and 1901, however, there was a complete change in the trend; and for 30 years there was a steady but slow decline in mortality, the rate falling from 22 to 17 per 1,000 and the age-standardized rates falling by 30 percent. New compulsory public health acts were passed, housing was improved, universal compulsory schooling was started in 1871; and although there was industrial and agricultural depression in the 1880's, this was not serious enough to neutralize the effects of social advances.

With the new century there was an increased renewal in social and medical reform. Pensions in old age and industrial health insurance were introduced in 1908 and 1911 and new Factory Acts were also passed. Unfortunately, this legislation was to be followed by the war of 1914-18. Nevertheless, during the 30 years 1901-31 the mortality rate fell from 17 to 12 per 1,000 and the age-standardized rates fell by 35 percent.

The next generation (1931-61) provided even greater contrasts than any generation before. The beginning of the generation in 1931 was a period of depression, with widespread unemployment and a low level of wages throughout the entire country. Conditions improved slowly during the 1930's, but they were to be followed by the cataclysm of war which lasted for 6 years in this country. After the war there was a period of far-reaching changes in the pattern of the health and welfare services. The National Health Service was widened to offer free access for all; and benefits in sickness, unemployment, and retirement were improved. The last decade of the period was one of increasing affluence and scientific advance. This generation also saw the introduction of the sulfonamides in the late 1930's, of penicillin in the early 1940's, and the other antibiotics in the later 1940's. All these advances

provided possibilities for medical treatment that had not been previously available. Yet despite all this the crude mortality rate did not decline but remained fairly constant at about 12 per 1,000 population.

It is thus apparent that in England and Wales since 1840 the crude mortality rate has not reflected the trends in social and medical advances in the country. There have been periods of greater advances in medical knowledge and standards of living when the crude mortality rate has been constant; there have been other periods when conditions have been bad but the mortality rate has fallen. It is, therefore, necessary to analyze the mortality of a country in much greater detail both by age and sex and by cause of death in order to have any idea as to what are the relative changes and what are the possibilities of future trends. The present report proposes to examine in such detail the changes in mortality trends in England and Wales in the period 1931-61.

VALIDITY OF THE DATA

First it is necessary to consider whether administrative improvements, advances in medical diagnosis, or statistical methodology may have produced, by an artifact, a change in the rates.

Administrative Changes

The only major administrative advance in recent years has been the introduction of registration of stillbirths in 1928 which may have had an influence in improving birth registration and registration of infant deaths; but there has been no other major change in the method of registration or census taking in the period under review, and it is believed that there has been no improvement in the quality of registration. However, there have been several changes in the method of calculating death rates. During the decade 1939-49 many young men and women were in the armed services, all deaths of civilians which occurred in England and Wales were recorded, and the population used for calculating mortality rates was the civilian population only. Unfortunately, this civilian population was heavily weighted with people who were not fit for service and with servicemen, discharged usually for medical reasons; hence the death rates based upon this residual population are not a true picture of the trends in the country. As there were nearly 5 million men and women under arms by 1944 this method completely distorted the age-specific rates between the ages of 15 and 44 for this decade, and it is not possible to make retrospective adjustments for all these factors. Consequently between these ages it is necessary to treat with great reserve the age-specific rates for the period 1939-49.

Advances in Medical Care

When the individual causes of death are to be considered, there are two factors of importance. First, changes in medical knowledge are such that it is difficult to compare diagnostic ability of 1961 with the diagnostic facilities available in 1931, and many diseases which are now known to be prevalent were not even recognized at the earlier period. It is necessary therefore to confine an analysis over many years to those diseases which were both common and readily recognized during the whole period of time.

Second, there has been a relative increase in the number of doctors in the population; and access to medical care has been facilitated, but the effect of this on the standard of death certification cannot be estimated.

Recent studies have been made by the Registrar General comparing clinical diagnosis of causes of death with the pathological findings, and it must be admitted that the findings are not entirely satisfactory. In consequence, it is necessary to confine detailed analysis of changes in mortality to widely defined causes of death.

Methods of Classification

Difficulties arise due to the method of classification of causes of death. During the 31 years under review there have been four different revisions of the International Classification of Causes of Death (table B). From 1931-39 the Fourth Revision was used; this

Table B. Classifications used in the comparison of the various revisions of the International Statistical Classification of Diseases: England and Wales, 1931-65

Cause of death (Seventh Revision of the International Lists, 1955)	Revision number and years in use			
	Seventh Revision 1956-1965	Sixth Revision 1950-1955	Fifth Revision 1940-1949	Fourth Revision 1930-1939
Infective and parasitic diseases	001-139	001-139	1-44	1-44
Tuberculosis of the respiratory system	001-008	001-008	13	23
Tuberculous meningitis	010	010	14	24
Measles	085	085	35	7
Diphtheria	055	055	10	10
Influenza	See Respiratory Diseases Classification			
Malignant neoplasms	140-199	140-199	45-55	45-53
Of digestive organs and peritoneum	150-159	150-159	46	46
Of stomach	151	151	46b	46
Of respiratory system	160-165	160-165	47	47
Of lung and bronchus	162-165	162-165	47b	N.A.
Of uterus	171-174	171-174	48	48
Of cervix	171	171	48a	N.A.
Of breast	170	170	50	50
Leukemia	204	204	74	72
Vascular lesions affecting central nervous system	330-334	330-334	83	82,97.1
Diseases of the circulatory system	400-468	400-468	---	---
Chronic rheumatic heart disease	410-416	410-416	---	---
Chronic endocarditis not specified as rheumatic	421	421	---	---
Arteriosclerotic heart disease, including coronary disease	420	420	---	---
Other myocardial degeneration	422	422	---	---
Diseases of the heart[1]	---	---	90-95	90-95
Chronic affections of the valves and endocardium[1]	---	---	92	92
Diseases of the myocardium[1]	---	---	93	93
Diseases of the coronary arteries and angina pectoris[1]	---	---	94	94
Other diseases of the heart[1]	---	---	95	95
Diseases of the respiratory system	470-527	470-527	104-114,33	104-114,11
Influenza	480-483	480-483	33	11
Bronchitis	500-502	500-502	106	106
Pneumonia	490-493	490-493	107-109	107-109
Deliveries and complications of pregnancy, childbirth, and the puerperium	640-689	640-689	140-150	140-150
Congenital malformations	750-759	750-759	157	157
Accidents, poisonings, and violence	E800-E999	E800-E999	163-198	163-198
Suicide	E970-E979	E970-E979	163,164	163-171
Accidents	E800-E962	E800-E962	169-195	176-195
Motor vehicle accidents	E810-E835	E810-E835	170	206,208, 210,211

[1]Fifth Revision of the International Lists, 1938.

had been introduced in 1930 and reflected the diagnostic practices of the late 1920's. The instructions to the clerks who were doing the numerical coding of the certificates of death were such that if there were multiple causes of death indicated on the death certificate the clerks were to select the particular cause of death to be coded and give precedence from an arbitrary list of priority causes.

In 1940 the Fifth Revision was introduced. This classification of causes of death followed the same general pattern as that of the Fourth; there was almost no serious change in definitions introduced at this particular point, but the method of coding deaths changed considerably. The coding clerks were now instructed to accept the sequence in which a doctor certified multiple causes of death and to accept his definition of the underlying cause. This had a very marked effect upon certain causes. The Registrar General undertook dual coding of deaths occurring in 1939 both by the Fourth Revision and by the rules of the Fifth Revision. The principal changes which were found are given in table C.

This table shows that the revised method of coding made little difference in deaths attributed to infectious diseases, cancers, diseases of the digestive system, or diseases of infancy and old age, and also in deaths from violence. There were, however, increases in diseases of the nervous system, of the respiratory system, of the genitourinary system and in deaths attributed to childbearing and to congenital causes. There were falls in diseases of the endocrine system, blood and heart diseases, and in diseases of veins and arteries.

The individual causes of death examined in conjunction with the revised instructions to coders suggest some reasons why there were drastic alterations in these causes of death. There was a fall of approximately 17,000 deaths due to arteriosclerosis and a rise of nearly 20,000 in deaths due to vascular diseases of the nervous system; this is simply due to certifying doctors indicating that "stroke" was the underlying cause of death, whereas under the Fourth Revision coders had been instructed to attribute some of these deaths to arteriosclerotic diseases irrespective of the doctor's certificate.

It was at this stage that bronchitis became such an important statistical cause of death in England and Wales. The number of deaths attributed to this cause more than doubled, while there was a corresponding fall in deaths due to myocardial diseases and chronic endocarditis. Thus it appears that doctors in England and Wales in 1939 had frequently attributed terminal myocardial disease to a preceding bronchitic condition. Under the instructions contained in the Fourth Revision cardiac disease had priority over respiratory disease and so the deaths were attributed to the cardiac condition. Under the rules of the Fifth Revision, however, where the certifying doctor was allowed to select the underlying cause of death, these deaths were assigned to the underlying bronchitic condition.

Diabetes was also affected by the changes in the Fifth Revision and no longer took precedence over other diseases unless the certificate indicated that it was a real underlying cause of death.

The Fifth Revision was in use for 10 years until 1949 when the Sixth Revision was introduced.

The major changes between the Fifth and Sixth Revisions based upon the death certificates for 1949 are shown in table D.

Although this revision altered the terminology of diseases and brought the statistical classification in line with medical practice of the late 1940's, there were fewer reclassifications necessary as a result of the recoding. Influenza was now classified with the respiratory diseases rather than with the infectious diseases because many practitioners were inadequately discriminating between deaths due to influenza and those due to pneumonia. Leukemia was now regrouped with the malignant diseases and rheumatism was divided into rheumatic endocarditis and rheumatoid arthritis and reclassified with heart diseases and joint diseases, respectively. Hypertension now appeared as an important cause of death, and it would seem that it was easier under the Sixth Revision to classify a death as due to hypertension than it had been previously. Arteriosclerosis continued to decline as instructions made clear that deaths due to arteriosclerotic heart diseases were to be assigned to

Table C. Comparison of the number of deaths for all ages assigned to selected causes according to the Fourth and Fifth Revisions of the International Lists: England and Wales, 1939

Cause of death (Fifth Revision of the International Lists, 1939)	Number of deaths assigned according to—		Change	Percent change
	Fourth Revision	Fifth Revision		
All causes	498,968	498,968	-	-
Major cause groups				
Infectious and parasitic diseases (including influenza)	43,314	43,866	+552	+1.3
Cancer and other tumors	71,609	69,517	-2,092	-2.9
Rheumatism, diseases of nutrition and of the endocrine glands, other general diseases, and avitaminoses	14,943	10,343	-4,600	-30.8
Diseases of the blood and blood-forming organs (including leukemia)	5,069	3,978	-1,091	-21.5
Diseases of the nervous system and sense organs	41,101	57,679	+16,578	+40.3
Diseases of the circulatory system:				
Diseases of the heart	139,232	125,894	-13,338	-9.6
Diseases of the arteries and veins	32,041	14,546	-17,495	-54.6
Diseases of the respiratory system	41,959	61,509	+19,550	+46.6
Diseases of the digestive system	23,030	22,996	-34	-0.1
Diseases of the genitourinary system	21,346	23,097	+1,751	+8.2
Diseases of pregnancy, childbirth, and the puerperium	1,815	1,997	+182	+10.0
Diseases of skin and bone	2,319	2,142	-177	-7.6
Congenital malformations	4,152	4,629	+477	+11.5
Diseases peculiar to the first year of life	14,174	14,119	-55	-0.4
Senility	17,328	17,267	-61	-0.4
Violent or accidental deaths	24,509	24,310	-199	-0.8
Ill-defined and unknown causes	1,027	1,079	+52	+5.1
Some specific diseases				
Diabetes mellitus	7,627	5,160	-2,467	-32.4
Intracranial lesions of vascular origin	28,975	48,666	+19,691	+68.0
Chronic endocarditis	19,598	17,892	-1,706	-8.7
Diseases of the myocardium	92,031	82,632	-9,399	-10.2
Diseases of the coronary arteries	19,496	17,844	-1,652	-8.5
Arteriosclerosis	27,449	10,570	-16,879	-61.5
Bronchitis	15,463	31,423	+15,960	+103.2
Pneumonia	22,209	23,370	+1,161	+5.2

coronary artery disease and not to arteriosclerosis.

The Seventh Revision was introduced in 1956, but the modifications at this revision were small.

It must be remembered when considering these tables that these changes are not due to any advances in medical science nor to any further detailed certification of the causes of death. In each year when there was a change in classification, the coding clerks took all the death certificates and simply recategorized them according to the revised rules without further reference to the certifying practitioners. The differences in the results are entirely due to statistical artifact.

Table D. Comparison of the number of deaths for all ages assigned to selected causes according to the Fifth and Sixth Revisions of the International Lists: England and Wales, 1949

Cause of death (Sixth Revision of the International Lists, 1949)	Number of deaths assigned according to—		Change	Percent change
	Fifth Revision	Sixth Revision		
All causes	509,973	509,973	-	-
Major cause groups				
Infective and parasitic diseases (excluding influenza)	25,296	24,780	-516	-2.0
Malignant neoplasms (including leukemia)	84,397	85,178	+781	+0.9
Various general diseases	6,787	7,917	+1,130	+16.6
Diseases of the blood and blood-forming organs (excluding leukemia)	2,282	2,345	+63	+2.8
Diseases of the nervous system and mental disorders	65,295	67,449	+2,154	+3.3
Diseases of the circulatory system:				
Diseases of the heart	154,259	149,711	-4,548	-3.0
Hypertension	6,201	16,757	+10,556	+170.2
Diseases of veins and arteries	16,057	14,153	-1,904	-11.9
Diseases of the respiratory system (including influenza)	63,963	59,421	-4,542	-7.1
Diseases of the digestive system	17,314	16,927	-387	-2.2
Diseases of the genitourinary system	18,632	14,114	-4,518	-24.2
Deliveries and complications of pregnancy, childbirth, and the puerperium	727	727	-	-
Diseases of skin and bone	1,063	2,643	+1,580	+148.6
Congenital malformations	4,920	4,644	-276	-5.6
Certain diseases of early infancy	10,995	11,839	+844	+7.7
Symptoms, senility, ill-defined conditions:				
Senility	12,880	12,338	-542	-4.2
Symptoms and ill-defined conditions	18,645	18,513	-132	-0.7
Accidents, poisonings, and violence:				
Violence	260	517	+257	+98.8
Some specific diseases				
Diabetes mellitus	3,444	3,438	-6	-0.2
Vascular lesions affecting central nervous system	59,236	60,051	+815	+1.4
Chronic rheumatic heart disease	13,796	14,966	+1,170	+8.5
Diseases of the myocardium	92,383	82,200	-10,183	-11.0
Diseases of the coronary arteries	42,922	47,128	+4,206	+9.8
Hypertension	6,201	16,757	+10,556	+170.2
Arteriosclerosis	13,663	10,942	-2,721	-19.9
Bronchitis	30,433	28,981	-1,452	-4.8
Pneumonia	20,781	20,132	-649	-3.1

SELECTION OF TIME PERIODS

It is thus apparent that each one of the three time periods 1931-39, 1940-49, and 1950-61 should be treated as separate entities. During each of the periods there was one method of calculating death rates in use, and there was one revision of the International Statistical Classification for coding the causes of death. But between each of these periods there was a discontinuity which can only be bridged by making calculations from the effect of the changes in a particular year. Thus throughout the report tables have been prepared based upon these periods of time, and graphs have been prepared showing the discontinuity between 1939 and 1940 and between 1949 and 1950.

These changes mean that some information which was not available in an earlier period has had to be omitted in a later period; for instance, the Fourth Revision classified all malignant neoplasms of the respiratory system together, whereas in later revisions it was possible to specify cancer of the lung and bronchus. Therefore, to produce a consistent series over the 31 years it has been necessary to make comparisons between the larger group of all cancers of the respiratory tract. Fortunately, in this instance cancers of the lung and bronchus account for 90 percent of all respiratory cancers, and trends for the larger group are also valid for the smaller. In the case of cancer of the cervix of the uterus, however, it is not possible to make comparisons before 1940, when only cancers of the uterus were distinguished as an entity and no valid comparisons may be made.

The Registrar General did undertake special coding for some classifications which were not required for the International List, and sometimes it is possible to obtain a special tabulation covering a series of years.

SELECTION OF DISEASE CATEGORIES

It is possible to discuss a pattern of disease in a community at two different levels. At the first level wide groups based upon complete systems of diseases such as all infectious diseases or all cardiovascular diseases are examined. Although such broad categories are of interest to social scientists and public health administrators, they are of less interest to epidemiologists and physicians who wish to know details concerning specific diseases if these can be defined. At the second level specific diseases are examined but diagnostic changes may confuse the general picture of mortality.

Table B shows the groupings which have been selected for analysis and shows how these categories may be subdivided into specific diseases or regrouped into broad systems.

In the section of this report which deals with mortality within each age and sex group the five most important causes of death have been examined for each year from 1931 to 1961. If in any year a cause of death rises into the first five causes, the progress of this disease has been analyzed throughout the 31 years. Thus in every group at least 5 causes of death, and occasionally 10, have been examined in detail.

GENERAL TREND OF MORTALITY, 1931-61

When allowance is made for changes in the age of the population, the general trend of the mortality during this period has been downward. Crude death rates and standardized mortality ratios are given in table E and figure 2.

At the beginning of the period the country was suffering from the effects of the world-wide industrial depression which was particularly severe in Northern England and in Wales, where the coal, steel, and textile industries were concentrated. It is difficult to estimate the real influence of social and economic environment upon the mortality rates in the country, but it is clear that as economic conditions improved in the 1930's so did mortality. The Standardized Mortality Ratio (SMR)[2] in 1931 was 142, in 1935 it was 127, and by 1939 it had fallen to 122—an improvement of 14 percent in 8 years.

[2]The Standardized Mortality Ratio is the ratio percent of the observed number of deaths in a certain population in a given year divided by the number of deaths which might have occurred if the age- and sex-specific mortality rates for England and Wales in the 3 years 1950-52 had prevailed in that population. The population is enumerated by age and sex; the means of the mortality rates for 1950-52 are multiplied by the population to give an "expected" number of deaths, and these are totaled. The actual number of deaths is divided by the expected and multiplied by 100. This method is equivalent to finding in a given population, by indirect standardization, a Standard Mortality Rate and finding the ratio of that rate to the true rate in that population.

Table E. Death rates per 1,000 population and standardized mortality ratios (1950-52 standard) by sex: England and Wales, 1931-61

Year	Both sexes	Male	Female	Both sexes	Male	Female
	Death rate per 1,000 population			Standardized mortality ratio		
1961	12.0	12.6	11.4	92	95	90
1960	11.5	12.2	10.9	89	92	87
1959	11.6	12.3	11.0	91	94	89
1958	11.7	12.4	11.0	92	95	90
1957	11.5	12.3	10.7	91	94	88
1956	11.7	12.5	10.9	94	96	92
1955	11.7	12.5	10.9	95	97	93
1954	11.3	12.2	10.5	93	95	91
1953	11.4	12.2	10.7	95	96	94
1952	11.3	12.2	10.5	95	96	93
1951	12.5	13.4	11.8	106	106	106
1950	11.6	12.3	11.0	99	98	101
1949	11.8	12.6	11.1	101	99	103
1948	11.0	11.9	10.1	94	93	95
1947	12.3	13.6	11.3	107	106	108
1946	12.0	13.4	10.9	103	101	106
1945	12.6	15.0	10.8	104	103	106
1944	12.7	15.3	10.8	107	106	108
1943	13.0	15.3	11.3	112	109	114
1942	12.3	14.4	10.7	110	109	111
1941	13.5	15.7	11.8	126	124	127
1940	14.4	16.1	12.9	139	135	141
1939	12.1	13.0	11.3	122	117	126
1938	11.6	12.5	10.8	119	116	123
1937	12.4	13.2	11.7	130	124	135
1936	12.1	12.9	11.4	129	123	134
1935	11.7	12.5	11.1	127	120	132
1934	11.8	12.5	11.1	129	123	136
1933	12.3	12.9	11.7	138	129	146
1932	12.0	12.7	11.4	137	129	144
1931	12.3	13.0	11.6	142	133	150

The influence of improved medical treatment is also difficult to assess. Sulfonamides were first introduced in 1935 and became widely available in general medical practice from 1937 onward; penicillin became available in 1940 but was not frequently used in civilian practice until the end of the war; the antituberculous drugs were available in 1946-47 and were used extensively as soon as they became commercially available; tetracyclines and other broad-spectrum antibiotics followed in the early 1950's. Although it is clear that clinically all of these new methods of treatment were very effective in preventing many deaths, it is often difficult to distinguish their statistical effect on mortality from the influence of other trends.

This country declared war in 1939, and the year 1940 was a very difficult one indeed. There was aerial bombardment, evacuation of the civilian population, and conscription of the young adults; but the major reason for the high mortality in 1940 (SMR 1939) was the severity of the weather as the winter of that year was comparable to the winters of 1929 and 1951, all of which caused a marked rise in the mortality rates.

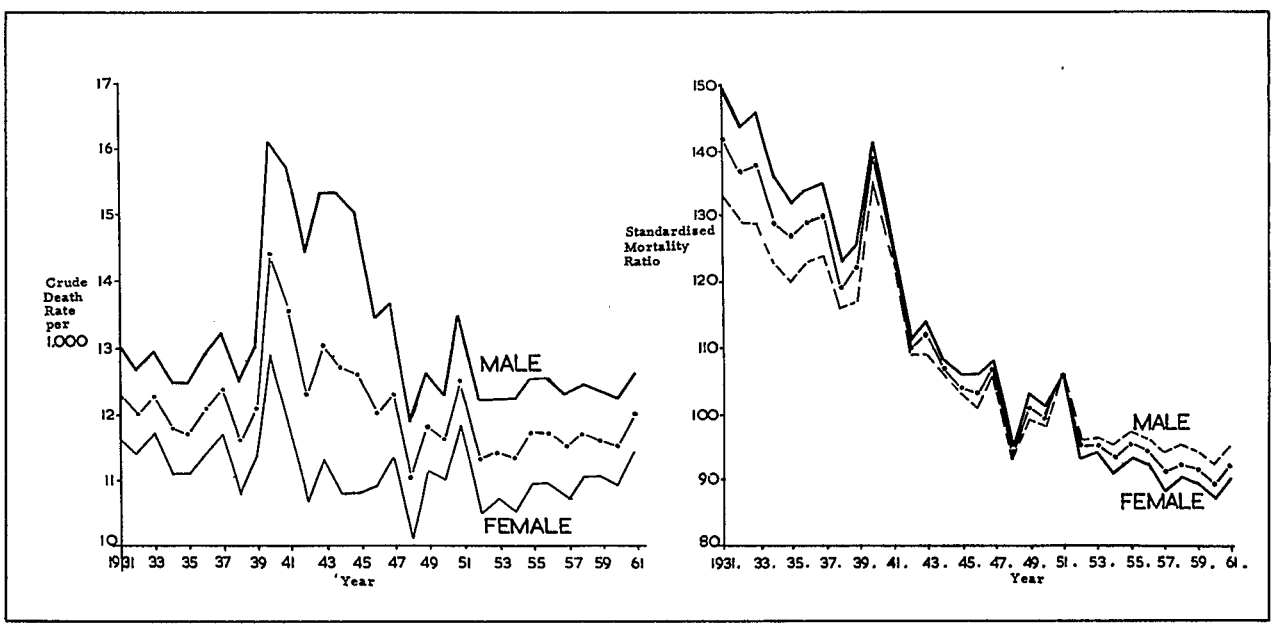

Figure 2. Death rates per 1,000 population and standardized mortality ratios (1950-52 Standard), 1931-61.

The following years of the war saw improved nutrition of the general population as a result of rationing with no recurrence (except in 1944) of the heavy civilian air raids. As a consequence the mortality declined so that in 1945, the last year of the war, the SMR was 104—a decline of 15 percent in the 6 years from 1939.

The first 5 years of the postwar era saw many social and administrative changes in this country, with a revised national health service in 1947. The Standardized Mortality Ratio fell to 99 in 1950—a decline of 5 percent in 5 years.

The decade of the 1950's was a more conservative one in which the affluence of the population increased, but the mortality rates did not improve as rapidly as they had in the preceding 20 years. Between 1950 and 1956 the SMR fell by 5 percent in 6 years to 94, and between 1956 and 1961 it fell by 2 percent in 5 years to 92. Thus the improvements in mortality which had been continuous for the preceding 90 years had almost worked themselves out.

AGE GROUP

The death rates for each age group and for both sexes in 1931 and 1961 are shown in table F and figure 3. The general pattern of mortality throughout life remains constant—the risk of death declines from birth until the age of about 10, it increases rapidly during adolescence, remains constant in early adult life, and then rises steadily throughout the rest of life. But within this general pattern there have been marked changes in the actual death rates during these 31 years. There has been an improvement in the rate for children almost of the order of eight times. There have been moderate changes in young adult life, but there has been very little change in old age. This ratio of the age-specific death rates in 1931 divided by the rates in 1961 are shown in table F and in figure 4.

At all ages, females have advanced more than males despite the fact that in 1931 female death rates were already lower than those for males. The ratio of the male to the fe-

Table F. Age-specific death rates for all causes per 1,000 population and ratios by sex: England and Wales, 1931 and 1961

Age	Male		Female		1931 to 1961 ratio		Male to female ratio	
	1931	1961	1931	1961	Male	Female	1931	1961
	Rate per 1,000 population				Ratio			
All ages-------	13.0	12.6	11.6	11.4	1.03	1.02	1.12	1.11
Under 1 year[1]--------	75.2	23.9	57.1	18.8	3.1	3.0	1.3	1.3
1-4 years----------	8.0	1.0	7.0	0.8	8.0	8.8	1.1	1.3
5-9 years----------	2.3	0.5	2.0	0.3	4.6	6.7	1.2	1.7
10-14 years----------	1.5	0.4	1.5	0.3	3.8	6.0	1.0	1.6
15-19 years----------	2.6	0.9	2.4	0.4	2.9	6.0	1.1	2.3
20-24 years----------	3.3	1.1	2.9	0.5	3.0	5.8	1.1	2.2
25-34 years----------	3.5	1.2	3.3	0.7	2.9	4.7	1.1	1.7
35-44 years----------	5.8	2.4	4.5	1.8	2.4	2.5	1.3	1.3
45-54 years----------	11.6	7.2	8.3	4.4	1.6	1.9	1.4	1.6
55-64 years----------	23.9	22.0	17.6	10.7	1.1	1.6	1.4	2.1
65-74 years----------	58.7	54.3	44.4	30.9	1.1	1.4	1.3	1.8
75-84 years----------	138.4	124.0	114.4	87.1	1.1	1.3	1.2	1.4
85+ years----------	295.9	257.4	255.3	227.1	1.1	1.1	1.2	1.1

[1]Rate per 1,000 live births.

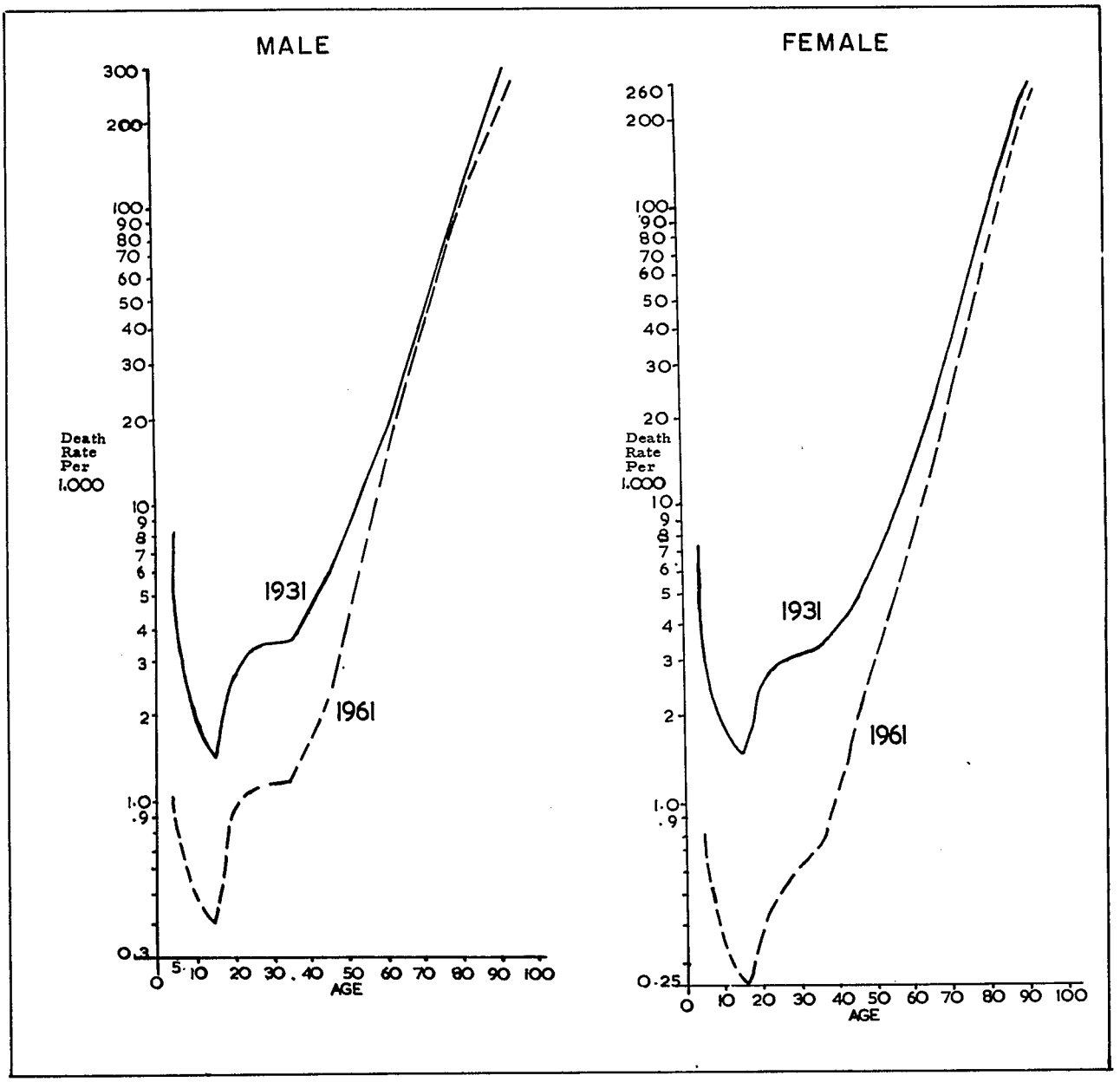

Figure 3. Age-specific death rates per 1,000 population, 1931 and 1961.

male death rate for the same ages is given in table F and in figure 5 for the 2 years 1931 and 1961. In 1931 this ratio varied between 0.99 for ages 10-14 years, implying that the male rate was slightly lower than the female rate, and 1.40 at ages 45-54. But in 1961 the ratio varied between 1.30 for ages 1-4 and 2.19 for ages 15-24 years. At no age between 1 and 84 did the male to female ratio decline during these 31 years.

Infant Mortality Rates—Under 1 Year

It is not the intention of this report to study infant mortality rates in detail. During the period under review, the infant mortality rate has fallen by 70 percent, from a rate

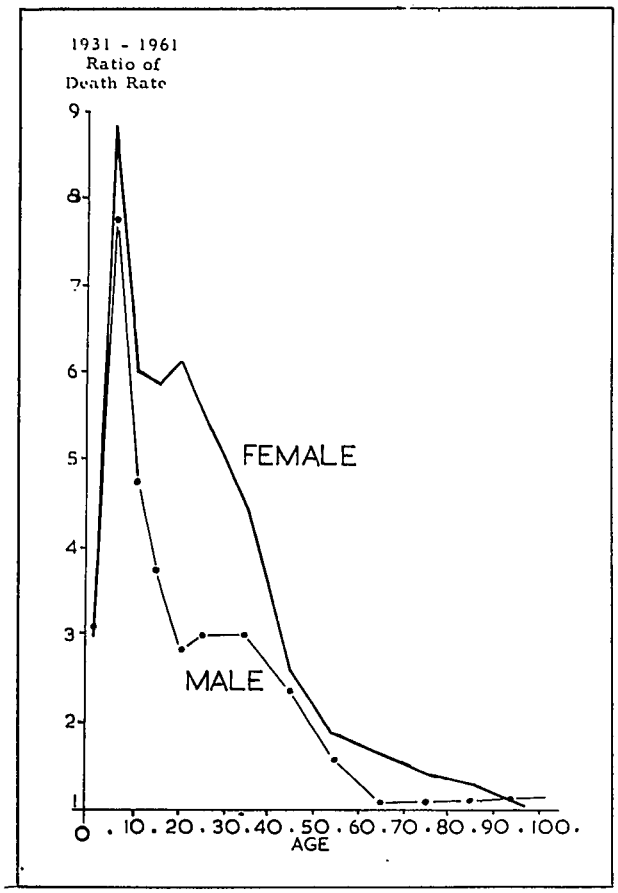

Figure 4. Ratio of mortality in 1931 to mortality in 1961, by age.

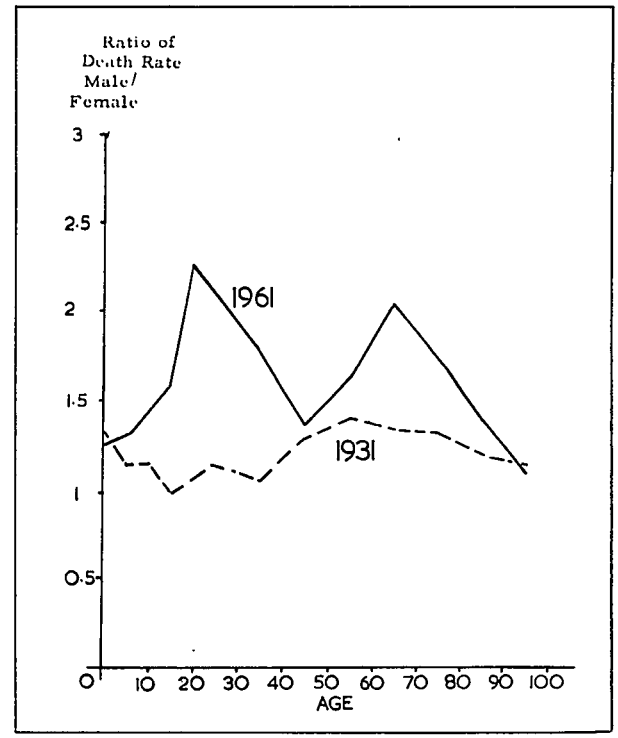

Figure 5. Ratio of male mortality to female mortality, by age, 1931 and 1961.

of 75 per 1,000 births in 1931 to 22 per 1,000 births in 1961. An analysis of the ages at death of infants in 1931 compared with 1961 shows that the greatest improvements have been made in protecting infants between the ages of 1 month and 1 year, whereas there has been only a relatively small improvement in infants from birth to the age of 1 month. When the causes of death are examined, it is seen that there has been almost a complete elimination of deaths due to gastroenteritis and a great reduction in the mortality from bronchopneumonia, but little improvement has been made in congenital diseases and in diseases of the respiratory system associated with immaturity. Because the infant mortality rate has fallen to a level as low as 20 per 1,000 births implies there is little room for further improvement. The causes of death under 1 year of age are now immaturity, congenital malformations, respiratory disease of the newborn, and birth injuries. Advances in the reduction of these causes of death are likely to be made by a general improvement in eugenics, antenatal care, and maternal education.

Preschool—1-4 Years

The preschool child has benefited most of all from the advances of medical science during the last 31 years (fig. 6). In the early 1930's, 7 children out of every 1,000 died each year; in the late 1950's this toll had been reduced to fewer than 1 out of every 1,000—a reduction of about 85 percent. The female improvement has been greater than the male.

This rate of improvement was not constant during the period; there was a steady decline from 1931-39, and during the war years this improvement was accelerated and continued

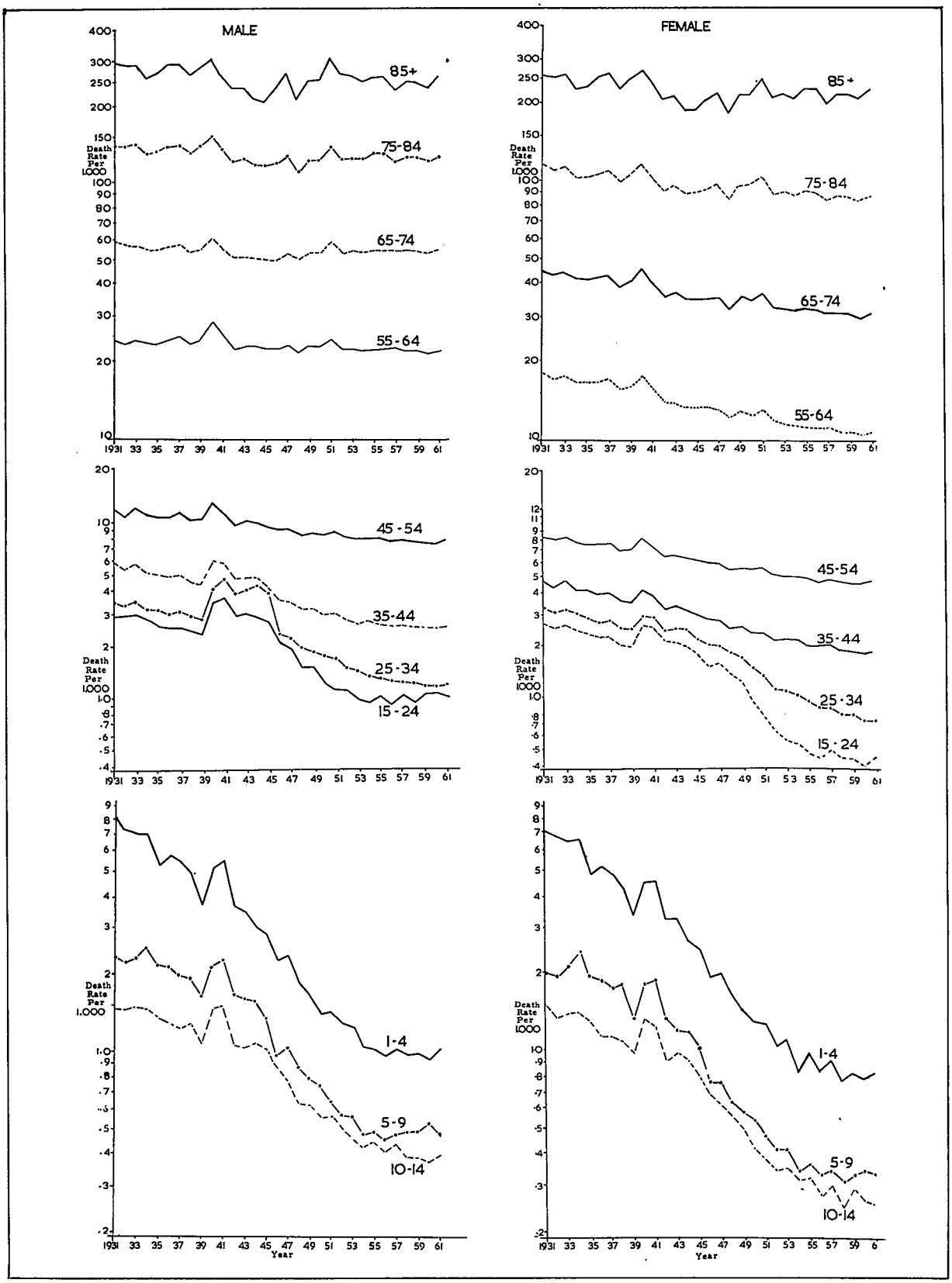

Figure 6. Age-specific death rates for all causes per 1,000 population, 1931-61.

for the following 5 years. By 1950, however, the impetus had died, and since 1955 there has been no real improvement in the mortality of this age group.

This general trend has resulted in a complete transformation in the diseases causing death at this age. In 1931 the killing diseases were pneumonia, measles, diphtheria, whooping cough, tuberculous meningitis, and bronchitis, all of them infectious diseases. In 1961 pneumonia alone remained a major killer followed by congenital malformations, road accidents, and leukemia and other malignant diseases—only one of them an infectious disease.

It is interesting to follow the pattern of change in each of these major diseases as their trends may be attributed to different causes in each case.

Pneumonia has remained the major cause of death throughout the whole period (fig. 7), and the curve of this disease reflects the general pattern of the age group. There was a steady but slow improvement throughout the period 1931-39; but in 1940-41 there was a sudden exacerbation of the disease, probably due to poor conditions and the severe weather of these years, which declined rapidly in 1942 and this decline continued until

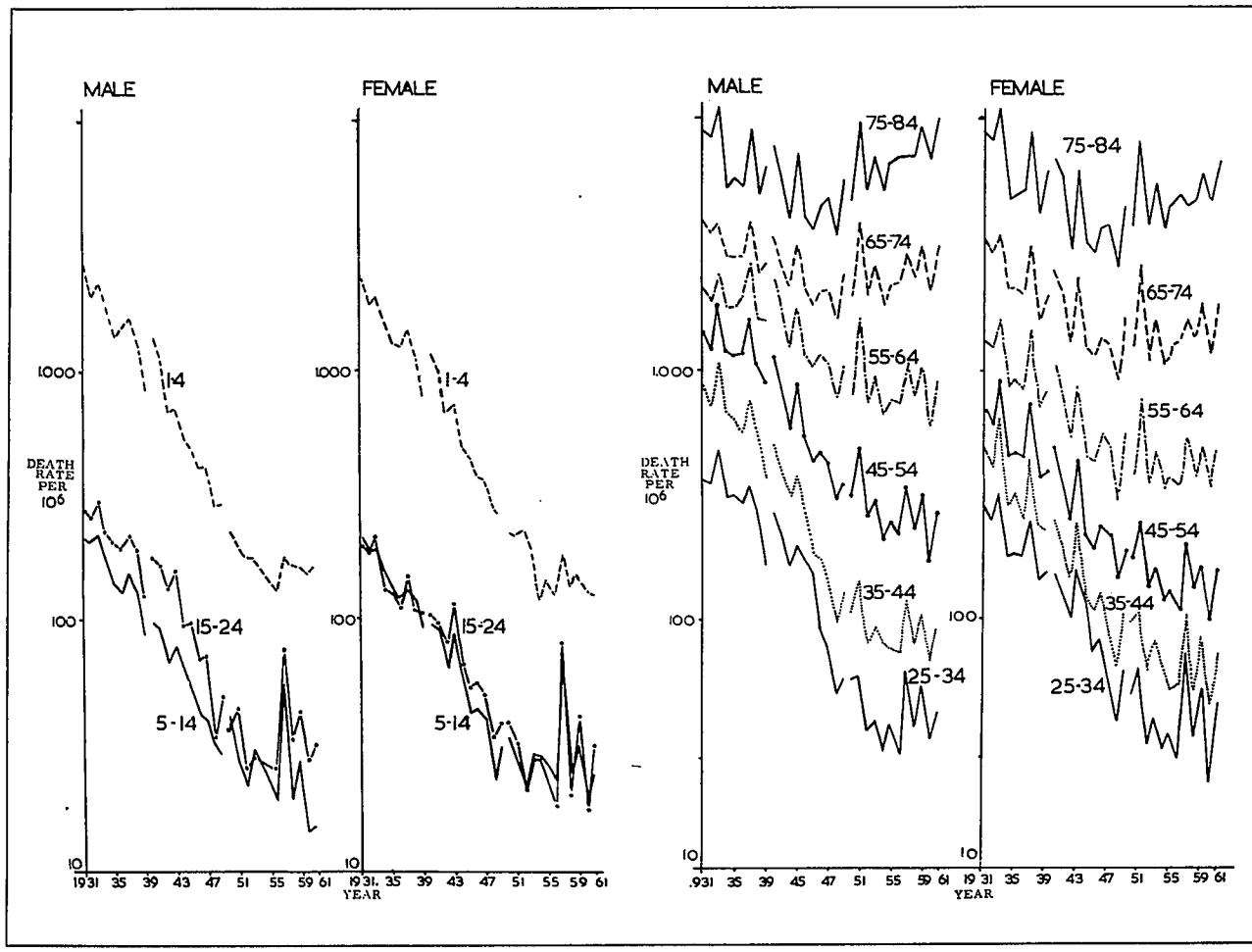

Figure 7. Death rates by age for influenza and pneumonia per million population, 1931-61.

about 1954. Since that time mortality has been relatively constant at about 130 deaths per million children. It is unlikely that all these changes in mortality can be entirely attributed to drug therapy as the improvement occurred during the early 1930's before the introduction of sulfonamides, and there has been little improvement in the 1950's after the introduction of tetracyclines. It is probable that social changes, improved maternal care, healthier children, and better medical facilities as well as medical treatment have been important influences in the decline of deaths from pneumonia among preschool children.

Diphtheria was one of the few diseases that was on the increase in the 1930's, reaching a maximum in 1934 with a secondary peak in 1941 (fig. 8). An intensive national immunization campaign started in 1940-41 and was pressed vigorously throughout the war years. Within 10 years the mortality had been reduced by 99 percent, and in 1959 no deaths from diphtheria were recorded in the whole country. It is probable that this remarkable success may be attributed almost entirely to the immunization campaign, but in view of similar falls in some of the other infectious diseases which have to be attributed to social conditions, this attribution is not absolute proof.

Measles is notoriously an endemic disease with epidemic peaks at intervals of 2 years. The disease still remains endemic in England and Wales, although incomplete notification makes it difficult to draw adequate comparisons over a period of years (fig. 9). Deaths from measles, however, have declined during the period so that each successive peak and trough of an epidemic wave has been lower than the preceding wave. It is thus clear that

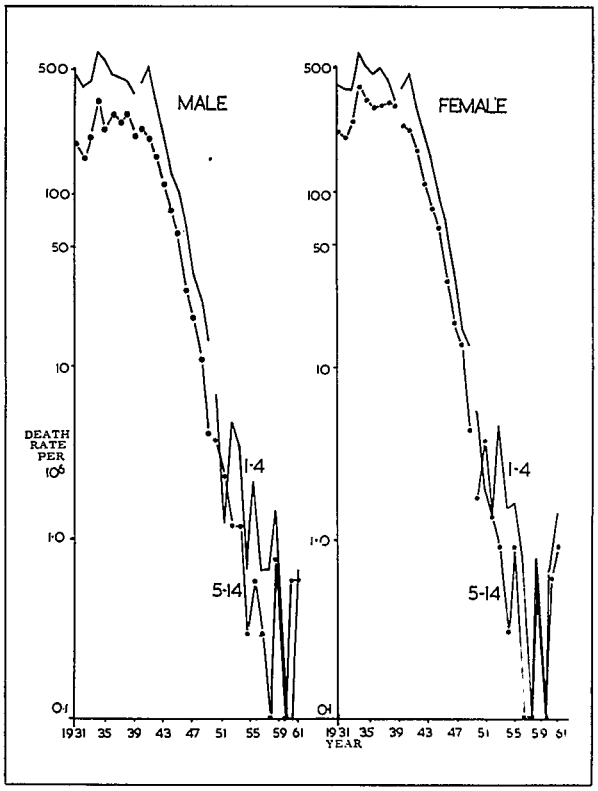

Figure 8. Death rates for diphtheria per million population aged 1-14 years, 1931-61.

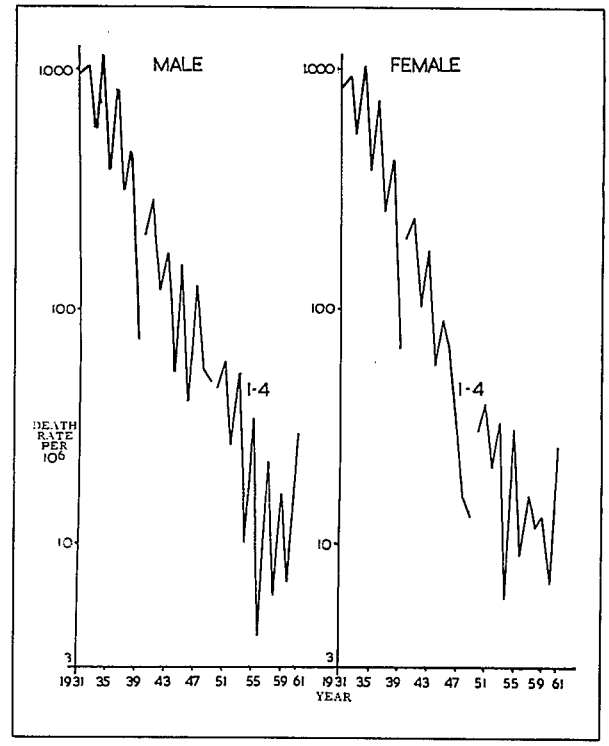

Figure 9. Death rates for measles per million population aged 1-4 years, 1931-61.

the case fatality rate has declined considerably. This decline in the mortality cannot be attributed to immunization because no form of prophylaxis had been introduced generally in the population by 1960, and the incidence of the disease has shown only a relatively small decline. Consequently, as pneumonia is the usual terminal cause of death, factors similar to those causing the decline in pneumonia death rates are probably responsible for the improvement in deaths from measles.

Whooping cough has the distinction of being one of the few diseases for which the female death rate is higher than the male rate (fig. 10). In the early 1930's it was one of the major killing diseases of preschool children,

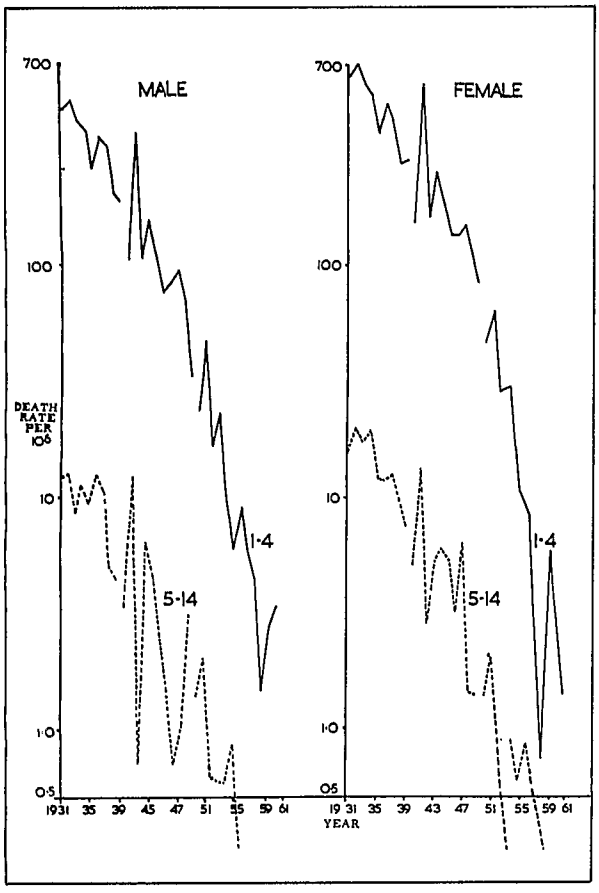

Figure 10. Death rates for whooping cough per million population aged 1-14 years, 1931-61.

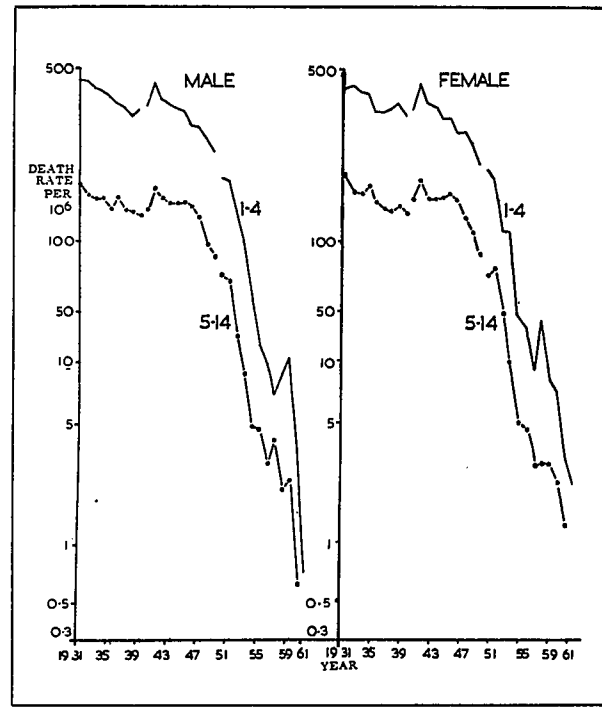

Figure 11. Death rates for tuberculous meningitis per million population aged 1-14 years, 1931-61.

with a death rate of 600 per million. The rate fell steadily during the 1930's, and by the outbreak of the war it had been reduced by 76 percent; but even as recently as 1947 the rate was still 148 per million. Since then, however, the rate has fallen more rapidly and consistently. Deaths due to pertussis have not been completely eliminated, but in recent years the rate has been of the order of 2 per million. Immunization against whooping cough was introduced in the triple vaccine about 1950, and the use of this became widespread in 1951. Thus, it may be said that 76 percent of the reduction in mortality had already taken place before an effective vaccine was introduced, but that the virtual elimination of the disease as a cause of mortality must be attributed to the preventive measures taken.

Tuberculous meningitis was a common cause of death in the 1930's, and although the mortality from this disease declined slowly during

the next decade, there was a recrudescence of the disease during the war (fig. 11). After the war the decline continued gradually until 1952, when there was a precipitous fall; and by 1961 the disease had almost been eliminated from this age group. Factors influencing mortality from tuberculous meningitis must have been social and medical care, improved case finding of known open contacts, isolation of adult cases, and extensive BCG immunization of "at risk" cases which was introducted into the country in 1953. But this is clearly a disease where the introduction of specific chemotherapy after 1950 has transformed the scene and almost eliminated the condition entirely.

The recent prominence of congenital malformations, especially congenital heart disease (fig. 12), as a cause of death among preschool children is due to two factors. Some infants who would otherwise have died in infancy are now able to survive the first year but are not able to cope with the more active life of the toddler. Although the actual mortality from this cause has increased little in these 31 years, due to the complete ebb of the tide of infections, the rock of congenital diseases has become more prominent. It is not possible to decide whether there has been a rise

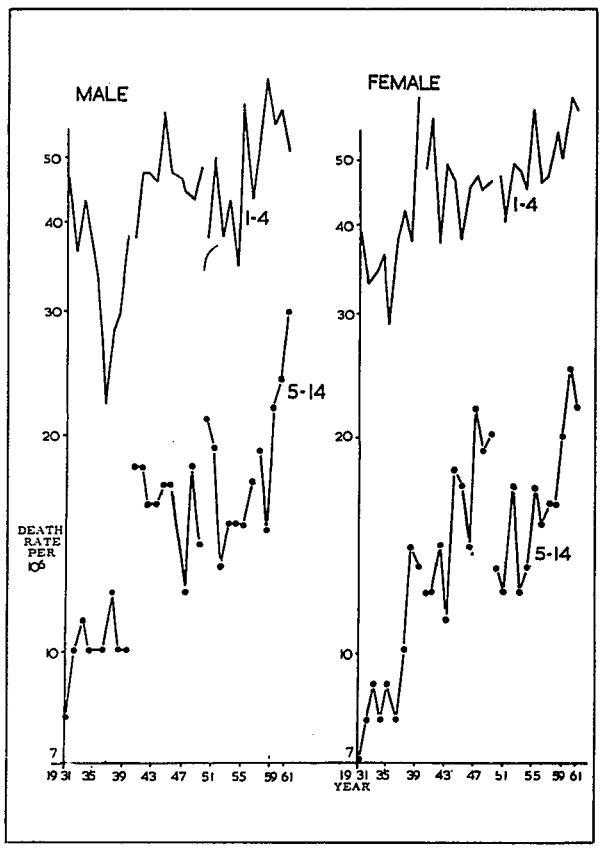

Figure 12. Death rates for congenital heart disease per million population aged 1-14 years, 1931-61.

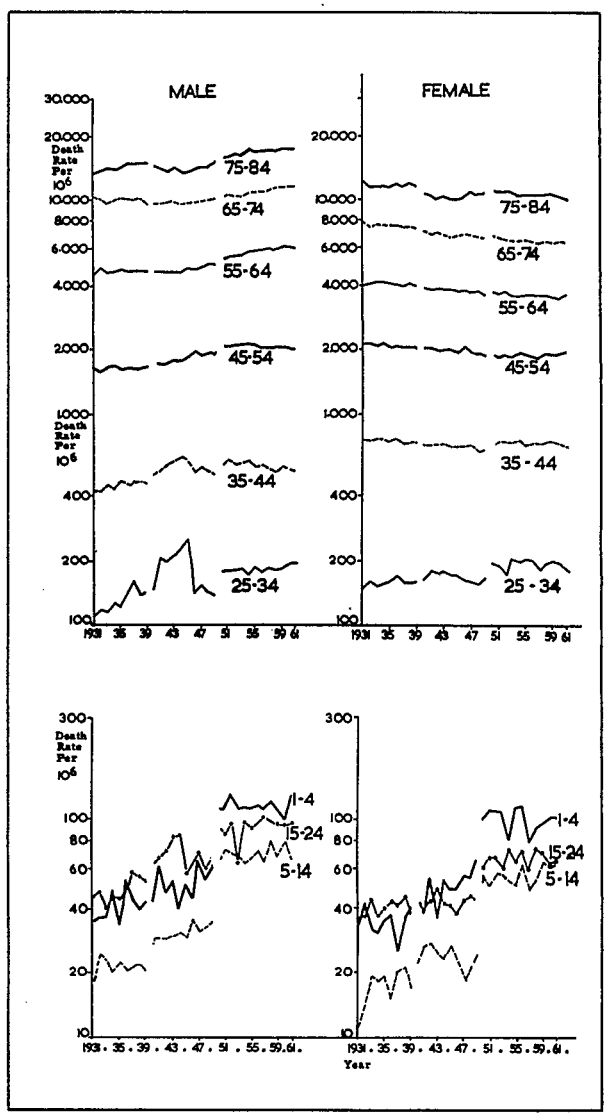

Figure 13. Age-specific death rates for all malignant diseases per million population, 1931-61.

in the incidence of such cases during this period as a national register of congenital defects would be required to prove this conclusively, but it seems probable that this effect has been minimal.

Similarly, the relative importance of leukemia and other cancers (figs. 13 and 14) as a cause of death in 1961 is due to a very small increase in the absolute rate and a decline in other rates. The reason for this may be improved medical diagnostic ability, changes in the methods of classification, and a possible true rate of increase. Whether there has been a true increase in incidence of these diseases during the period under review is almost impossible to say, as there were changes in methods of classification and coding in 1940 and in 1950 and hematological examinations have become much more frequent.

Despite the very great increase in road traffic, deaths from road accidents in early childhood (fig. 15) are now fewer than they were 31 years ago, and there has been no tendency for them to increase since 1951. To some extent this is due to improved accident services and blood transfusion, which have reduced the case fatality rates, but it is also due to the education of parents and children to take care on the roads. It is interesting to see that even at ages 1-4 years, boys are killed on the road with much greater frequency than girls.

Other accidental deaths, a miscellaneous group, declined slowly during the period but was an important relative cause of death in 1961, due to greater improvements in other death rates.

School Child—5-14 Years

The school child is a vigorous biological animal most resistant to the ravages of disease; but despite the low rates of mortality prevalent in 1931, these rates have been reduced by over 80 percent in the following 31

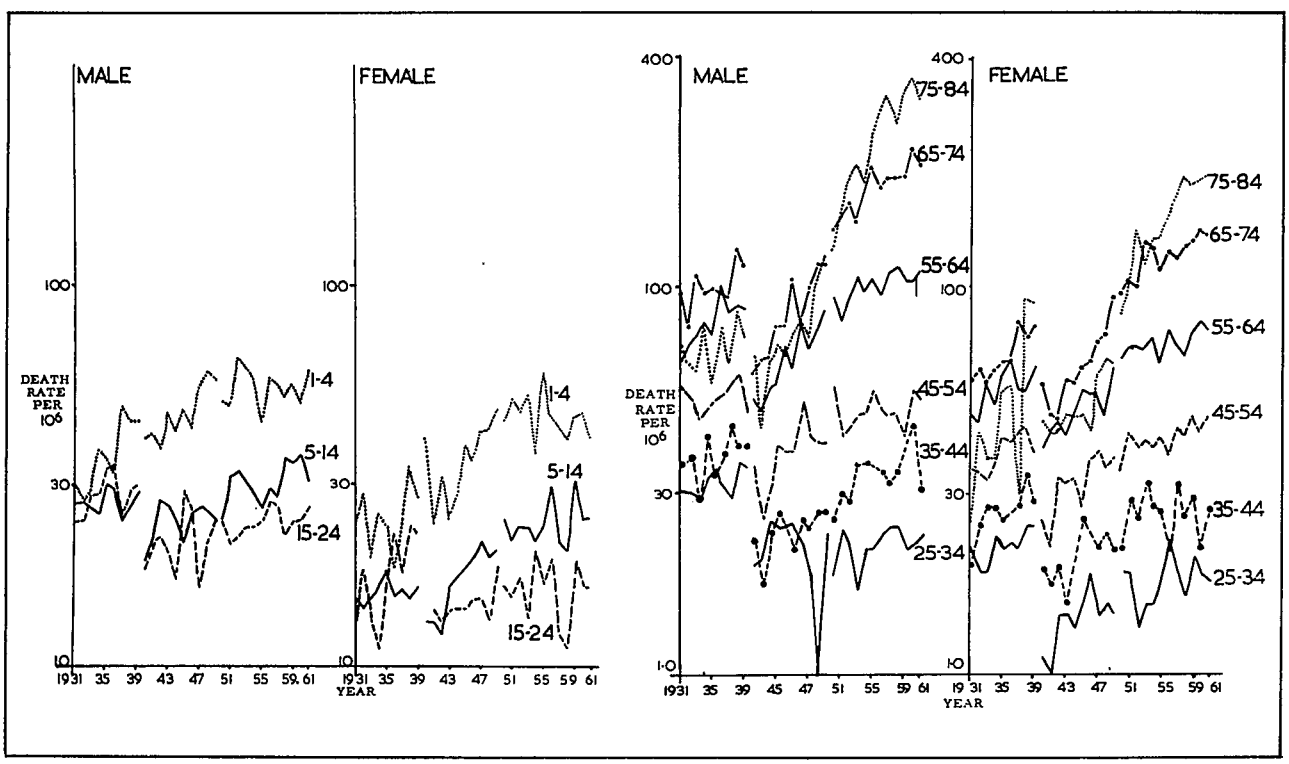

Figure 14. Death rates by age for leukemia per million population, 1931-61.

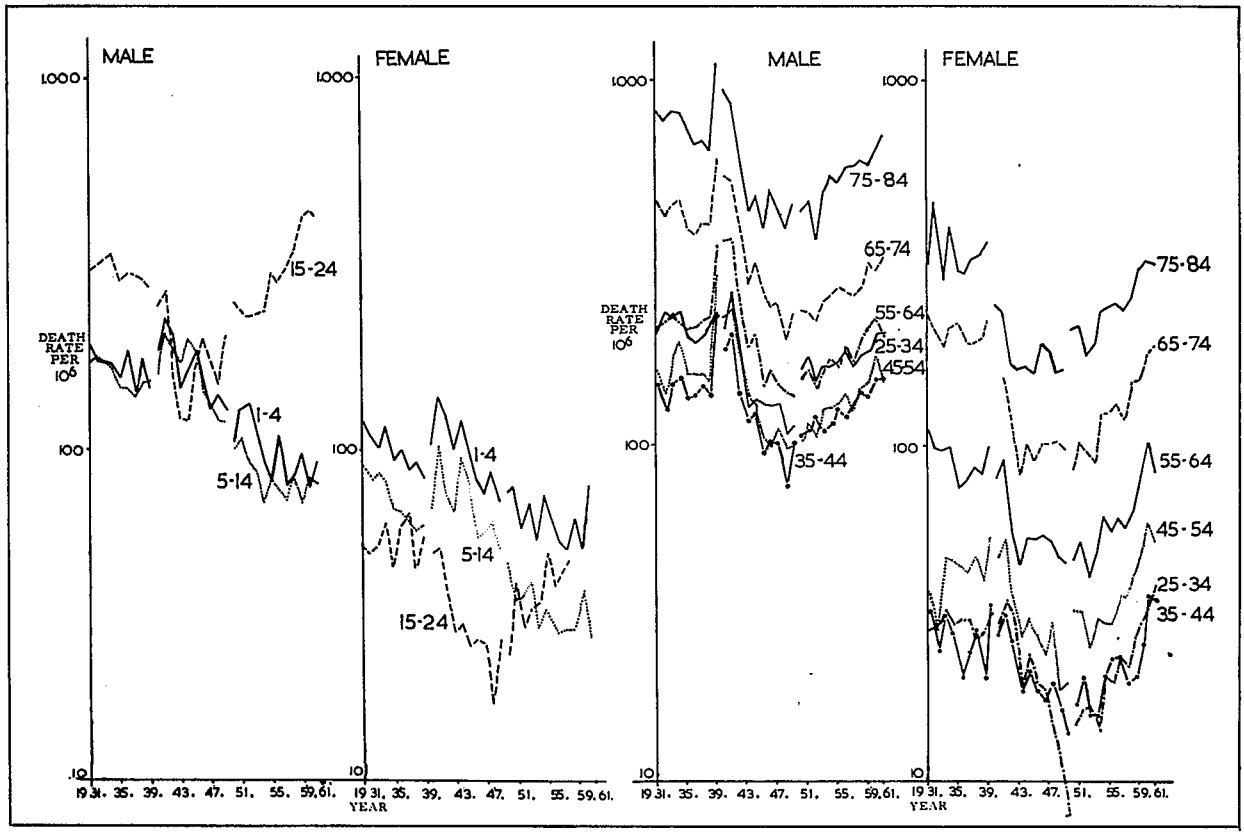

Figure 15. Death rates by age for road accidents per million population, 1931-61.

years, and once again it is apparent that the girls have benefited much more than the boys. In 1931 the rates for boys and girls were similar, but by 1961 the female rate was more than 30 percent lower than the male rate (fig. 6).

In 1931 the major causes of death were diphtheria, pneumonia, road accidents, tuberculous meningitis, and rheumatic heart disease; in 1961 these had changed to road accidents, leukemia, other malignant disease, congenital heart disease, and pneumonia.

Diphtheria (fig. 8) has always been an important cause of death among school children, from the time corynebacterium was recognized as a cause of the disease previously known as membranous croup. There had been some steady improvement, however, in mortality from the disease but this was arrested in the 1930's. The disease appeared to be on the increase, reaching a peak of 350 deaths per million in 1934. There was little improvement in this rate for the next 5 to 6 years; but after the introduction of free immunization in 1940, school children did not show an epidemic peak in 1941 although this was apparent among preschool children. The rate fell very rapidly indeed, and in 1957 no deaths from this disease were recorded among the school children. In recent years there have been a few outbreaks of the disease, with an occasional death attributed to it in social circumstances which have been associated with failure of immunity, but it is considered that the disease is virtually eradicated from this country.

Pneumonia and influenza as a cause of death among school children declined during the 1930's and continued to decline fairly rapidly during the war and the immediate postwar period (fig. 7). It reached the low level of about 40 deaths per million children in 1950; since then the

mortality rate from this cause of death has fluctuated slightly and has shown no particular trend.

Road accidents among school children have shown a considerable improvement over the period of 31 years (fig. 15). During the 1930's, in spite of traffic increase there was a slow decline in these deaths; during the war years due to the blackout, the poor illuminations, and heavy military and industrial traffic there was a rise in mortality, but this rapidly declined during the years following the war and has continued to decline. There is a remarkable fact, however, that the male to female ratio is greater than 2, and that boys at this age are being killed twice as frequently as girls.

The trends of deaths attributable to tuberculous meningitis at school ages have shown exactly the same trends as in the case of the preschool child, although the rates for the school child have been lower than those for the toddler (fig. 11). There was very little change in the death rate until about 1947, when there was a small decline which became very much more pronounced in the early 1950's with the introduction of effective treatment. There was a hesitation in the drop of the curve in 1956 and 1957 which at the time was feared to be due to resistance to the main antituberculous drugs. Fortunately, however, this possible leveling off of the curve did not persist and the rate has continued to decline.

Rheumatic heart disease like whooping cough is one of the few diseases for which the male to female mortality ratio has usually been less than 1. The rate declined slowly during the 1930's but improved rapidly during the war years and has continued to decline throughout the subsequent years. The rate has now fallen from about 80 per million children in 1931 to less than 1 per million children in 1961, but even with this low rate there is still a slight predominance of females.

Congenital heart disease on the other hand has increased from approximately 8 per million children in 1931 to approximately 26 per million in 1961 (fig. 12). Several factors may be involved—the first is refinement in diagnostic procedures and the second is the survival into school age of younger children who would previously have died in infancy. A third is statistical artifact due to changes in coding classifications. Figure 12 shows there were some most remarkable discontinuities in the coding system; and as these discontinuities appeared to affect the sexes differently, it is not possible to be quite certain what has been the effect of these statistical artifacts on the mortality from congenital heart disease.

There has been a steady but quite slow increase in the rate of mortality from leukemia and other malignant diseases (figs. 13 and 14), but once again it is not possible to determine whether this effect is due to improved diagnosis or to increased incidence, or whether children who had malignant disease at an earlier stage would have died of some other complaint.

Adolescence and Early 20's—15-24 Years

This age range is a mixture both socially and physiologically; within it the individual passes out of the stresses of puberty to become a young adult. Indeed before the close of this decade many will accept the responsibilities of family life. There are undoubtedly differences in the mortality experienced at these various stages, and marriage appears to affect the risk of death; but in a general statistical survey of this type it is necessary to aggregate all young adults under one decade of age.

It should also be remembered that this age group was one that was severely affected by the stresses of war and by the statistical artifacts introduced into the calculation of rates during the decade 1939-49. The mortality at 15-24 years of age was falling slightly during the 1930's; it rose very steeply (largely due to artifact during the war years) and then fell rapidly in the period 1945-55. Since 1955 the male rate has risen slightly and the female rate has continued to fall, but this rate of fall has been slower than in the preceding 10 years (fig. 6).

In 1931 the main cause of death during this decade of life, far exceeding every other cause, was tuberculosis. Following behind this

captain of the men of death were rheumatic heart disease, road accidents, influenza and pneumonia, suicide in the case of males, and puerperal deaths in the case of females. In 1961 the outstanding cause was road accidents which in the case of the males accounted for over 40 percent of the total mortality. Following a long way behind as causes of death were influenza and pneumonia, suicide, leukemia, and in the case of women puerperal causes.

Mortality from respiratory tuberculosis (fig. 16) was falling slowly during the 1930's, and in fact this fall at this period was the reason for the general trend in deaths due to all causes. In the period 1940-45 there was a sharp rise in the mortality among the males which was almost certainly an artifact as unfit men remained in the civilian population; however, there may also have been a natural increase in the disease because of wartime conditions. But with the return of peace in 1946, there was a sharp fall which has continued almost consistently until in 1961 the mortality from this disease in this age range was less than 2 per million persons compared with the rate of approximately 1,000 per million in 1931. There has been one interesting change in the effect on this age range; females remained more susceptible to the disease than the males, but the adolescent females do not continue to have a rate higher than those of women of the more advanced ages. This is probably due to a cohort effect, because the women who were 45 years of age in 1961 were themselves girls of 15 in 1931; and these women remain a high risk group. In 1961 the mor-

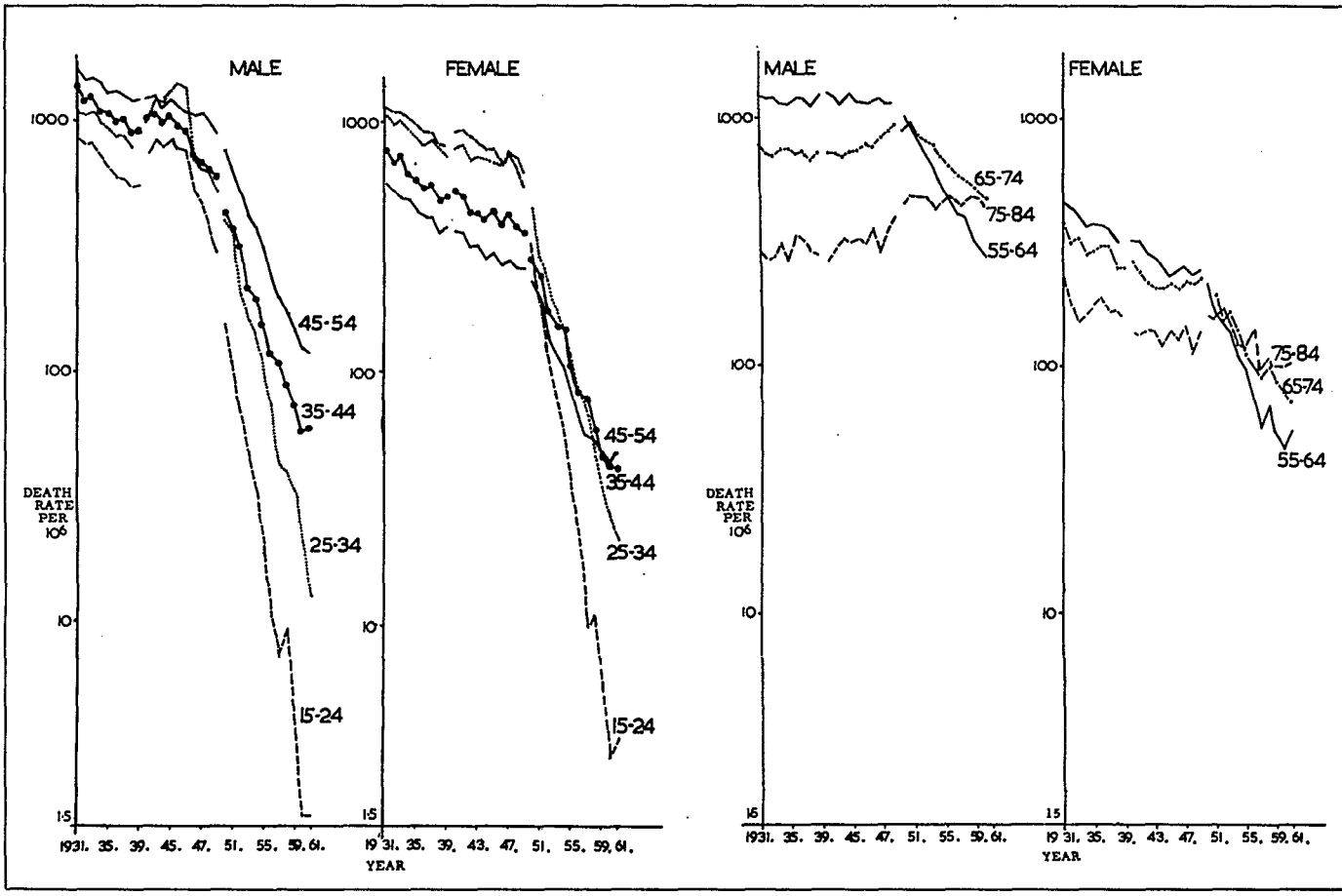

Figure 16. Death rates for respiratory tuberculosis per million population aged 15-84 years, 1931-61.

tality from this disease increased in each decade of life from 15-55 years of age, whereas before the war the disease decreased in women with advancing age.

Unfortunately, many of the gains which have been won by the improved mortality from tuberculosis have been lost on the roads of the country. Among males, mortality from road accidents (fig. 15) now accounts for about 42 percent of all deaths at this age range; it is now approximately equal to the mortality from tuberculosis in 1939, and it continues to rise. These road accidents are predominantly a male phenomenon, the male to female ratio being of the order of 5. The motorcycle is a popular teenage recreation in this country; and it is obviously a dangerous instrument, almost as lethal as the mycobacterium tuberculosis used to be a generation ago.

Pneumonia and influenza (fig. 7) fell during the 1930's, rose to a peak in 1940 and 1941 due to wartime conditions, improved rapidly in the postwar period, but has not shown any general trend since 1950. In 1957, however, there was a large peak in mortality attributable to the influenza epidemic of that year which was especially severe on the young adolescent.

Suicide (fig. 17) among young males has fluctuated during this period. There was a peak in the rate of 74 per million in 1933, at the depth of the industrial depression, which then

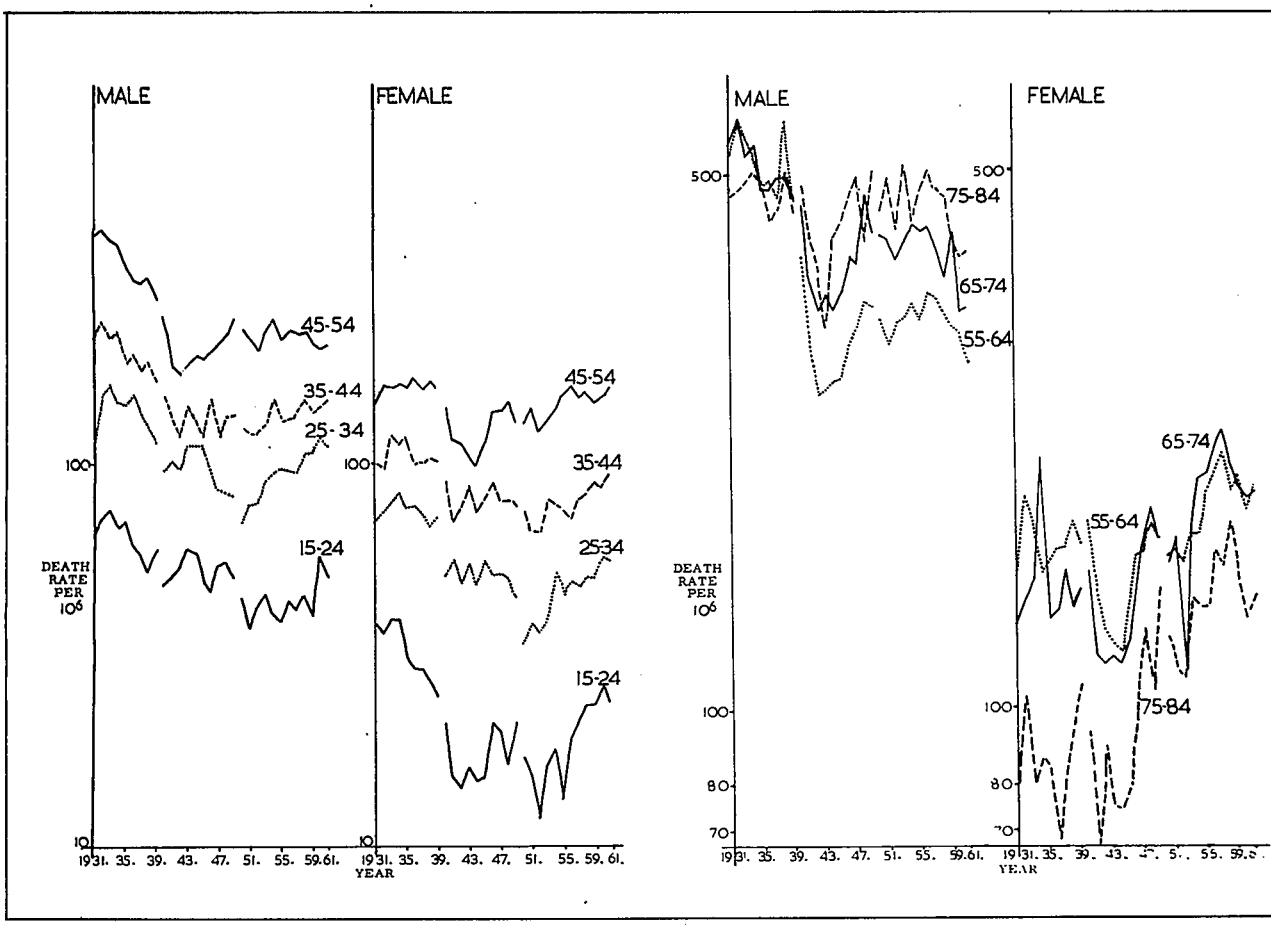

Figure 17. Death rates for suicide per million population aged 15-84 years, 1931-61.

declined and continued to decline throughout the war years and the postwar revival until a minimum rate of 37 per million was reached in 1951. During the 1950's, however, the rate increased again reaching a secondary peak of 56 per million in 1960.

Deaths of young women due to puerperal causes (fig. 18) in the early 1930's were approximately 140 per million; but in 1935 an improvement was discernible, which has continued with minor fluctuations. As the number of births to women in this age range has increased proportionately more than the general population during the period, this relative improvement is even greater than it appears. The reason why puerperal causes still account for one of the major causes of death is because of the remarkable improvement in all other causes.

Young Adult—25-34 Years

The human organism is fully developed at 25 years of age and from then onward there are very few deaths which can be attributable to congenital or developmental causes; yet the body has not aged sufficiently for degenerative causes to give rise to a considerable number of deaths. The general trend in mortality during the 31 years under review has been downward. During the first 4 or 5 years of the 1930's mortality was constant, but a decline started before the beginning of the war in 1939. During the 1940's the apparent mortality of adults 25-34 years of age was grossly distorted by the methods of calculating mortality rates, by which only the unfit civilians remaining in the country were enumerated. In 1946, however, the rate for both males and females was considerably lower than the corresponding rate for 1939, and this rate has continued to decline. During the later 1950's, a marked divergence of the male and female rates became apparent. Since 1955 the male rate has hardly improved, whereas the female rate has continued a marked improvement, so that the male to female ratio has widened considerably, where in 1931 the male to female ratio was 1.06 and in 1961, 1.58 (fig 5).

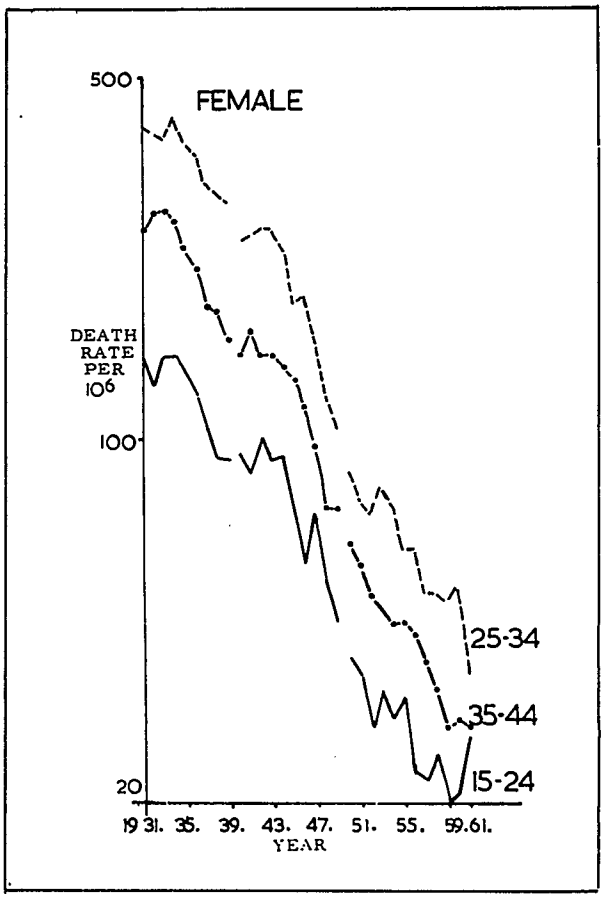

Figure 18. Death rates for complication of the puerperium per million females aged 15-44 years, 1931-61.

In 1931, the main causes of death were respiratory tuberculosis, pneumonia and influenza, road accidents, rheumatic heart disease, suicide among males and childbearing among the women. By 1961, the causes of death were road accidents, suicide, coronary artery disease among men, rheumatic heart disease among women, pneumonia and influenza and deaths attributable to childbearing among women.

Tuberculosis of the respiratory system (fig. 16) declined from 1,030 per million population to 16 per million population in 1961, a reduction of nearly 99 percent. This decline started in the early 1930's and continued until the outbreak of the war, when there was an artificial peak which reached a maximum in 1944; there was then a rapid decline dur-

ing the immediate postwar years which has continued without any hesitation until the present time—a dramatic demonstration of the efficiency of treatment.

Pneumonia and influenza (fig. 7) have shown a similar pattern; but the fall has not been quite so precipitous, so that in 1961 this group of diseases still remains among the five major causes.

Road accidents (fig. 15) have been promoted from third to first cause of mortality among the adults in the age range 25-34 though surprisingly enough the rates of mortality have hardly changed at all. In the 1930's the male mortality rate was slightly higher than 200 per million, and in 1961 it was exactly 200 per million. The rate for females has also shown little change; in the 1930's it was almost 33 per million, and in 1961 it was 42 per million. As motor traffic has increased fivefold in this interval and as adults of this age range are most exposed to the hazards of motor traffic, this is a remarkable phenomenon which should probably be attributed to increased care in driving, to improved engineering, and to public health education, as much as to medical care in saving the lives of those already injured.

The study of the etiology of suicide (fig. 17) is a most difficult but important problem, for suicide is now the second most important cause of mortality in the age range 25-34. In the early 1930's deaths from suicide were about 150 per million males and about 75 per million females, reaching a peak in 1933 at the depth of the depression. During the war, despite the artifactual elevation of the total mortality rates, the suicide rate showed a considerable decline. This decline continued into the postwar years, reaching its lowest rate in 1950; but subsequently there has been a slow but quite steady rise in the mortality, and now suicides among males are over 100 and among females about 50 per million population. Throughout the whole period, the male to female ratio has remained at about 2.0. There was a considerable decline during the national exhilaration of war and the reconstruction period following it, but in both the depression years of the 1930's and the affluent years of the 1950's suicides increased. This may be another demonstration of Durkheim's hypothesis that the suicide rate is an expression of the failure of social cohesion in society.

Heart disease was in the 1930's one of the five major causes of death, and it still remains in this category (fig. 19). There has been a considerable shift in the type of heart disease occurring. In the 1930's rheumatic heart disease was one of the major causes of death for both males and females, but this has now declined to about one-third of its original rate; whereas in the case of coronary artery dis-

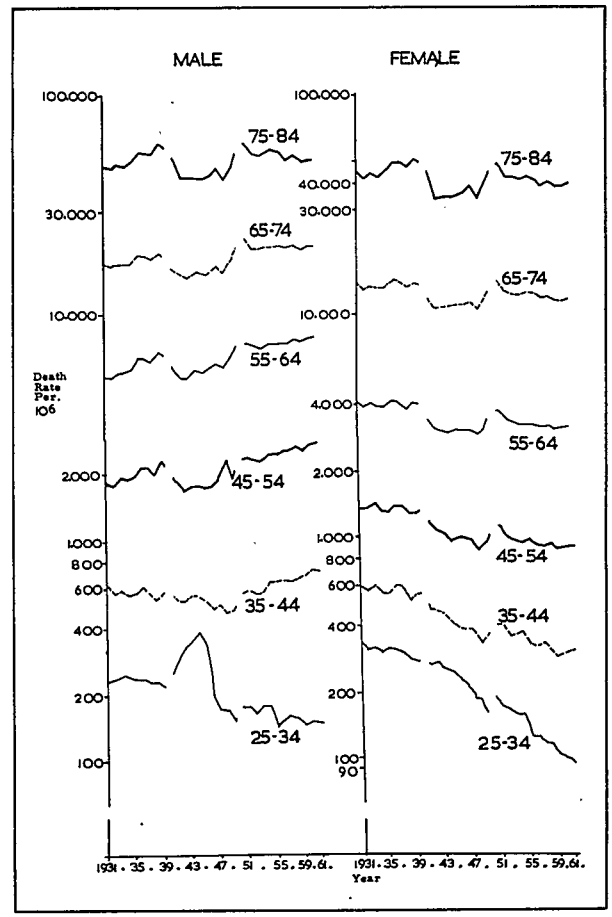

Figure 19. Death rates for all cardiovascular diseases per million population aged 25-84 years, 1931-61.

ease there has been an increase both in the male and female rates.

Deaths attributable to childbearing (fig. 18) are still a cause for some concern. The rate in 1934 was over 400 per million women, whereas in 1961 it declined to 35 per million women; and in the intervening period births to women of this age range had increased by nearly 50 percent. Nevertheless, deaths still occur to women either in childbearing or in pregnancy, and constant vigilance is needed to ensure that all women are delivered in the best of circumstances.

The Adult—35-44 Years

The age range 35-44 years is one similar in pattern to the preceding age range of 25-34 years, and it is difficult to make separate comment upon the major causes of death. The general trend of mortality has been downward, and improvement started in the 1930's; and although interrupted by the war, in 1946 the mortality rate carried on the trend prevalent before the war. It has continued downward in the case of the females right throughout the following period of 15 years, but in the case of the males there has been a leveling off of the rate around 1955, with little advance in mortality since that time (fig. 6).

The principal causes of death for both sexes in 1931 were tuberculosis, pneumonia and influenza, rheumatic heart disease, suicide, road accidents, and in the case of women childbearing. In 1961 the pattern was coronary artery disease, lung cancer, road accidents, suicide, and rheumatic heart disease for men, whereas in women there was a different grouping of causes of death—cancer of the breast being first, followed by rheumatic heart disease, cerebrovascular disease, suicide, and cancer of the cervix.

The change in the total mortality at this age range may be attributed largely to the drop in the tuberculosis death rates for both sexes, which have fallen consistently and still continue to fall. Pneumonia and influenza (fig. 7), which was also an important cause of death in the 1930's, has been deposed as one of the major killers and now appears at the bottom of the list. Rheumatic heart disease (fig. 20) has also improved considerably, but the rate of improvement has been greatest among the men, whereas among the women it still persists as a major cause of death. Women 45 years of age in 1961 who die of rheumatic heart disease will usually have acquired their infection of acute rheumatism some 20 years before, consequently we can expect that this rate will continue to fall throughout the next decade.

But the major reason male mortality has differed from female mortality at this age may be found in the causes attributable to coronary artery disease (fig. 21). In 1931 the death rates attributable to this cause were 60 per million males and 11 per million females; in 1961 they were 477 for males and 65 for females. Although this means there has been a similar proportional increase for both sexes of 6 or 7 times above the original rate, the

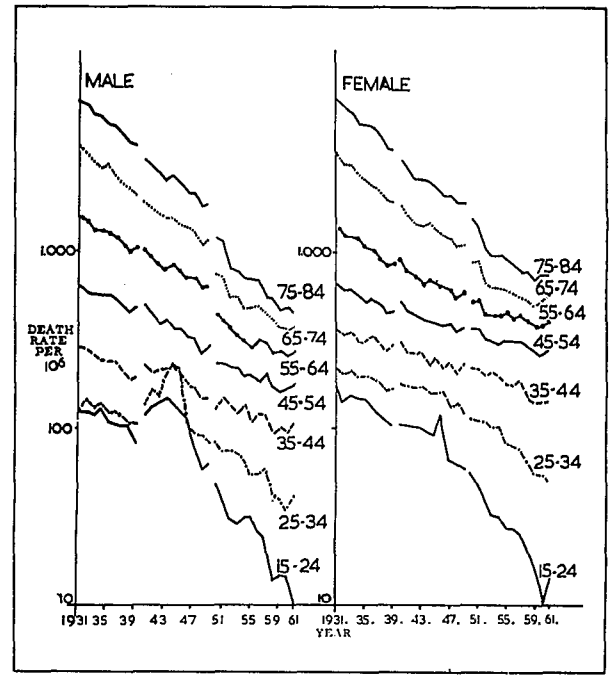

Figure 20. Death rates for rheumatic heart disease per million population aged 15-84 years, 1931-61.

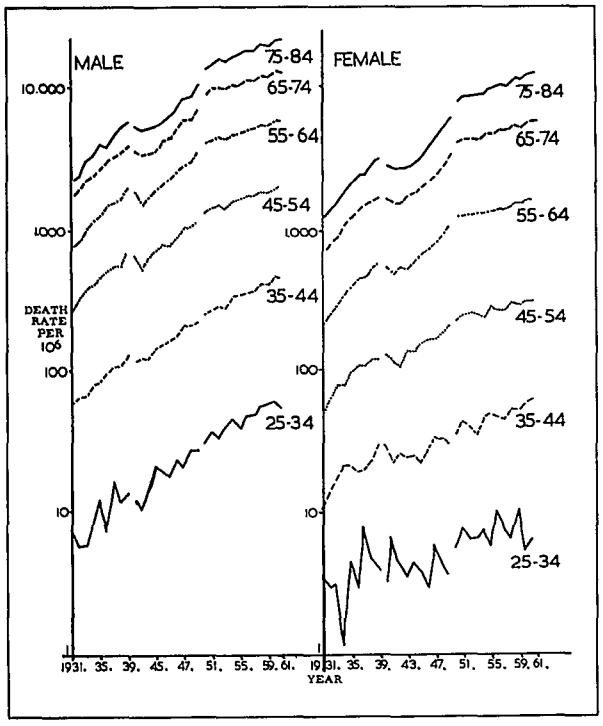

Figure 21. Death rates for coronary artery disease per million population aged 25-84 years, 1931-61.

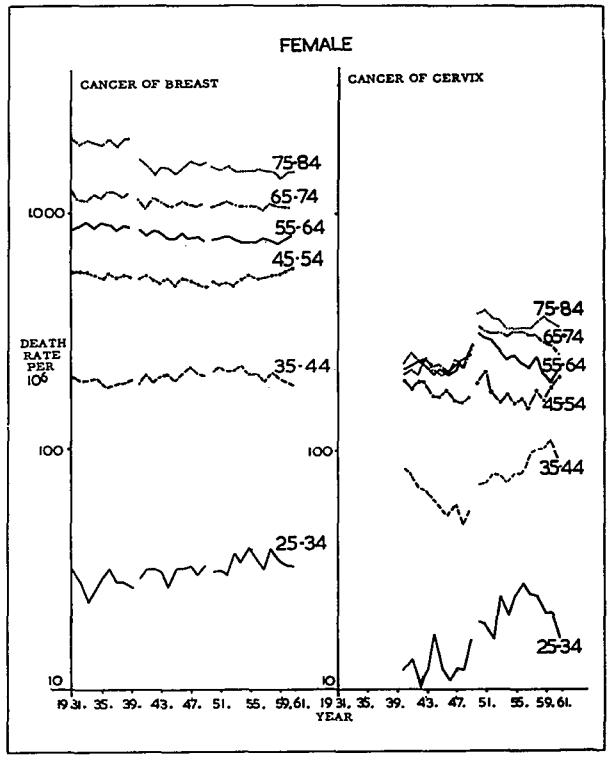

Figure 22. Death rates for cancer of the breast and cervix per million females aged 25-84 years, 1931-61.

absolute increase among males has been much greater nevertheless so that coronary artery disease now accounts for 20 percent of the mortality of men 35-44 years of age. Throughout the whole period deaths attributable to this cause in men have risen slowly but quite consistently; and the causes for this rise are, of course, the subject of numerous investigations.

Deaths from suicide (fig. 17) were fourth in the order of mortality in the 1930's and remained fourth in the 1960's. The pattern seems to be similar to the pattern for suicides at the younger ages; mortality declined from its peak in 1934 to a low point in the early 1950; since then it has increased slowly.

Cancers (fig. 13) begin to appear at this age range as one of the major causes of death, and cancer of the breast (fig. 22) looms as a major killer among women. In the whole period from 1931-61 the mortality from breast cancers has fluctuated closely, about 200 per million adult women; and no particular trend is discernible. But due to the great improvement in other causes of mortality, this means that cancer of the breast is now promoted from fifth cause of death in 1931 to first cause of death among women 35-44 years of age.

Cancer of the cervix (fig. 22) is also an important cause of death, but in contrast with cancer of the breast, which is stationary, this is tending to increase. It was introduced as a separate category in the Statistical Classification in 1940, and deaths remained relatively constant at between 70 and 80 per million women until 1956 when the rate began to increase slowly, and it is now approximately 100. It is difficult to know whether this is due to a true increase in the incidence of the disease or whether it is due to improved case finding and certification.

Cancer of the lung (fig. 23) in men 35-44 years of age rose from an unimportant diagnosis in 1931 to be the second leading cause of death in 1961. A great deal of work has been done to analyze these figures to assess whether this is a true increase or whether it is an artifact of improved diagnosis; and the general conclusion is that this is a true increase in the disease.

Early Middle Age—45-54 Years

Middle age is a stage of life which seems to recede as the individual himself becomes older so that here the term middle-aged is used simply as an indication of that period of life which lies in the middle between the climacteric and the onset of senescence. It may be divided into two decades, early middle life 45-54 years of age and late middle life 55-64 years of age.

In early middle age male mortality has declined from 11.4 per 1,000 in 1931-33 to 7.2 per 1,000 in 1959-61, a fall of 37 percent. The female rate, however, declined from 8.2 to 4.4 per 1,000, which is a fall of 46 percent (fig. 6).

The male mortality rate remained high during the 1930's, reaching a peak in 1940; but then there was a rapid decline during the war and postwar years so that by 1950 there had been a decline of 34 percent. But in the following decade the improvement was relatively small.

The female mortality, however, was improving during the 1930's and continued to fall even further during the 1940's except for a peak in the bad winter of 1940, and in the postwar years it has continued to fall.

In 1931 the major causes of death were tuberculosis, influenza and pneumonia, rheumatic heart disease, cerebrovascular disease, with bronchitis among the men and cancer of the breast among the women. In 1961 these had changed to coronary artery disease, cerebrovascular disease, influenza and pneumonia, and bronchitis, with cancer of the lung among the men and cancer of the breast among the women.

Even at this stage of life the fall in respiratory tuberculosis mortality (fig. 16) has been of great importance in the general pattern of the total mortality. Deaths due to tuberculosis among males and females were falling slowly during the 1930's, and they continued to fall in the 1940's. There was a rapid decline in the 1950's, reducing the number of deaths in the period of 31 years by over 90 percent. The disease, however, has not yet been eradicated from among the middle aged as it has been among younger people, as deaths still occur to people with longstanding infections. But these rates are now so low that there is little opportunity for further improvement.

Pneumonia and influenza (fig. 7) when stated to be a cause of death in the elderly or mid-

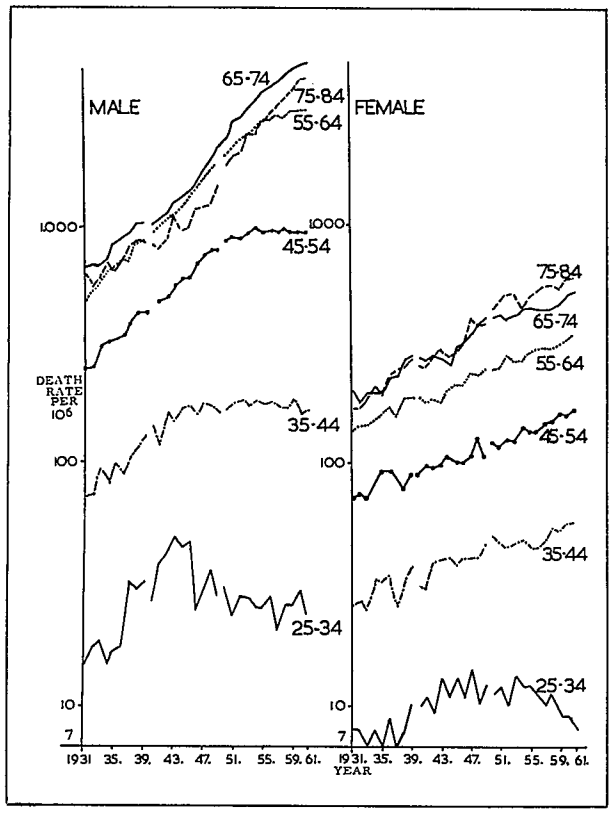

Figure 23. Death rates for cancer of the respiratory system per million population aged 25-84 years, 1931-61.

dle aged may sometimes be considered as a nonspecific diagnosis. Therefore the fall in mortality attributable to this cause may well be due to improved diagnostic ability rather than to chemotherapy, medical care, or better social conditions. Nevertheless, whatever the cause, the rates have fallen by over 75 percent for both men and women 45-54 years of age.

The fall in these deaths has been balanced by an increase due to coronary artery disease (fig. 21). In 1931 only 3 percent of all deaths among males were attributed to coronary artery disease, whereas in 1961 the proportion was at least 28 percent. In the case of women the mortality in 1931 had been less than 1 percent, and it rose by 1961 to 7 percent of all deaths among females. It is impossible to explain the etiology of this cause of death in a brief note; but this subject is examined later in further detail, where it is concluded that this trend is a real increase in a new disease and is not an artifact from diagnostic factors.

Cerebrovascular disease (fig. 24) has remained fairly constant throughout the 31 years both among men and women, and there has been no particular trend throughout this period. This disease was subject to an artifactual change in the method of coding with the introduction of the Fifth Revision of the International Statistical Classification of Diseases, but this effect was not so great as to distort the pattern of the disease. The male to female ratio from this type of disease has also remained fairly constant between 0.8 and 1.

Bronchitis as a cause of death appears to be typically an English complaint, and it becomes an important feature of the mortality tables in middle age. The diagnosis of this cause of death was affected by the Fifth Revision, but this does not seem to have been as severe in influencing diagnosis in middle age as it was in the later stages of life. Bronchitis behaves in a manner similar to that of other respiratory diseases in that it has epidemic peaks coinciding either with an influenza epidemic or with a winter in which the temperature falls consistently below zero degrees centigrade (0°C.). But if allowances are made for these fluctuations, the mortality remains fairly constant throughout the period

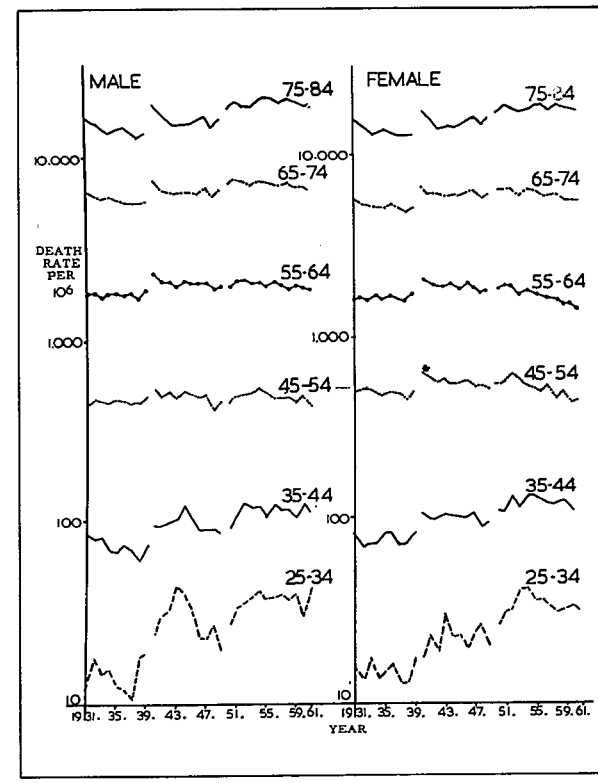

Figure 24. Death rates for cerebrovascular diseases per million population aged 25-84 years, 1931-61.

of 31 years. The introduction of the broad spectrum antibiotics in the mid-1950's does not appear to have influenced the mortality from this disease.

The two most common forms of cancer causing death in middle age are cancer of the lung among men and cancer of the breast among women. But whereas the male lung cancer rate (fig. 23) rose consistently throughout the 31 years, the female breast cancer rate (fig. 22) tended to remain constant. By 1961 cancer of the breast had become the first cause of mortality among women and cancer of the lung the second most important cause among men. There is this important difference in the diseases, however, because the etiology of cancer of the lung is known, there is hope that we may be able to influence the mortality, whereas the etiology of cancer of the breast is unknown.

Late Middle Age—55-64 Years

In late middle age the mortality trend has been somewhat similar to that of early middle age, but the rate of fall has not been quite as steep. The male mortality has declined from 23.7 per 1,000 in 1931-33 to 21.7 per 1,000 in 1959-61, a fall of only 8 percent; whereas the female rate has declined from 17.4 per 1,000 to 10.7 per 1,000, a decline of 39 percent. It is especially at this period of life when the climacteric has passed and before senescence begins that the human female demonstrates her greater viability. Female mortality at these ages is less than one-half of that of the male, and this in itself implies a considerable difference in the expectation of life (fig. 6).

The killing diseases in 1931 were cerebrovascular disease, rheumatic heart disease, influenza and pneumonia, cancer of the stomach, and tuberculosis. By 1961 these had become coronary artery disease, cerebrovascular disease, influenza and pneumonia, and bronchitis, with cancer of the lung among males and cancer of the breast among females.

As in early middle age there has been a great change in mortality due to tuberculosis (fig. 16) in males and females. Mortality began to decline in the 1930's and continued slowly in the 1940's, becoming more rapid in the 1950's so that deaths due to this disease have now decreased by over 75 percent in the 31-year period.

Mortality due to pneumonia and influenza (fig. 7) follows a trend similar to that of the early middle aged although the pattern is not quite so marked. The mortality rate for this disease has declined over the 31-year period by over 55 percent, but, as in the previous age group, this fall may be largely due to improved diagnosis of other diseases.

Coronary artery disease (fig. 21) has changed from a relatively unimportant cause of death in 1931 to the first cause of death in 1961. Deaths due to coronary artery disease in 1931 accounted for about 3 percent of all deaths among males and about 1 percent of all deaths among females. In 1961, however, coronary artery disease was responsible for about 27 percent of all deaths in males and 15 percent of all deaths in females.

Cerebrovascular disease (fig. 24) has altered little during the 31 years for both males and females and no particular pattern has evolved during this time. The male to female ratio has remained fairly constant at about 1.2.

Bronchitis mortality among people 55-64 years of age has also followed no particular trend. The mortality rate during the 31-year period has remained almost constant, except for a few peaks caused by epidemics.

Cancer of the lung (fig. 23) among males has increased considerably from 1931 to 1961. In 1931 only 2 percent of all deaths among males was attributed to cancer of the lung, whereas in 1961 the proportion was over 13 percent. The mortality rate rose constantly, and cancer of the lung is now the second major cause of death among males.

Female mortality from cancer of the breast (fig. 22) has remained fairly constant throughout the period considered, but the disease itself is now the third most important cause of death among females.

Retirement Age—65-74 Years

By the middle of the seventh decade the pattern of the causes of death has become typical of old age. Neoplastic diseases continue to take an increasing toll of life; but they are surpassed in importance by the cardiovascular and respiratory diseases, especially coronary artery disease and bronchitis.

Both male and female mortality rates declined during the early 1930's, from a peak in 1931 to a trough in 1938. The decline for males was of the order of 10 percent and that for females about 14 percent during these 7 years. In 1940, however, there was a sharp rise back to the original rates due to the exceptional conditions of that year. During the remainder of the war years and immediately afterward, the mortality rate fell by over 20 percent; but since 1948 the male rate rose slightly and the female rate fell slowly. As a consequence the male to female ratio was 1.3 in 1931 and 1.8 in 1961.

The main causes of death in 1931 were cerebrovascular lesions, which are subsequently referred to as "strokes," rheumatic heart disease, pneumonia and influenza, bronchitis, and cancer of the stomach. It is interesting to note that al-

though the absolute level of mortality was different between the two sexes, the pattern of disease and the order of frequency were the same.

In 1961 the main causes had changed only slightly to coronary artery disease, "strokes," bronchitis, pneumonia and influenza, cancer of the lung in men, and cancer of the breast in women.

The mortality from "strokes" (fig. 24) in 1931 was 6.4 per 1,000 males and 5.6 per 1,000 females; in 1961 it was 6.6 for males and 5.6 for females. Although there has been no apparent change in mortality; it should be remembered that there was a marked increase in the certification and coding for this cause of death with the introduction of the Fifth Revision of the International Statistical Classification in 1940. If this sudden alteration in the rates over a period of 1 year is considered to be an artifact, then it appears that there was a reduction in mortality from "strokes" in the 1930's; but that since 1941 there has been little improvement in the rates. The only reason this cause of death has fallen from first place to second is because of the rise in deaths attributed to coronary artery disease.

Rheumatic heart disease (fig. 20) was a classification included in the International List only with the Sixth Revision in 1950; in the preceding revisions there had been a classification for "chronic affections of the valves and endocardium" of which the major subdivision was "mitral valve disease." At the time of the dual coding exercise in 1949, it was decided the great majority of these deaths were due to "rheumatic heart disease" but that some of them would have been nonspecific myocardial degeneration. It is not possible therefore to bridge adequately the gap between 1949 and 1950 in the statistical certification from this cause of death. But it is possible to consider the trends within each decade (tables H and J and fig. 20).

There was, however, a marked decline of over 70 percent in the mortality from rheumatic heart disease between 1931 and 1949. In 1931 the rates per 1,000 were 3.96 males and 3.71 females, in 1949 they were 1.19 males and 1.10 females. In the period between 1950 and 1961 there was also a considerable fall of about 40 percent in these rates. It is thus apparent despite difficulties arising from statistical artifacts to making valid comparisons, there has been a considerable reduction in the diagnosis of valvular or rheumatic heart disease as a cause of death at this age.

Coronary artery disease (fig. 21) was introduced as a statistical classification in 1931, prior to which time it had been coded under angina pectoris. During the following 31 years this cause of death has continued to rise for both sexes and all ages as shown in table F and figure 21.

In England and Wales there has been a rise in 31 years in deaths attributed to coronary artery disease or to angina pectoris of between sevenfold and eightfold; and this rise has been similar in both sexes.

Table G. Ratio of male to female death rates for all causes, by age and specified years: England and Wales

Age	1961	1951	1941	1931
Under 1 year	1.26	1.31	1.29	1.30
1-4 years	1.30	1.14	1.12	1.14
5-9 years	1.45	1.41	1.21	1.15
10-14 years	1.60	1.54	1.21	0.99
15-24 years	2.19	1.41	1.45	1.08
25-34 years	1.58	1.24	1.63	1.06
35-44 years	1.38	1.28	1.50	1.28
45-54 years	1.63	1.62	1.52	1.40
55-64 years	2.06	1.87	1.63	1.36
65-74 years	1.76	1.59	1.40	1.32
75-84 years	1.42	1.31	1.33	1.21
85+ years	1.13	1.24	1.07	1.16

Table H. Death rates for rheumatic heart disease per 1,000 population 45-84 years, by sex, for specified years: England and Wales

Year	45-54 years		55-64 years		65-74 years		75-84 years	
	Male	Female	Male	Female	Male	Female	Male	Female
	Rate per 1,000 population							
1961	0.18	0.28	0.27	0.41	0.37	0.56	0.46	0.72
1951	0.23	0.36	0.41	0.53	0.72	0.88	1.15	1.37
1949	0.29	0.38	0.63	0.59	1.19	1.10	1.90	1.99
1941	0.46	0.46	0.91	0.77	1.83	1.64	3.13	3.02
1939	0.49	0.46	1.04	0.87	2.16	1.98	4.11	3.92
1931	0.63	0.65	1.59	1.42	3.96	3.71	7.17	7.48
Percent change, 1961/31	0.29	0.43	0.17	0.29	0.09	0.15	0.06	0.10

Table J. Death rates for all cardiovascular diseases per 1,000 population 45-84 years, by sex for specified years: England and Wales

Year	45-54 years		55-64 years		65-74 years		75-84 years	
	Male	Female	Male	Female	Male	Female	Male	Female
	Rate per 1,000 population							
1961	2.66	0.90	8.04	3.13	20.7	11.9	51.5	38.4
1951	2.30	1.10	7.62	3.68	22.5	14.2	60.4	48.2
1949	1.87	0.94	6.46	3.11	17.8	11.8	46.2	38.4
1941	1.84	1.14	5.70	3.33	16.3	11.9	50.9	43.0
1939	2.23	1.29	6.87	4.04	19.3	14.1	59.7	50.4
1931	1.83	1.37	5.33	4.11	17.2	14.1	47.0	44.0
Percent change, 1961/31	1.5	0.66	1.5	0.75	1.20	0.84	1.10	0.87

In contrast to coronary artery disease all cardiovascular diseases have shown different trends according to sex (table J and fig. 19).

If all such diseases are considered together, the mortality for males has increased at 65-74 years of age by 21 percent in 31 years although the rate during the last 10 years has been relatively constant. The mortality for females has fallen by 16 percent in the 31 years and the rate has continued to fall during the last 10 years.

If we were to consider these statistics alone, it would suggest that some cardiovascular diseases that had a relatively high incidence among women have been replaced by another disease that affects men more severly than women. Thus it is probable that the increase in coronary artery disease and the fall in rheumatic heart disease is not mainly an artifact due to changes in diagnostic fashion or statistical coding but it is a real trend with one disease declining and the other rising.

Mortality due to pneumonia and influenza (fig. 7) has shown a decline for both sexes; but deaths due to these causes tend to fluctuate from year to year according to the weather or the epidemicity of influenza itself, with typical peaks in 1933, 1937, 1940, 1943, 1951, and 1957. There appears to have been a general improvement by both sexes between the early 1930's and the end of the war, but in the postwar era little improvement has been detected. The relative effects of the introduction of therapy and improved social condition cannot now be assessed accurately.

Bronchitis as a cause of death was severely influenced by the introduction of the Fifth Revision when according to the revised coding instructions the mortality attributed to this cause more than doubled. Hence it is not possible to discuss the changes in these deaths as a continuous function over 31 years, but each decade should be considered separately. Between 1931 and 1939, according to the Fourth Revision, deaths from bronchitis were declining quite rapidly in both men and women. The rate for men was 3.3 per 1,000 in 1931 and 1.8 in 1939. For women the rate fell from 2.7 in 1931 to 1.1 in 1939. The year 1940 was an exceptionally bad one for bronchitis due to the special climatic conditions as well as to the change in code. Since 1941 the bronchitic death rate among men remained relatively constant at about 4.5 per 1,000, except for epidemic peaks, until about 1954. Since this date there has been a definite rise in the general level of the death rate so that in 1961 the rate was 5.5 per 1,000. Among women mortality from bronchitis since 1941 has shown a constant decline with small epidemic peaks, and in 1961 it had fallen to 1.2 per 1,000.

All neoplastic diseases (fig. 13) among men remained constant from 1931 until approximately 1954 when there was a steady rise in the total rate, from 10.5 in 1931 to 11.7 in 1961; but among women there has been a steady but small decline throughout the whole period—in 1931 the female cancer rate was 7.9 and in 1961 it was 6.1, a fall of 23 percent in 31 years.

The pattern of cancers, however, has changed. Among men stomach cancers (fig. 25) have declined by 25 percent and respiratory cancers (fig. 23) have increased sevenfold. For women stomach cancers have fallen by 42 percent and breast cancers have fallen by 13 percent, and cancer of the cervix uteri has declined little and that mostly during the latter 1950's.

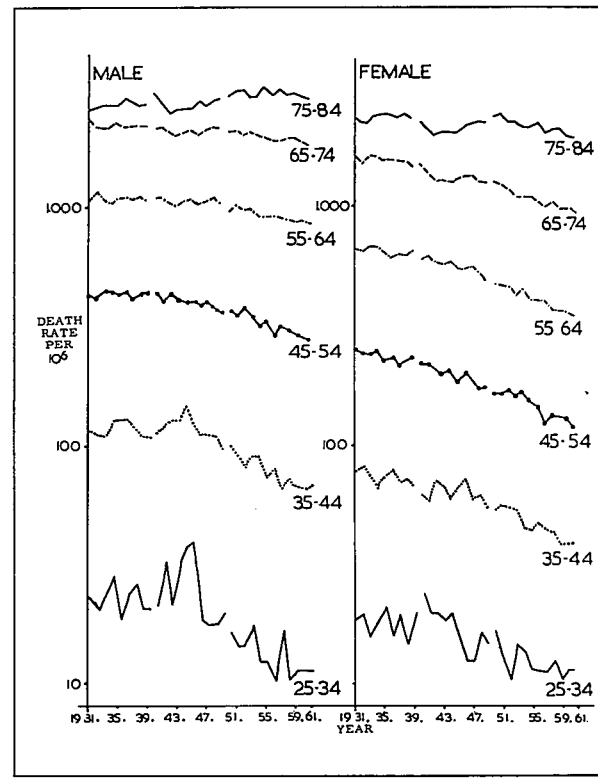

Figure 25. Death rates for cancer of the stomach per million population aged 25-84 years, 1931-61.

Old Age—75-84 Years

Until 1942 the Registrar General did not tabulate separately persons over 80 years of age, and, consequently, prior to this date it has been necessary to include into the old age group all persons over 75; subsequent to that date only the decade 75-84 is considered (fig. 6).

Above the age of 75 cardiovascular and respiratory diseases are the most prominent causes of death.

The main causes of death in 1931 are similar to those at 65-74 years of age and are the same for both sexes: "stroke," bronchitis, pneumonia and influenza, rheumatic heart disease, and all cancers, with cancer of the stomach prominent in both sexes.

In 1961 these had changed to "stroke", coronary artery disease, pneumonia and influenza, bronchitis, and all cancers, with cancer of the lung as the most important site among men and cancers of the stomach and of the breast among women.

At this age the mortality attributed to "strokes" declined during the 1930's, but then there was a discontinuity due to the change in coding introduced by the Fifth Revision. Since 1942 the trend appears to have been upward for both sexes.

Mortality from the cardiovascular diseases (fig. 19) has shown trends similar to those discussed in detail above. Deaths due to all cardiovascular diseases have increased for men and decreased for women. Rheumatic heart disease has declined as a cause of death, but coronary artery disease has more than compensated for this decline.

Mortality from all the respiratory diseases (fig. 26) seemed to improve from 1931 until about 1948; since then the rate among men, especially for pneumonia, has increased but the rate among women has continued to fall a little, although the epidemicity of respiratory diseases makes it most difficult to detect trends accurately.

Deaths from malignant neoplasms (fig. 13) among men have increased, especially from cancer of the lung, whereas among women neoplastic deaths have declined, especially from cancer of the stomach.

Senescence—85+ Years

Over the age of 85 considerable difficulties arise in interpreting any trends in mortality. Declaration of the age of the deceased upon the death certificate is not accurate, and certification by the doctors is not so careful, while multiple causes of death due to general degenerative diseases give rise to many problems in classification. As a consequence no discussion on individual causes of death at this age is given.

Total mortality at this age improved slightly during the 1930's, continued to improve during the war years, and has remained constant (fig. 6).

The improvement during the war years (except for 1940) was probably a real one and was also detectable among persons 75-84 years of age. It is interesting to speculate why in England

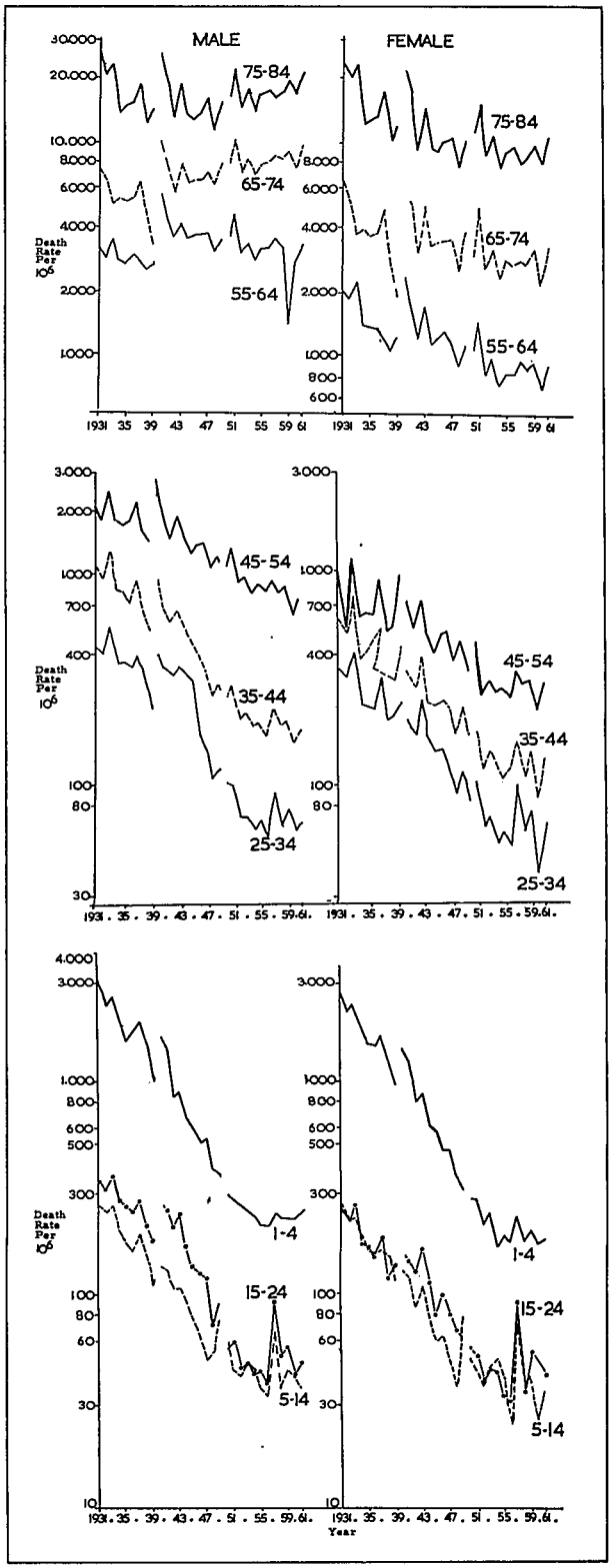

Figure 26. Age-specific death races for all respiratory diseases per million population, 1931-61.

and Wales old age should have benefited from the shortages and sufferings of the war years. This effect may be due to improved nutrition and better social care; communal kitchens were organized in many areas during the war to economize the food, and all people in the area could have at least one cooked meal a day at a low cost. It is probable that for the elderly who frequently live alone this was an improvement both in their nutrition and in their welfare as it brought them into closer contact with the community so that when they fell ill medical provision could be made for them more easily.

MALE TO FEMALE MORTALITY RATIO

One feature of the mortality rates throughout the whole period 1931-61 is the widening of the gap between the sexes. This has occurred at every age from 1 to 84, and it has occurred for almost every disease which has been considered; there are some factors in modern society which are inimical to the survival of the male which are beneficial to the female.

Figure 5 and table F show that even in 1931 the male was at a disadvantage compared with the female at all ages except 10-14 years; but by 1961 at all ages from 1-84 years the male was suffering a death rate at least 30 percent higher than the female rate, and in some age groups more than double. Figure 27 analyzes these ratios in detail for each age group and for years between 1931 and 1961.

In childhood between 1 and 14 years of age, the death rate for boys in 1931 was approximately 10 percent higher than for girls, and much of this difference was due to a higher death rate for accidents and respiratory diseases. By 1961, the gap between the two sexes had widened to over 40 percent, largely due to accidents both at home and on the road. In the case of respiratory diseases it is apparent that despite modern therapy boys still fare worse than girls, and even in malignant diseases there is a marked disadvantage to the male.

During adolescence and early adult life 15-34 years of age, the male disadvantage in 1931 was only of the order of 6 to 8 percent. This was due partly to deaths attributed to childbearing, but mainly due to incidence of respiratory tuberculosis and rheumatic heart disease which were particularly fatal to young women at this time.

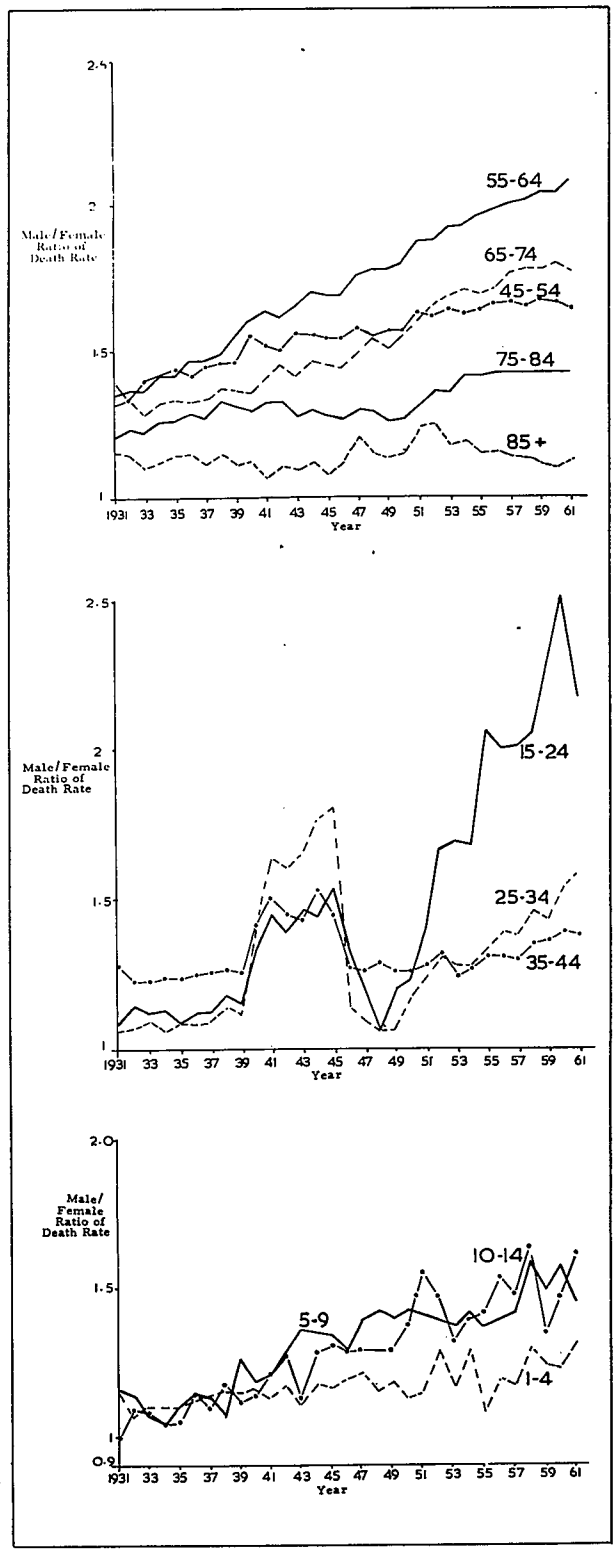

Figure 27. Age-specific ratio of male mortality to female mortality, 1931-61.

Almost all of the other diseases in this age group were higher among men. The picture altered completely in 1961; males 15-24 years of age now have a mortality rate more than double that of women. Although the absolute male rate has improved during the 31 years, it is the greater improvement among the females which is so dramatic. Almost all of this difference in sex mortality during adolescence can be attributed to deaths from violence, especially to deaths from road accidents which are five times as frequent, and from suicide which are twice as frequent.

During early adult life, 25-34 years of age, in 1961 males have a mortality rate 60 percent higher than their wives or sisters. Most of this difference can be assigned to four causes of death—road accidents, where the male rate is five times that of the female; suicide, where it is twice as high; coronary artery disease, where it is eight times as high; and cancer of the lung, where it is three times as high.

In middle life, 35-64 years of age, the male death rate in 1931 was approximately 35 percent higher than the female rate, but by 1961 the relative difference between the two sexes had widened to approximately 60 percent, and this gap was especially wide at 55-64 years of age when the male rate was double that of the female. The causes for this gap in 1931 were respiratory diseases, tuberculosis, road accidents, and suicide; in 1961 the relative increase in the male rate was due to coronary artery disease, cancer of the lung, road accidents, and suicide. In the case of both coronary artery disease and of lung cancer the male death rates were at least four times higher than the female rates, and in the case of road accidents and suicide it was approximately twice as high.

For elderly persons, 65-84 years of age, the male death rate in 1931 was about 25 percent higher than the female rate, whereas in 1961 it was 60 percent higher. In 1931 the main contributors to this excess were tuberculosis, respiratory diseases, all cancers, and suicide; in 1961 the male killers were coronary artery disease, which was twice as high, bronchitis four times as high, and lung cancer seven times as high.

At the advanced ages, over 85 years, the male to female ratio has remained relatively constant at approximately 13 percent to the disadvantage of the male. This ratio of the relative difference between males and females is of fundamental importance and offers opportunities for public health administrators and epidemiologists to speculate on the reasons why this should have occurred and to investigate whether it would be possible to reduce male mortality. If mortality of males had improved at a rate similar to that of females, there would be a saving of approximately 20 percent of male deaths.

When we consider why the excess of male deaths has continued to increase, it is clear that the causes are the same at most ages—road accidents, violence, suicide, bronchitis, lung cancer, and coronary artery disease. Why should the male have an excess of suicides and accidents at all ages when he has so many other opportunities of killing himself? Is this symptomatic that many of the other predominantly male diseases are also expressions of a "deathwish"? Bronchitis and lung cancer could certainly be decreased by reducing cigarette consumption and controlling urban air pollution; coronary artery disease could probably be decreased if men would reduce their weight and take more exercise.

Suicide and road accidents are, however, two problems which have proved very intractable and may be symptomatic of the whole problem. Modern society has not the will to take the steps that are known to be effective.

DISEASE-SPECIFIC MORTALITY

In the following section it is proposed to discuss the trends of mortality within disease groups.

Infectious Diseases

Because of coding and classification conventions, influenza and pneumonia are excluded from this group of diseases and will be considered in detail under the respiratory diseases.

Major advances in the last 31 years have been made in the conquest of these diseases (fig. 28), and there have been three lines of attack—specific chemotherapy, immunization programs, and advances in the social environment. As in any warfare, it is impossible to determine to what extent the ultimate victory was due to any specific ally, and after the battle all that can be done

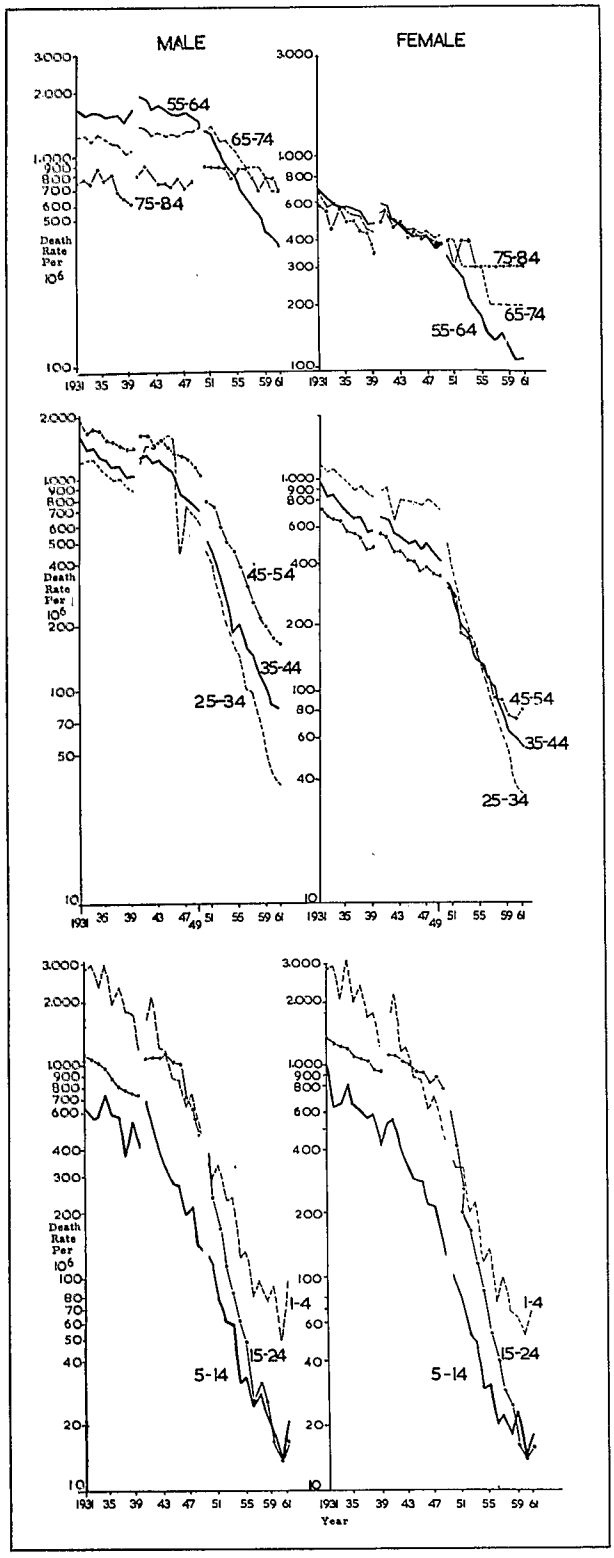

Figure 28. Age-specific death rates for all infectious diseases per million population, 1931-61.

is to indicate what sections of the battlefield were under attack from which army when a bulge appeared in the line.

The extent of the victory is clear. In 1931 there were 51,441 deaths attributed to infectious diseases, 35,818 of them due to tuberculosis; and there were also 47,982 deaths due to influenza and pneumonia. In 1961 there were 5,639 deaths due to infectious diseases, 3,334 from tuberculosis; and the number of influenza and pneumonia deaths had fallen to 36,377.

In 1931 the battle against the enteric fevers or the socially communicative diseases was over, with only cleaning up operations to be completed; but the personally communicative diseases were still a serious force. In childhood scarlet fever, which had been such a virulent disease in the earlier part of the century, had lost its effectiveness for no apparent reason; but diphtheria, measles, and whooping cough were each taking a heavy toll and each was to yield to a different attack.

Deaths from diphtheria (fig. 8) continued to increase during the 1930's despite attempts by certain local authorities and isolated general practitioners to encourage the use of immunization. Only with the threat of war and the possibility of a pandemic in the shelters and evacuation areas was the responsibility for the immunization program accepted by the Government and free immunization was successfully carried out by the local school and health authorities. There was an epidemic in 1941 when fortunately many school children were immune, and the brunt of the attack was borne by the preschool children who had not yet been fully immunized. This was the last push by the corynebacterium, and by 1949 the mortality had fallen by 98 percent; and by 1959 no deaths from this cause occurred in this country. Victory had been achieved by general immunity. But between 1922, when the Ministry of Health in its circular No. 68/Med first gave instructions on the Schick method of active immunization, and 1940 over 49,000 children had died from a disease that was preventable.

Whooping cough (fig. 10) was not defeated so dramatically. There was a slow improvement during the 1930's and the rate of fall increased with the introduction of sulfonamides. There was a sharp epidemic peak in 1941, but then the rate of fall continued throughout the 1940's. A vaccine

was introduced in 1950 which accelerated the improvement, but unfortunately the disease still causes an occasional death. This victory was an allied one between chemotherapy, immunization, and improved social conditions.

Measles (fig. 9) remains a dangerous disease in childhood; there was a peak in the mortality in 1934, and since then every epidemic peak (except 1961) has been lower than the preceding peak. Most of the deaths from measles are the result of complications either of pneumonia or encephalitis; chemotherapy has controlled the pneumonic complications and hospital care is usually successful in the management of encephalitis. No specific chemotherapy nor any vaccine was available for this disease by 1961. So in this case the success is largely due either to a loss of virulence by the virus, or to medical success in the management of complications, or to improved social conditions.

Tuberculosis (figs. 11 and 16) is clearly a disease that has been defeated by specific chemotherapy. There had been small but definite advances during the 1930's partly due to improved social conditions but also as a result of sanatorium care, collapse therapy and isolation of contacts, and identification of infectious cases by tuberculin testing. But the rate of progress was very slow, and in the older age groups mortality was rising. It was a particulary distressing feature of the mortality that the groups most affected were women in early reproductive life, 15-24 years of age, and men in early middle life, 45-54 years of age. During the war years this advance continued despite unfavorable conditions.

In late 1946 streptomycin was first heard of in this country, and when the first supplies became available in 1947 the Medical Research Council immediately organized a controlled trial in a select number of hospitals which was so successful that supplies became available for use in other hospitals in late 1947 and early 1948. The effect, especially among young women, was dramatic; their mortality fell by 90 percent in the next 5 years and had fallen by 99 percent within 10 years. The reduction in the older age groups was not quite so sharp but was nevertheless very satisfactory. There was some hesitation in the rate of improvement in 1953-54, probably due to development of a resistance to therapy; but fortunately new drugs became available and the advance continued. This complete victory was largely due to chemotherapy.

Neoplastic Diseases

Throughout the 31 years there has been a small but constant rise in death rates attributed to neoplasms among men and a small decline among women (fig. 13). There has been no important change in the classification of these diseases during this period, and the coding changes of 1940 do not appear to have affected seriously neoplastic diseases.

Diagnostic changes have, of course, been considerable; and the advances in surgery, radiotherapy, and even chemotherapy have been important. Even today it is realized that many neoplasms are not diagnosed until post-mortem examination and that many others could be detected at an earlier stage. It is difficult to say therefore whether there has been an increase in the incidence of neoplastic disease accompanied by improved survival rates which have resulted in a constant mortality or whether the total incidence has been level and therapy has been relatively ineffective.

When specific sites are examined, however, it is possible to make some positive statements about trends. Three neoplasms account for almost half the total deaths—cancer of the stomach, cancer of the lung and bronchus, and cancer of the female breast. The trends for each of these sites have been different.

Cancer of the stomach (fig. 25) at all ages below 75 and for both sexes has declined as a cause of death throughout the period. It is only possible to speculate on the reasons for this. Stomach cancer has always been a disease associated with poverty and malnutrition. In England and Wales there is a steep social class gradient in the mortality, and it is highest in the industrial areas of the North and in Wales. It is exceptionally high in parts of rural Wales. As prosperity has increased and nutrition improved the incidence of the disease has declined. Although extensive palliative surgery is performed for this disease, it seems improbable that improved treatment has affected mortality during this period. Therefore, it is concluded that this

is a disease of declining incidence, declining mortality, and of doubtful etiology.

Mortality from cancer of the female breast (fig. 22) has remained constant during the whole period, and the pattern of the disease is the same in 1961 as it was in 1931. There have been no advances in diagnosis, very little advance in therapy, and no decline in the survival rates. As other causes of death among women are so low, cancer of the breast becomes the most important cause of death in middle-aged women, 45-54 years of age. This is a disease of constant incidence, constant mortality, and of unknown etiology.

Cancer of the cervix (fig. 22) was classified separately in 1940 and since then the mortality has increased slightly. Diagnostic facilities have improved, and although cytology has not been available on a national basis, surgery and radiotherapy have both improved. It would appear that this is a disease with an increase in diagnosis which may be a real increase in incidence but with little change in survival. It is, however, a disease curable by early detection.

Cancer of the respiratory system (fig. 23) has increased at all ages and in both sexes during the 31-year period, and almost all of this increase is cancer of the lung and bronchus. It is over 14 years since papers were published indicating cigarette smoking as an important cause of this disease, and it is 3 years since the Surgeon General and 2 years since the Royal College of Physicians declared the case proved; but mortality continues at a rate of 23,000 per year and its cause is unchecked. It is interesting to note that among men 25-54 years of age the mortality from this disease has not risen during the last 5 years, and it is possible that an equilibrium between the etiological agent and the disease has been reached. This is a disease of increasing incidence and increasing mortality with a known preventable cause.

There are many reasons why leukemia (fig. 14) has shown an apparent increase at almost all ages since 1931. The total number of deaths attributed to leukemia and aleukemia in 1931 was 1,272, in 1961 it was 2,645. The effect of this increase on the total death rate was negligible but the reasons are difficult to determine. There has been increased interest in the disease with improved hematological laboratories and an awareness by doctors that many of the older patients formerly believed to be suffering from wasting diseases are really cases of chronic lymphatic leukemia. Acute leukemia in childhood has also increased, and again it is impossible to state whether this is due to an artifact or is a real increase. Leukemia is therefore a malignant disease with increasing mortality for reasons unknown.

Cardiovascular Diseases

Although there have been no extensive changes in the coding and classification of infectious and neoplastic diseases, this is not true for the cardiovascular diseases. This group of diseases has been especially affected by changes in nomenclature, methods of diagnosis, classification, and coding instructions. This is so much so that it is difficult to trace a continuous thread through the whole 31-year period.

As seen in table C, the alteration from the Fourth to the Fifth Revision of the International List in 1939-40 caused a large shift in coding from arteriosclerosis to cerebrovascular disease and from myocardial degeneration to bronchitis. The extent of these changes were different for different age groups. Table C indicates that when the Fifth Revision was replaced by the Sixth in 1949-50, there was a smaller shift back again from respiratory diseases to the heart diseases, and within the cardiovascular system there was a large increase in hypertension at the expense of arteriosclerosis and nephritic disease. The sharp rises and falls between 1939 and 1940 and between 1949 and 1950, which are seen in figures 19-21, 24, and 26, are largely due to artifacts of this kind.

There has been a large increase over 31 years in deaths attributed to the vascular system including vascular lesions of the central nervous system (fig. 19). In 1931 there were 151,000 deaths, or 28 percent of the total, whereas in 1961 they had risen to 282,000, or 51 percent of the total.

But the importance of this rise must be overemphasized, it is largely due to two factors—the aging of the population and the relative decline of other diseases. If the age-specific death rates

are compared in figures 19 and 24, it is clear that there have been no startling rises in the age-specific mortality from all vascular diseases, and among women there have been some falls.

Table J summarizes some of the death rates for the cardiovascular diseases in 10-year-age groups from 45-84 years, and figure 19 shows the rates for ages 25-84 years. There was a rise in mortality from all cardiovascular diseases between 1930 and 1939 for all men over 45 years of age and women over 65 years, but this rise was artificially interrupted by the change in coding methods introduced in 1940. During the war the rates continued to rise slowly, but there was a sharp upturn in the years 1947-49. Since 1950, however, over the age of 65 there has been a decline for both males and females, whereas under the age of 65 there has been a rise in the male rate and a decline in the female rate which has produced the widening gap in the male to female ratio which was noted previously. Over the whole period 1931-61 the male rate between ages 45 and 64 years rose by about 50 percent, whereas the female rate fell by 30 percent. Between ages 65 and 84 years the male rate rose about 15 percent and the female rate fell 15 percent.

Cerebrovascular disease (fig. 24 and table K) declined slowly during the 1930's especially at ages over 65 years. In 1940 with the Fifth Revision there was a sharp increase due to the shift of deaths formerly attributed to arteriosclerosis; since then there has been very little change in mortality.

This disease which caused 77,000 deaths in 1961 has remained constant in its sex and age pattern for 20 years, the only disease other than cancer of the breast which has done so. Only at ages 75-84 years is there any suggestion that there may have been a minor increase in the mortality rate.

In contrast rheumatic heart disease (fig. 20) has shown a marked decline in both sexes and at all ages. In 1961 there were only 7,000 deaths attributed to rheumatic valvular disease. The fall from 1931-61 at the younger ages 15-24 years has exceeded 90 percent, in middle age the fall has been less steep, but in old age once again the improvement has been greater than 90 percent. Both sexes have benefited by similar amounts. Although there were changes in the coding systems which affected this group of diseases, these changes did not seriously interrupt the trends (table H).

It may be safely deduced that there has been a real fall in the mortality from rheumatic heart disease, and that effective treatment of early rheumatic carditis in the acute stage will further reduce the rates in middle and advanced ages in the future.

Table K. Death rates for all cerebrovascular diseases per 1,000 population 45-84 years, by sex for specified years: England and Wales

Year	45-54 years		55-64 years		65-74 years		75-84 years	
	Male	Female	Male	Female	Male	Female	Male	Female
	Rate per 1,000 population							
1961	0.44	0.46	1.85	1.44	6.57	5.58	19.14	17.79
1951	0.49	0.57	2.04	1.95	7.30	6.45	19.47	18.40
1949	0.46	0.54	1.92	1.82	6.55	6.11	16.14	16.23
1941	0.49	0.62	2.09	2.02	6.46	6.14	17.41	15.75
1939	0.48	0.51	1.85	1.75	5.58	5.02	13.75	12.63
1931	0.44	0.52	1.80	1.63	6.44	5.58	16.29	15.32
Percent change, 1961/31	1.00	0.88	1.03	0.88	1.02	1.00	1.18	1.16

The picture for coronary artery disease (fig. 21 and table L), however, is entirely different. Coronary artery disease was a term introduced to the International Statistical Classification in 1931 when the total number of deaths attributed to this cause together with angina was 6,628; since then they have continued to rise until 1961 when these causes were responsible for 95,000 deaths.

The changes in coding in 1940 caused a small apparent drop at all ages which was counterbalanced by an increase in 1950, the net result being that coding cannot account for the rise in the disease.

The contrast with the fall in rheumatic heart disease might suggest that there may have been a gradual shift in diagnosis by younger doctors from rheumatic heart disease to coronary artery disease. To some extent this may be true but close inspection of figures 20 and 21 and tables H and L show that the fall in rheumatic heart disease has been especially marked among young women, whereas the rise in coronary artery disease has been prominent among middle-aged men. The absolute fall in rheumatic heart disease in the 31-year period has only been of the order of 20,000 deaths, whereas the rise in coronary artery disease has been 89,000 deaths. This would all suggest that there has been a true and absolute rise in deaths attributed to coronary artery disease.

Respiratory Diseases

The Sixth Revision in 1949-50 included influenza with the respiratory diseases rather than with the infectious diseases as studies had shown that the age and sex pattern of deaths from influenza in nonepidemic years was similar to that of pneumonia. Even in epidemic years an increase in influenza deaths was always accompanied by a peak in pneumonia deaths. In this report influenza deaths from 1931 onward have been included in all respiratory diseases and have been excluded from the infectious diseases.

Coding changes with the Fifth Revision in 1939-40 were severe, and many deaths which had formerly been attributed to the cardiovascular system were now assigned to the respiratory system, especially to bronchitis. This was largely due to the change in coding instructions which now allowed the coding clerks to take cognizance of the doctor's statement of the underlying cause of death rather than to compel them to allocate an arbitrary priority to certain causes when there were multiple causes of death given in a certificate.

Figure 26 shows that there was a marked discontinuity between 1939 and 1940. Some of this was due to these coding differences but part of this difference was a real one due to the special conditions of that year.

Table L. Death rates for coronary artery disease per 1,000 population 45-84 years, by sex for specified years: England and Wales

Year	45-54 years		55-64 years		65-74 years		75-84 years	
	Male	Female	Male	Female	Male	Female	Male	Female
	Rate per 1,000 population							
1961	2.04	0.33	6.04	1.63	13.23	5.94	22.63	13.14
1951	1.44	0.26	4.39	1.25	9.80	4.43	15.19	8.76
1949	1.15	0.22	3.56	1.05	7.27	3.42	10.62	6.04
1941	0.55	0.12	1.51	0.51	3.45	1.55	5.09	2.78
1939	0.68	0.13	1.99	0.59	3.93	1.73	5.82	3.30
1931	0.27	0.05	0.78	0.23	1.78	0.71	2.31	1.26
Percent change, 1961/31	7.6	6.6	7.7	7.1	7.4	8.4	9.8	10.4

There appears to be only two major influences that cause a marked fluctuation in the total mortality rate of an individual year in England and Wales, and these are either a severe cold winter or an influenza epidemic. A cold spell in England in which the temperature falls below $0^{\circ}C$. for a period of a month is rare but this occurred in 1929 and 1940; and in each of these years there was a considerable increase in total mortality, and most of the excess mortality occurred in the winter quarter January to March. Influenza epidemics, on the other hand, may occur at any time of the year and tend to be cyclical.

Epidemics which had an appreciable effect on total mortality occurred in 1933, 1937, 1943, 1951, and 1957.

The trend of mortality during the last 31 years from all respiratory diseases has been a decline for both sexes and at all ages.

The decline at the younger ages has been very marked, and at ages under 25 years, the reduction is of the order of 80 percent of mortality. Much of this improvement may be attributed to improved therapy; but it is interesting to note that the trend was already well established in the early 1930's, and there was no alteration in the rate of improvement (except for 1940) after the introduction of the sulfonamides subsequent to 1937, or of penicillin after 1944, or of tetracyclines after 1950. At these ages the rate continued to fall until 1956. In 1957 there was a peak due to the influenza epidemic of that year which especially affected the younger population, and subsequent to that outbreak the long-term trend has completely altered and now appears to be constant.

At ages between 45 and 54 years there have been falls of the order of 60 percent over 31 years in the respiratory mortality, and once again the introduction of the antibiotics does not appear to have modified the trend; but this has been altered after the epidemic of 1957.

Violent Deaths

Violent deaths in 1931 accounted for only 21,578 deaths and in 1961 for 23,314. Within the various categories of violence, the pattern of the causes of death remained constant as is shown by the total number of deaths occurring in 1931 and 1961.

Cause of death	1931		1961	
	Number	Percent	Number	Percent
Total--	21,578	100	23,314	100
Suicide------	5,147	24	5,200	22
Homicide-----	190	1	255	1
Motor vehicle traffic accidents-----	5,818	27	6,544	28
Accidental falls-------	5,632	26	5,376	23
All other violent deaths------	4,791	22	5,939	25

Within this constant pattern, however, there have been important changes in the age-specific mortality (fig. 29). All violent deaths at ages 1-14 years remained fairly constant from 1930-39, rose sharply in 1940, and then declined rapidly until 1954; since then they have been fairly constant. At ages 15-24 years, however, there was a constant rate between 1930 and 1939 and a sharp rise in 1940 with a fall which persisted only until 1949; since then there has been a sharp and continuing rise in both sexes. In adult and middle age there was the same fall in the later 1940's and a small rise during the 1950's; this pattern was repeated in the older ages.

Suicide, however, has had an interesting pattern (fig. 17). The suicide rate for most ages increased between 1930 and 1933, but then it started to fall and this fall was increased during the war years. Suicide unlike most other causes of death did not show the sharp peak in 1940 and reached a trough in the period 1942-44; this pattern being most clearly demonstrated by the age groups 45-64 years in both sexes.

In the postwar years there was a rise in the suicide rate at most ages until approximately 1950 when a divergence appeared. In the last decade the female suicide rate has continued to rise at all ages, but the male rate has remained constant over the age of 45 years and has only risen at ages under 45 years. Despite this

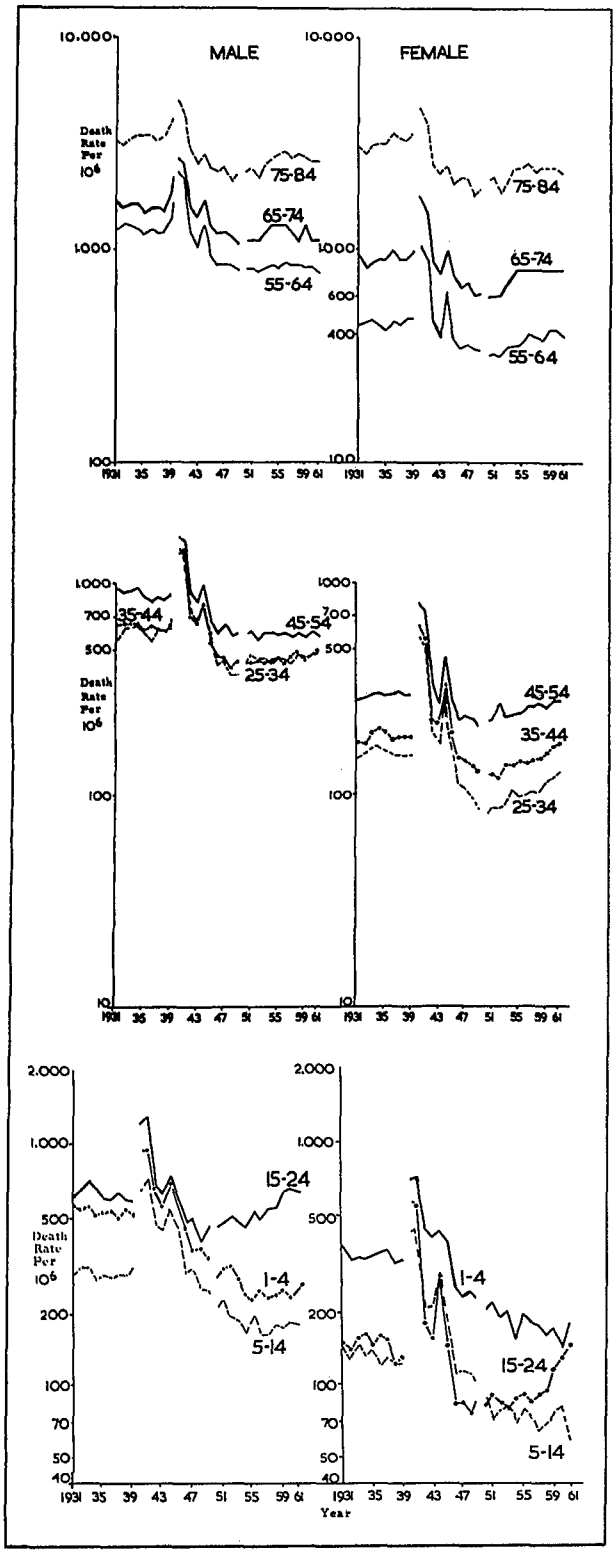

Figure 29. Age-specific death rates for all violent deaths per million population, 1931-61.

divergence, however, it remains true that at all ages the male suicide rate is greater than the female.

Deaths due to homicide in England and Wales have usually averaged about 200 per annum; but since 1956 there was a slight increase, and the 255 in 1961 was a maximum for the 31-year period.

Motor vehicle traffic accidents have been very remarkable; the number of vehicles registered in 1931 was 2.0 million and in 1961 this had risen to 9.2 million, but in contrast the number of deaths had remained almost constant. The age pattern had altered, however. The rates for children had fallen slowly during the 1930's, rose in 1940 and 1941, but have continued to fall ever since. In absolute contrast with this there has been a sharp rise in the mortality at ages 15-24 years, the male mortality in 1948 was 150 per million and in 1961 it was 418. The female rates, however, rose from 20 to 79, an increase to both sexes of approximately 3 times. At all ages above 25 the trends of mortality from road accidents have been similar, a small decline from 1930-38, a peak from 1939-41, a fall from 1942-48, and a subsequent rise which approximately doubled the mortality rates in 13 years.

Deaths from falls have not been tabulated in detail in this study. They are largely a phenomenon of women over age 65, and the age-specific rates have fallen slowly probably as a consequence of the introduction of antibiotics.

CALCULATED AGE TRENDS

The age-specific death rates for the period 1950-61 have been analyzed mathematically in order to determine whether the trends have altered during this period. This analysis was confined to the period 1950-61 because the population used for calculating mortality rates was changed in 1950 from the civilian to the total population thus affecting many rates. This restriction of the mathematical analysis should not unduly affect the conclusions, as by 1950 the country had recovered from the experience of the war years and the mortality at all ages under 75 was continuing to decline.

The method used in this analysis was to calculate the logarithm of the sex- and age-specific death rates and to fit these figures with a series

of orthogonal polynomials using the year as the independent variable with 1950 being the base year. Standard statistical tests were then applied to determine what was the lowest degree of polynomial to give a significant fit to the data. The orthogonal polynomials were then reconverted to the standard form as given in the equation

$$Y = b_0 + b_1 X + b_2 X^2 + b_3 X^3$$

where Y = logarithm of death rate (1)

X = (Year - 1950)

The equations may be interpreted as follows: b_0 is the logarithm of the expected death rate in 1950, ignoring small annual fluctuations, 1950 being the year in which $X = 0$.

b_1 is the main trend in mortality and is the amount by which the logarithm of the death rate is changing each year. If a logarithm is changing by a constant amount, this implies that the death rate itself is altering by a constant percentage; b_1 therefore is the annual percentage change in the mortality.

b_2 modifies b_1 and because it is a function of X^2 it does so by an increasing amount each year; if b_2 is of the same sign as b_1 it acts as an accelerator to the rate of change, whereas if it is

Table M. Analysis of the trend of mortality, by sex and age: England and Wales, 1950-61

Age	Mean level in 1950 b_0	Trend b_1	Damping factor b_2	Turning date $b_1 / 2b_2$
Male				
All ages	+1.094	-	-	Before 1950
Under 1 year	+1.539	-.023	+.0008	After 1961
1-4 years	+0.179	-.042	+.0024	1959
5-9 years	-0.139	-.052	+.0035	1957
10-14 years	-0.240	-.033	+.0016	1960
15-19 years	-0.015	-.023	+.0021	1955
20-24 years	+0.151	-.027	+.0017	1958
25-34 years	+0.229	-.036	+.0018	1960
35-44 years	+0.473	-.017	+.0008	1960
45-54 years	+0.918	-.006	-	After 1961
55-64 years	+1.359	-.002	-	After 1961
65-74 years	-1.733	-	-	Before 1950
75-84 years	+2.10	-	-	Before 1950
85+ years	+2.403	-	-	Before 1950
Female				
All ages	+1.039	-	-	Before 1950
Under 1 year	+1.427	-.025	+.0010	After 1961
1-4 years	+0.113	-.043	+.0021	1961
5-9 years	-0.286	-.050	+.0030	1958
10-14 years	-0.395	-.031	+.0011	After 1961
15-19 years	-0.128	-.074	+.0044	1958
20-24 years	+0.021	-.072	+.0039	1960
25-34 years	+0.150	-.044	+.0017	After 1961
35-44 years	+0.360	-.012	-	After 1961
45-54 years	+0.728	-.016	+.0008	1960
55-64 years	+1.107	-.014	+.0006	1961
65-74 years	+1.538	-.006	-	After 1961
75-84 years	+1.983	-.005	-	After 1961
85+ years	+2.338	-	-	Before 1950

of the opposite sign it acts as a damper and may in fact destroy the main trend altogether.

b_3 suggests a complete alteration in trend, and as it is a function of X^3 may rapidly become dominant; but fortunately in no instance was any b_3 factor statistically significant in the period 1950-61.

Table M and figure 30 give the results of these calculations.

At every age b_0 for males was higher than for females, and the difference between these two factors within one age group is a measure of the ratio of the male to the female rates in 1950. They suggest a pattern exactly the same as in figure 4 and table G. The difference is greatest in the age group 55-64 years.

At all ages below 65 in the males and below 85 in the females b_1 was negative. This means that at these ages the main trend in mortality was downward. The actual values of b_1 fluctuate a little between age groups, but in almost every case the rate of change of females was greater than the rate for males even though their basic rate in 1950 was already lower than the male rate; furthermore this rate of improvement among women continued to a higher age group than for men.

In every instance where b_2 was statistically significant it was positive and opposite in sign to b_1; hence it is always acting as a dampening factor to decrease the rate of fall in the mortality and never as an accelerator.

It is possible to calculate from these equations when the dampening effect of b_2 overrides the main trend of b_1; at this point of time the mortality would be at a minimum and the subsequent trend would be upward. This can be calculated from the equations (2) and (3).

$$\text{When} \quad dy / dx = O \qquad (2)$$

$$\text{Then} \quad x = b_1 / 2b_2 \qquad (3)$$

This has been done in the right-hand column of table M, where it will be seen that in the great majority of age groups the turning point had already been reached prior to the end of 1961. It is not necessary therefore to extrapolate the data beyond the decade analyzed to estimate when the main trends of mortality were likely to change, as they had already done so.

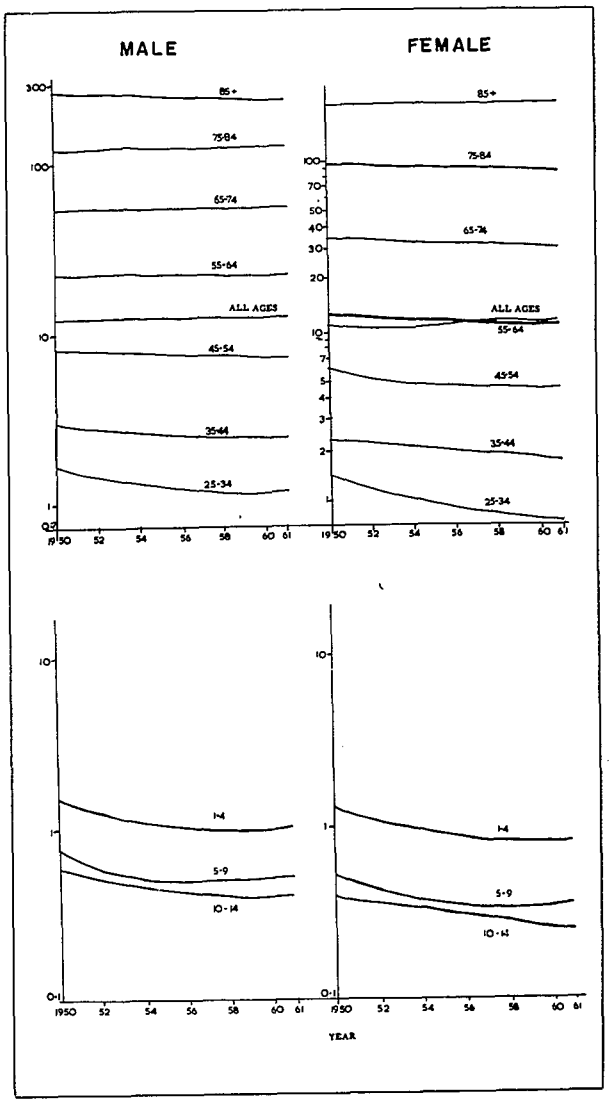

Figure 30. Estimated trends in the death rate, by age and sex, 1950-61.

Unless, therefore, some new factor intervenes which was not present during this decade, the age-specific mortality rates are not likely to show further improvement in the near future.

DISCUSSION

The purposes of a retrospective survey of mortality are twofold: first to examine the actual effects on mortality of certain economic, social, medical, and administrative changes as a guide

for action in the future and, second, to estimate probable future trends.

In this study it has proved very difficult to disentangle the various factors influencing survival over a prolonged period that covers economic depression, war, and therapeutic revolution, but some general conclusions may be drawn.

It seems probable that the 90 years of constant improvement in mortality which started in the early 1870's has almost come to an end so that in the future most age-specific rates are more likely to remain constant or to increase rather than to decrease.

In this country it is almost certain that the change in the general pattern of mortality by age and sex is not due to an artifact. Conceivably several statistical factors could influence the mortality rates; there could be improved registration of death, there could be underestimation of the total population, or there may be a decreasing tendency to overstate the ages of the deceased.

Only three censuses were taken during this period, in 1931, 1951, and 1961, but a national register of the whole population was established in 1939 which was used as a basis for food rationing and proof of identity during the war and postwar periods, and this did not suggest that there was any serious underestimation of the population. Similarly there are current registers for social security and for the national health services, none of which indicate any serious deficiencies in the census estimates of population. In fact, the final figures for the census of 1961 agreed very closely with the Registrar General's precensal estimates.

Death registration has been established throughout the country for 125 years; and cooperation among doctors, coroners, funeral directors, and cemetery superintendents has been perfectly efficient so that there is almost no possiblity of the disposal of a body without legal registration. There is no evidence of inadequate registration of deaths at any time in the last 31 years.

It is difficult to determine whether there has been a change in the stated age at death. It is not necessary to produce the birth certificate when registering a death, and no investigation has been made into the accuracy of stated ages. If previously stated ages had been overestimated and if during the period of study these had become more accurate, this would have the effect of apparently increasing the age-specific rates at all ages. An old age pension has been available for over 50 years in this country, and to collect this pension a birth certificate or other adequate proof of age has to be produced. There has been no recent change in this policy, thus the majority of elderly people know when they become eligible for the pension, consequently it seems improbable that there has been any reason why stated ages of deceased persons as declared by informants should have declined.

Thus it is certain that the halt in the decline of most age-specific death rates during the last decade in England and Wales is a true one. The reasons for this halt, however, are more difficult to determine. When the causes of death are examined, there are many artifacts of diagnosis and coding which may affect the disease-specific rates; but making full allowances for all possibilities a clear pattern emerges. Infectious diseases have declined by over 90 percent, respiratory diseases have declined by nearly 50 percent, neoplastic diseases and violent deaths have not altered greatly, and vascular diseases have increased slowly. The balance between these various trends has altered considerably, and now the sheer weight of numbers have permitted the slow inexorable increase in vascular deaths to tip the scales in favor of an absolute increase in mortality.

Within each disease group, however, there are considerable variations of the pattern. In some cases a specific disease may have decreased only to be replaced by another disease of the same system, and so even within the groups of diseases an uneasy balance is maintained which may or may not be an equilibrium.

Acute infectious diseases as agents of death have almost lost their former importance. Scarlet fever, diphtheria, pertussis, and measles have all declined by 99 percent, but each for a different reason—scarlet fever, presumably due to a loss of virulence by the streptococcus, diphtheria due to prophylaxis, pertussis possibly due to therapy, and measles for a variety of possible reasons. Fortunately these diseases have not been replaced by a worse devil as may well have happened if

poliomyelitis had not been conquered or infectious hepatitis had become more virulent.

Tuberculosis has been the one disease that has influenced the trend of total mortality for many years, and in the decade following 1950 it was mainly the dramatic fall in these deaths due to effective chemotherapy which tended to obscure the slow rise in other types of mortality; but now these deaths account for less than 1 percent of all mortality. Even the complete conquest of this disease would have little effect on total mortality.

Although the total neoplastic death rate has remained relatively constant, there has been an interesting contrast between the three most important sites of cancer. Cancer of the stomach has declined, cancer of the breast has remained constant, and cancer of the lung has increased steadily, while almost all other cancers have declined. The net result of these changes is an equilibrium but this appears to be entirely fortuitous and may not persist. If the female deaths from respiratory cancer continue to follow the pattern of male mortality with a 20-year lag between them as they appear to have done in recent years, then this possible increase would certainly upset the balance and cause a rise in the total neoplastic death rate. If, however, vigorous and effective action were taken to reduce cigarette smoking, then within 5 years the mortality from respiratory cancers would decline very rapidly and the total picture of neoplastic disease would be completely altered, leaving cancer of the breast as the most significant site.

Respiratory diseases have declined in total largely due to the fall in pneumonia deaths. This may be partly an artifact as pneumonia is frequently the terminal stage of many other diseases; and if diagnosis of these other causes had improved, then pneumonia would have declined. As a consequence it is difficult to decide whether this is a real improvement or not. The failure of the rate to be influenced by the introduction of the various antibiotics would suggest that there was some underlying trend which was of even greater importance than the therapeutic revolution that has taken place, and this may well have been the great improvements in diagnostic facilities. Influenza as an epidemic disease shows no sign of a real decline in mortality; the outbreaks in 1951 and in 1957 were quite as serious as many previous episodes, but as an endemic diagnosis there is evidence that it is slowly disappearing from the death certificates.

Bronchitis is a disease that has been severely influenced by diagnostic and statistical artifacts so that it is almost impossible to determine the true trend, but it is probable that at ages over 55 years there has been a recent increase in this cause of death.

Violent deaths are a relatively unimportant cause of total mortality, being only about 5 percent of all deaths. Suicides have fallen and risen again, road accidents have done the same and are now rising rapidly, other accidental deaths have fluctuated so that the whole group of deaths have remained almost constant.

Vascular diseases now dominate the whole trend of mortality as this one group of diseases accounts for 51 percent of total deaths, but due to several changes in coding and rapid advances in diagnostic techniques it is almost impossible to be precise concerning specific trends. Within the group it seems clear that there has been little change in cerebrovascular disease, that rheumatic heart disease has declined, and that coronary artery disease has increased. It seems to be fortuitous that the scales are overweighted by the increase in coronary artery disease, but unfortunately this one disease now accounts for 23 percent of male mortality; and its incidence continues to increase especially among middle-aged men. It is this rise that has halted age-specific mortality rates and has altered the whole prospect of the future trends in mortality.

In England and Wales the average age of the population is still increasing so that if there are no prospects of improvement in mortality at specific ages, then the crude mortality will rise in the future and may rise by as much as 10 percent in the next 10 years unless major changes are made in the prevention and cure of coronary artery disease. Such changes in the prevention and cure of disease in the past have taken many years before they influence the major trend of total mortality.

It is possible to modify a disease process in a community at various stages. An environment conducive to the disease may be eliminated; this is the typical condition of a socially com-

municative disease such as the enteric fevers or malaria, where the environment itself is modified. There was no such disease in this study.

Alternatively the population may be taught to avoid particular hazards in the environment even though these hazards remain; such a case is the instruction of children in road safety which seems to have been so successful in this country in recent years.

Frequently with infectious diseases it is possible to offer some form of immunity to that section of the population most exposed to a particular risk; the classic example of this is vaccination, but in the period under review diphtheria is an excellent demonstration of the effectiveness of this technique.

If it is not possible to remove a hazard nor to immunize the population against a disease, the introduction of effective therapy to prevent active cases of the disease from becoming fatal may both reduce the mortality and ultimately the incidence of the disease; tuberculosis since 1947 is an excellent illustration of this.

Finally if it is not possible to cure a disease, it may be possible to avert a fatal result as with insulin treatment of diabetes.

What are the prospects of any major advances being made in any of these fields in the future?

The Clean Air Act of 1956 produced some excellent results in modifying the environment and may ultimately reduce some of the bronchitis mortality.

The Government may take measures to control cigarette smoking either by taxation or by legislation and possibly the population may be convinced of the scientific evidence concerning smoking. If so, this would decrease mortality from bronchitis, lung cancer, and possibly from coronary artery disease.

There is no major cause of death that could be influenced by immunization, but a revolution is just possible within the next decade in the management of coronary artery and hypertensive diseases. Such a breakthrough, however, cannot be predicted, and if it came would have a dramatic effect similar to the introduction of the antituberculous drugs.

Maintenance therapy is a field in which there is a great deal of research going ahead, with anticoagulants in vascular diseases and chemotherapy in the chronic respiratory diseases, but advances in these fields are unlikely to alter the main trends in mortality.

Thus except for the reduction in cigarette smoking there is no major advance in medicine or public health in prospect that is likely to alter the main trend in mortality which has failed to advance in the last few years. The present halt in the reduction is likely to be a lengthy one.

SUMMARY AND CONCLUSIONS

A review has been made of mortality in England and Wales from 1931 to 1961 analyzing the data by sex, age, and cause of death.

The general trend of mortality during this period, when allowance is made for changes in the age of the population, has been downward; the standardized mortality ratio based upon 1950-52 as 100 has fallen from 142 in 1931 to 92 in 1961. But due to the fortuitous balance between increasing age of the population and decreasing age-specific death rates, the crude mortality has remained almost constant.

The rate of improvement has been greatest in childhood between the ages of 1 and 4, where the mortality rates have fallen to less than 12 percent of the rates prevailing in 1931.

There has been only a small improvement in the male mortality above age 55 years.

At all ages not only is the female mortality lower than that of the male, but at all ages between 1 and 84 the female rates have improved more than the male rates.

The greatest improvements were found in the infectious diseases especially diphtheria, measles, and whooping cough.

Deaths due to tuberculosis have fallen by approximately 90 percent in the 31-year period, and this fall has been greatest at the younger ages, where tuberculosis has almost disappeared as a cause of death.

Neoplastic deaths have shown a small but constant rise in men and a small decline among women. Lung cancer has increased, leukemia has increased, breast cancer remains constant, and stomach cancer has fallen.

All vascular diseases have increased considerably from 28 percent of all deaths in 1931 to 52 percent in 1961. Cerebrovascular deaths

have remained constant, rheumatic heart disease has declined steeply, and coronary artery disease has increased.

Respiratory diseases have fallen, especially at younger ages; pneumonia has declined; bronchitis has fluctuated and may have been affected by coding changes; in epidemic years influenza remains a serious hazard.

Deaths due to violence remain relatively constant, but road accidents are now increasing.

There is clear evidence that the rate of improvement at most ages has been dampened and even arrested at some period between 1955 and 1961; and there is little probability that rates will improve in the next few years and the crude mortality rate will probably increase.

The reason for this recent halt in improvement is the lack of balance between the increase in vascular mortality, especially deaths attributed to coronary artery disease, and the diminishing improvements in infectious and respiratory diseases.

The best prospect to reverse this trend would be to determine why males have failed to match the improvement in female mortality and to remedy any environmental or social conditions that affect men rather than women.

In particular a reduction in smoking habits would probably result in a reduction of deaths due to lung cancer, bronchitis, and possibly vascular diseases.

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