Tuberculosis and Influenza in Relation to the World War, 1914-18

By EDGAR L. COLLIS, C.B.E., D.M., M.R.C.P.
Emeritus Professor (Preventive Medicine), University of Wales

INTRODUCTION

Oft, so oft as to have become trite, has the sequence been stressed that War leads to Famine, that Famine leads to Pestilence, and that Pestilence results in Death. Reversing the process, in history, the occurrence of a Pestilence may fairly be taken as connoting a precurrent Famine.

Totalitarian war is with us to-day. Either side, by blockade, strives to bring famine upon the other. History teaches that we may expect, as inevitable, the occurrence, in due course, of some deadly pestilence.

What happened in 1914-18 gives warning. That great war, as year followed year, led to ever-increasing and widespread food shortage, most accentuated in middle Europe. Its end coincided with the great and deadly influenza epidemic of the 1918-19 winter—an epidemic which slew more in a few months than the comparatively puny efforts of mankind in the previous four years. Had not the Armistice intervened, hostilities would almost certainly have been thereby closed down.

A review of what took place in the mortality from tuberculosis during those war years, and in the mortality from influenza as they ended, must be of timely interest to-day.

THE 'NORMAL' MORTALITY CURVE DUE TO ALL CAUSES OF DEATH

A mortality curve based upon deaths due to all causes occurring at the various age-periods of life—what may be called a 'normal' mortality curve—presents a concavity from infancy to old age as shown in fig. 1.

Such a curve is made up of components from all the various causes of death, most of the contributions from which conform to some part of the shape of the main curves.

INFANCY.—In infancy come failures in capacity to live—malformations, marasmus and the like—succeeded by the diarrhœas and bronchopneumonias of infancy, which, in their turn, are followed by many generalized infectious fevers such as scarlet fever, diphtheria, measles, mumps, whooping cough and influenza; very often these fevers are characteristically diseases of childhood and they fade away as childhood passes. Tuberculosis here also contributes its quota; and, when it occurs at this period of life, it is in a generalized or 'infantile' type.

OLD AGE.—At the other end of life as wear and tear begins to interfere with the vital mechanisms of the body—as the heart and circulatory system fail before the strain of existence, as the respiratory organs become chronically inflamed, as the digestive system falls prey to cancer, or the kidneys cirrhose—a different assortment of causes of death comes ever increasingly upon the scene. Here again, tuberculosis may claim its victims; but it is now a slow, localized infection, quite distinct from the generalized 'infantile' fever of childhood.

EARLY ADULT LIFE.—The concavity of the curve in early adult life would be

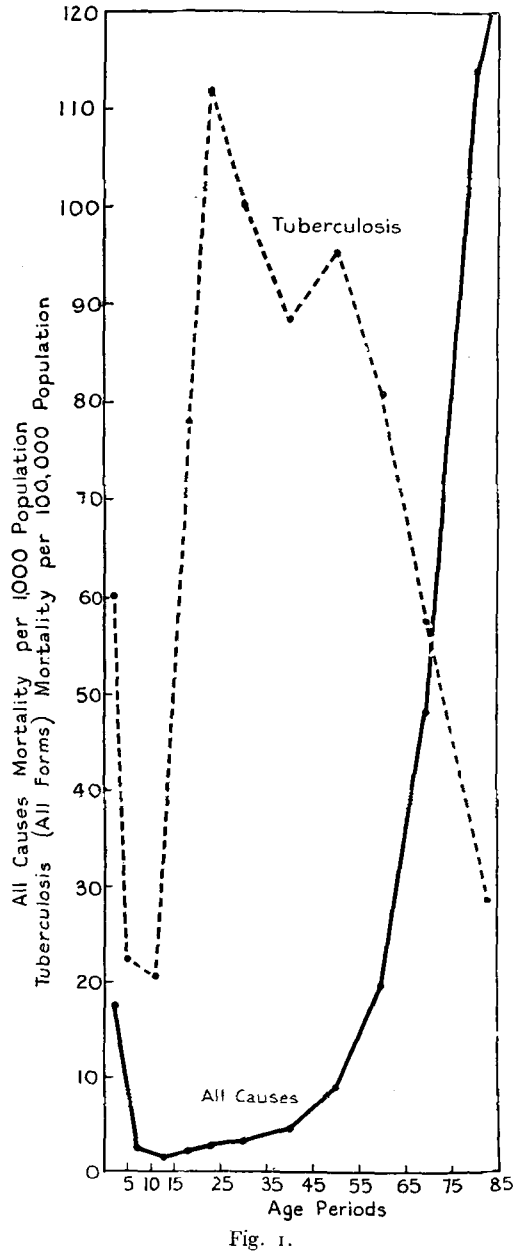

Fig. 1.

Mortality from Tuberculosis (all Forms) per 100,000 Population contrasted with that from All Causes per 1,000 Population England and Wales, 1934.

even nearer to the base line than it is, were it not for such causes of death as puerperal fever, lobar pneumonia, industrial and other accidents and, especially, pulmonary tuberculosis which, in itself, may account for one-third of all the deaths.

In order to facilitate comparison between age incidence of mortality from *all causes* and that from *tuberculosis* (*all forms*) different height-scales have been used for the two curves : that for *all causes* is on the basis of 1,000 population at risk and that for *tuberculosis* (*all forms*) on a basis of 100,000 population.

THE CURVE OF MORTALITY DUE TO TUBERCULOSIS

A curve representing the mortality rate from tuberculosis at the different age-periods is in shape only partially in accord with the 'normal' mortality curve.

INFANCY.—The curve starts high in the first year of life. The deaths are due, for the most part, to generalized non-pulmonary tuberculosis. At this age occur infections ending fatally among a proportion of the population with but slight power of resistance. The mortality, as it fades away before adolescence is reached, conforms to a normal curve.

EARLY ADULT LIFE.—Here, between ages 15 and 30, the course of the curve is aberrant. It rises to a peak between ages 20 and 25, and then falls away to age 30. This rise and fall, following upon the fade away after childhood, differs from the mortality curve usually seen for any other cause of death, with the possible exception of that for the bronchopneumonias and pneumonias taken together. There again, is an example of more generalized infections becoming more localized clinically in later years.

The curve is dominated by pulmonary tuberculosis. The infection, although febrile and often fairly rapid in its course, is for the most part localized to the respiratory tract.

MIDDLE LIFE.—Another curve shows up in middle life; it commences as the early adult curve falls away, and frequently so overlaps it that the two coalesce to exhibit one long-topped curve rather than two humps. This curve has its apex about age 45, and fades away about age 60.

Clinically the disease tends to be even more definitely localized to the lungs and to be less febrile. The lesions show more fibrosis.

Tuberculosis, when implanted upon silicosis, particularly favours this middle-age curve; a fact which suggests that wear and tear of life, by damaging the lungs, is a determining factor in this middle-age tuberculosis.

LATE LIFE.—Brownlee, to whose memorable researches [1] we owe so much regarding these curves of tuberculosis mortality, has pointed out that there is yet another curve, beginning about age 55 and centring about age 65 years. He pointed to its existence by statistical examination of English mortality records. But records for other countries, and in particular, for U.S.A., show it more clearly, so that the suggestion has been advanced that many of our old-age bronchitics are in reality unrecognized chronic tuberculosis. The work of Enid Williams among Welsh coal-miners supports this idea. Anyway, we should keep close watch on such unsuspected sources of infection and be mindful of the old superstition that children should not be too much with the old, because the old so abstract their youthful vigour that they waste away.

MORTALITY FROM TUBERCULOSIS 1914–18

Steadily, since at least 1850, in all civilized countries for which reliable records are available, the mortality due to tuberculosis has been receding at all age-periods, but by no means equally at these age-periods [2], thus:—

TABLE I

ANNUAL MORTALITY FROM TUBERCULOSIS (ALL FORMS) ENGLAND AND WALES AT THREE AGE-PERIODS, THAT FOR 1851–60 BEING TAKEN AS 100

Periods	Age-Period 0–5	20–25	45–55
1851–60	100·0	100·0	100·0
1901–10	29·9	41·1	74·1
1931–35	11·2	26·9	32·6

The figures indicate how the fall was greatest, during the last half of last century, at the beginning of life, while that in early adult life came next, and that in more advanced life was least. During the present century the rapidity of fall in early life has continued, that at ages 20–25 has slowed down, while that at ages 45–55 has quickened.

Mortality from tuberculosis at ages 0–5 especially represents non-pulmonary tuberculosis, the fall from which at all ages has been as follows:—

TABLE II

MORTALITY PER MILLION FROM NON-PULMONARY TUBERCULOSIS ENGLAND AND WALES

Periods	Males		Females	
1851–60	783	Fall per cent	629	Fall per cent
1931–35	175	77·6	151	76·0

The fall from respiratory tuberculosis at all ages has been as follows:—

TABLE III

MORTALITY PER MILLION FROM PULMONARY TUBERCULOSIS
ENGLAND AND WALES

Periods	Males		Females	
1851–60	2694	Fall per cent	2854	Fall per cent
1931–35	704	*73·9*	544	*80·9*

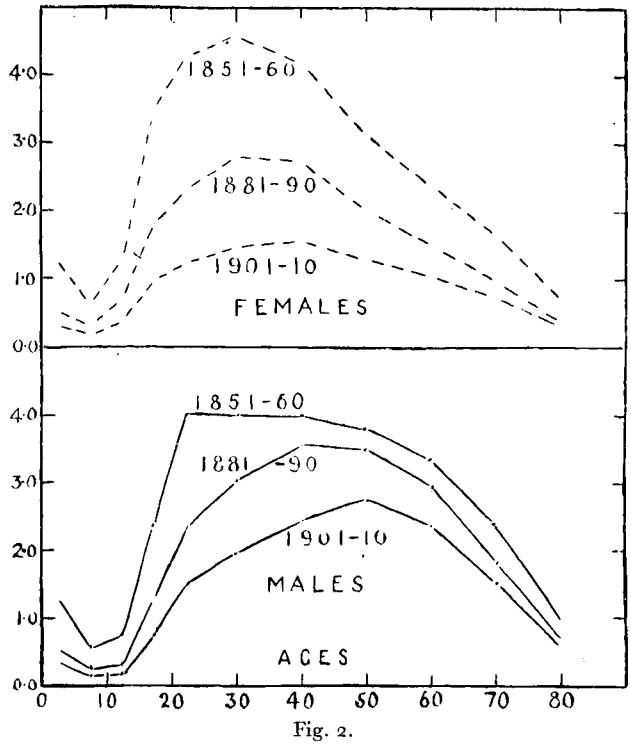

Fig. 2.

TABLE IV

DEATH-RATES FROM PHTHISIS IN ENGLAND AND WALES PER 1,000
LIVING AT EACH AGE-PERIOD

Period	0–	5–	10–	15–	20–	25–	35–	45–	55–	65–	75 and upwards
					MALES						
1851–1860	1·33	0·52	0·76	2·39	4·05	4·02	4·01	3·84	3·34	2·39	0·92
1861–1870	0·99	0·43	0·60	2·19	3·89	4·11	4·17	3·88	3·31	2·03	0·66
1871–1880	0·78	0·34	0·48	1·68	3·10	3·71	4·13	3·86	3·20	1·92	0·60
1881–1890	0·55	0·25	0·34	1·29	2·34	3·03	3·57	3·50	2·92	1·82	0·69
1891–1900	0·44	0·17	0·23	0·99	1·88	2·36	3·09	3·14	2·61	1·58	0·55
1901–1910	0·35	0·13	0·17	0·75	1·52	1·96	2·44	2·75	2·37	1·52	0·56
					FEMALES						
1851–1860	1·28	0·62	1·29	3·52	4·30	4·58	4·19	3·13	2·39	1·64	0·71
1861–1870	0·95	0·47	1·05	3·12	3·97	4·39	3·90	2·86	2·07	1·24	0·44
1871–1880	0·75	0·37	0·85	2·40	3·15	3·55	3·41	2·46	1·78	1·09	0·40
1881–1890	0·51	0·32	0·70	1·80	2·32	2·80	2·74	2·06	1·51	0·98	0·39
1891–1900	0·38	0·23	0·50	1·29	1·59	1·92	2·12	1·64	1·23	0·80	0·35
1901–1910	0·30	0·19	0·39	0·98	1·23	1·47	1·55	1·31	1·04	0·75	0·35

The influence of the war years, 1914–18, upon the mortality from tuberculosis is here considered for only two countries, England and Wales, and Prussia; but records for other countries are to be found in the Harben Lectures (Collis, 1924) [3].

ENGLAND AND WALES.—In this country, records for the war years, owing to the disturbance of the male population due to military service, are only good for females, at least up to age 15 and from age 45 onwards. However, the records for youth and advanced years for males present so similar a reaction to that of females at those ages that probability suggests that the lacking records, if available, would exhibit

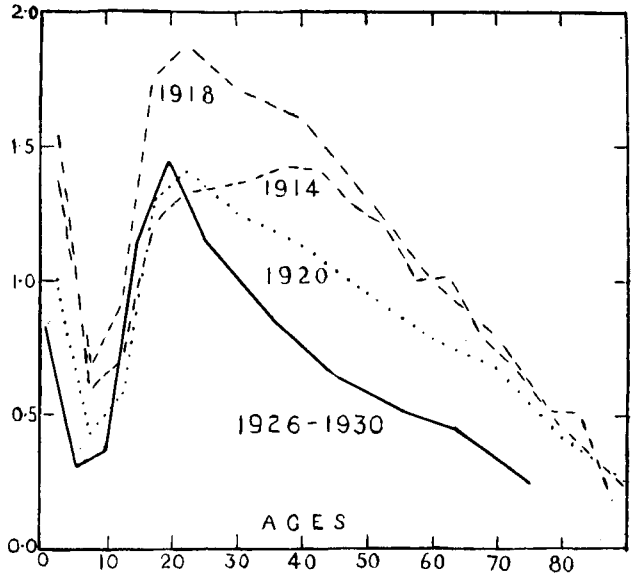

Fig. 3.

TABLE V

PERCENTAGE MORTALITY OF FEMALES IN ENGLAND AND WALES FROM PHTHISIS

The actual death-rates at each period in 1899-1903 are taken as 100, and for subsequent years are expressed as percentages.

Period	0–	5–	10–	15–	20–	25–	35–	45–	55–64
1899–1903	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
–1904	98·4	99·0	108·4	99·8	95·5	97·4	91·2	98·5	101·7
–1905	98·4	90·1	90·7	91·8	88·8	88·2	85·4	88·6	90·3
–1906	95·9	95·6	91·9	92·4	93·7	90·0	86·9	89·8	87·2
–1907	92·1	99·0	87·0	93·8	87·8	90·2	84·3	89·0	94·8
–1908	86·1	89·7	90·2	89·9	88·9	90·0	80·3	89·3	89·0
–1909	73·2	86·2	91·0	90·6	85·3	87·8	76·7	84·5	89·1
–1910	78·9	75·4	87·5	84·3	78·2	80·6	75·3	78·5	88·9
–1911	116·7	105·4	105·6	99·9	94·7	83·7	74·0	73·8	83·1
–1912	89·6	88·7	93·9	100·3	92·3	79·2	69·4	71·5	78·6
–1913	94·2	94·1	105·1	94·4	86·8	75·6	66·3	69·9	74·0
–1914	88·5	98·5	108·3	99·0	92·6	77·3	70·9	77·0	77·1
–1915	92·7	96·6	115·6	113·1	94·2	81·2	75·3	79·2	80·8
–1916	87·1	120·7	113·7	117·5	103·3	80·2	74·7	71·6	79·5
–1917	94·0	125·1	139·9	137·6	111·7	84·0	75·1	73·5	76·4
–1918	88·3	133·5	147·7	147·8	129·4	97·1	79·2	79·0	78·0
–1919	74·8	81·8	106·6	118·7	102·8	76·7	62·5	64·9	69·4
–1920	64·4	69·5	86·6	104·6	98·4	69·8	55·3	56·4	57·0

males throughout life reacting in a somewhat similar way to females—as, indeed, occurred in Prussia.

The way in which the mortality rates rose by 1918 is indicated in fig. 3, and also how they fell again by 1920. But a more accurate representation of the reactions at various ages may be obtained by examining fig. 4 which is based on the data of Table V.

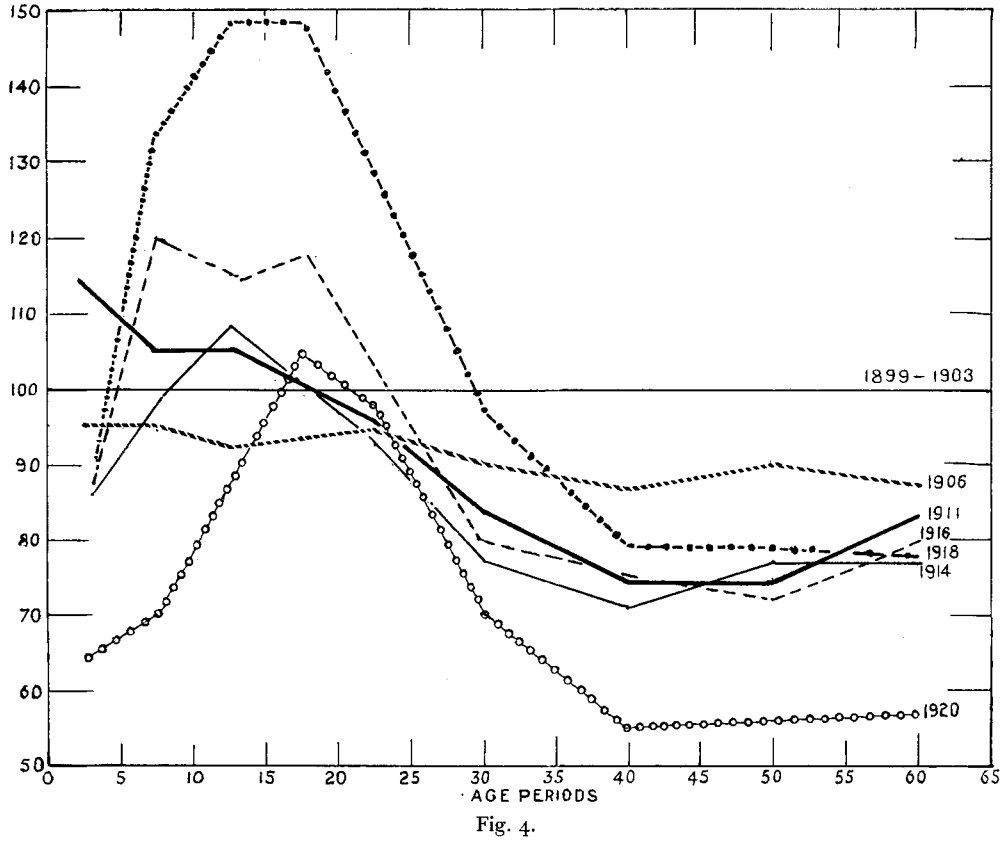

Fig. 4.

Nothing happened in the first five years of life. But, thereafter, until about age 30, a remarkable percentage increase in the mortality is manifest, ever growing as year succeeded year until 1918. From about age 30 onwards to old age, no increase was present.

This war period may be regarded as a definite experiment carried out on an extensive scale. Food shortage became more and more pronounced as the years passed. Simultaneously, the mortality from phthisis in youth and early adult life rose; although after age 35 little effect can be traced. The rise can only be attributed to deficiency in food supply. Greenwood showed that the rise among the females occurred in direct proportion to the extent that they were engaged upon producing munitions of war; it did not occur in districts where no such activities were in progress. The phrase 'a deficiency of food' must then be interpreted to mean a food supply which is deficient having regard to energy output, rather than a supply

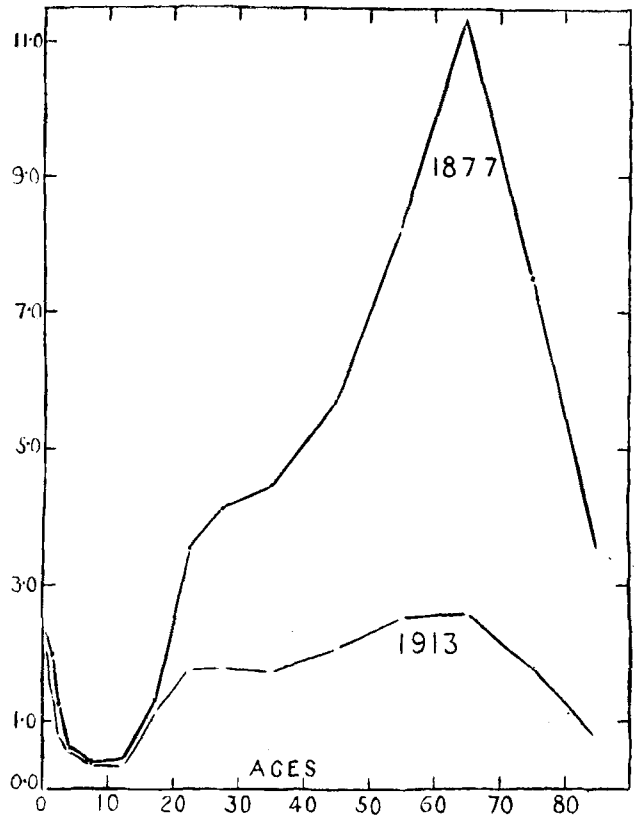
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Fig. 5.

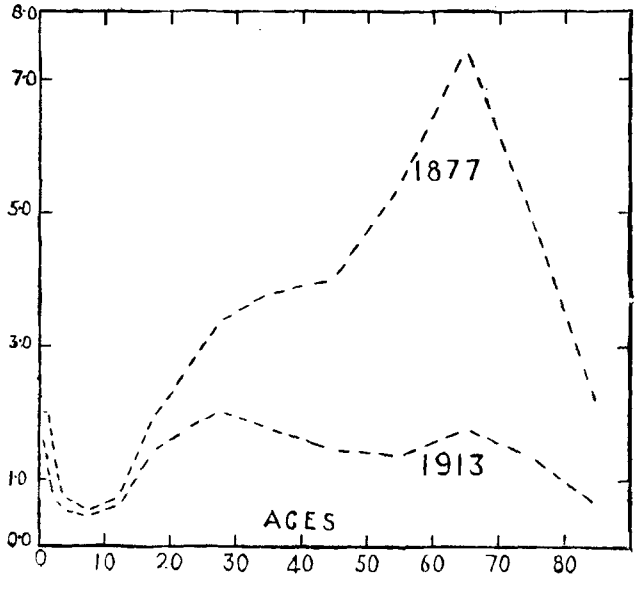
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Fig. 6.

deficient for merely maintaining life. When the war years passed, food became available again, and, owing to a temporary boom in trade, there was money for its purchase. A fall in the phthisis mortality took place at all ages, and especially at those ages where the war-time rise had been most pronounced. This fall occurred, notwithstanding a scarcity in housing accommodation more acute than had previously been experienced. The evidence seems clear that the war-time rise in the tuberculosis mortality was a food scarcity reaction, and that this reaction only concerned youth and early adult years.

One point must be stressed. At the ages when the rise occurred, during the years which followed, until indeed, the generation born after the war grew to attain these ages, a drag persisted in the fall in mortality which was taking place at all periods of life.

PRUSSIA.—Annual records, some of which are embodied in Table VI, are available back to 1877. Those for 1877 and 1913 are shown graphically in figs. 5 and 6. During this period, the male mortality fell from 3·57 per 1,000 to 1·42, or by 60·1 per cent, and the female fell from 2·84 to 1·31, or by 53·9 per cent.

TABLE VI

PRUSSIA. DEATH-RATES PER 1,000 LIVING FROM TUBERCULOSIS

	0–	1–	2–	3–	5–	10–	15–	20–	25–	30–	40–	50–	60–	70–	80 and over
							MALES								
1877	2·28	1·96	1·24	0·58	0·39	0·44	1·83	3·57	4·18	4·46	5·72	8·29	11·35	7·52	3·57
1887	2·59	2·17	1·28	0·72	0·44	0·47	1·75	3·09	3·37	4·35	5·48	7·34	9·38	6·52	2·28
1897	2·64	1·71	0·83	0·57	0·36	0·50	1·55	2·72	2·59	2·99	3·99	4·86	5·94	3·85	1·62
1907	3·00	1·93	1·00	0·59	0·40	0·42	1·25	2·15	2·06	2·20	2·84	3·59	3·55	2·45	1·32
1913	2·06	1·37	0·76	0·57	0·38	0·37	1·15	1·77	1·80	1·74	2·07	2·52	2·59	1·79	0·75
1918	2·00	2·00	1·40	0·99	0·62	0·64	2·77	3·54	2·99	2·57	2·88	3·62	3·49	2·27	1·13
							FEMALES								
1877	2·05	2·00	1·34	0·75	0·54	0·77	1·93	2·62	3·37	3·80	4·03	5·40	7·47	4·96	2·12
1887	2·27	1·89	1·28	0·83	0·60	0·94	1·99	2·40	3·15	3·10	3·58	4·59	6·38	4·45	1·66
1897	2·22	1·70	1·01	0·60	0·53	0·90	1·66	2·25	2·52	2·75	2·61	2·96	3·86	2·56	1·27
1907	2·46	1·71	0·90	0·68	0·49	0·76	1·63	2·17	2·25	2·21	1·86	1·95	2·29	1·85	0·73
1913	1·63	1·22	0·70	0·56	0·46	0·62	1·42	1·77	2·07	1·78	1·45	1·37	1·76	1·38	0·65
1918	1·68	1·85	1·34	1·10	0·85	1·11	2·86	3·29	3·41	2·95	2·69	2·40	2·54	1·94	1·24

The fall in the male mortality was greatest in advanced years, so that, although in 1913 the age of maximum rate was still at ages 60–70, an earlier peak centring about age 25 can be traced. This earlier peak can be observed coming into existence, not as a rise in mortality at that period of life, but as a delay in the fall compared with what was occurring at other age-periods.

The course of events was similar for female rates; but here, by 1913, there are two definite peaks, one about age 25, the other about age 65. The former has been left prominent as the tide of tuberculosis at other ages has receded.

Then came the war years, with ever-increasing food shortage, more severe than in England and Wales. Forthwith, here also, the mortality from tuberculosis rose year

by year to greater heights than in England and Wales. This rising tide might have been expected to submerge again the peak in young adult life which had just become visible in Prussian records; but, in fact, what happened was for this peak to be greatly accentuated. Indeed, the mortality rates from age 2 to age 20 attained

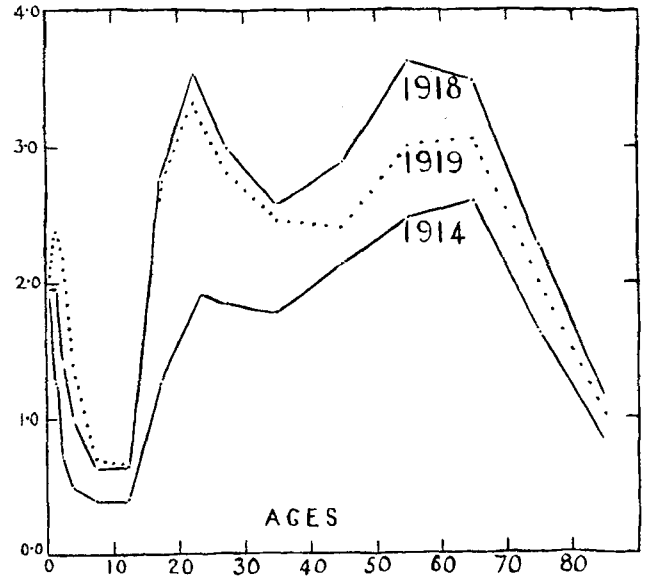

Fig. 7.

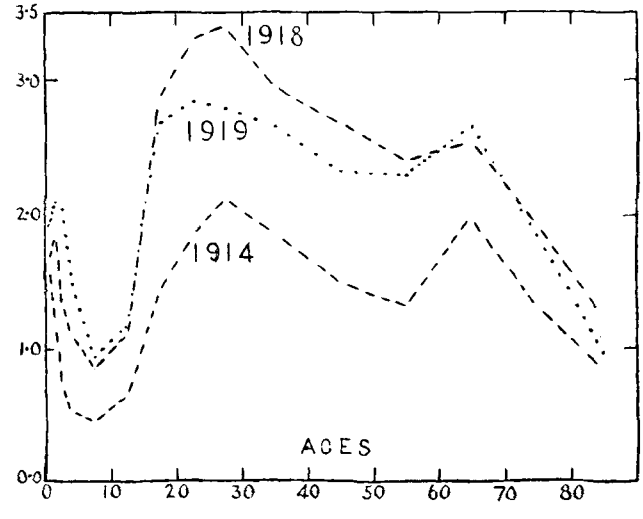

Fig. 8.

heights not previously recorded. Lesser rises took place in later life; by 1918, the curve for males shows two nearly equal and well-defined humps, one in early adult life, the other in late life; the female curve shows a similar, but wider, hump in early adult life, and a lower one in late life (*see* figs. 7 and 8).

After the war, food scarcity, although less severe, still existed in Prussia. The tuberculosis mortality rates reacted accordingly by medium falls.

These records point to another sensitive period, centring on ages 2 to 5, as well as that in early adult life. Late life seems again to be hardly disturbed.

Generally, the indications are the same for the records of England and Wales, but more exaggerated.

REAL WAGES AND TUBERCULOSIS

Further evidence of the influence exerted by nutrition upon the incidence of tuberculosis in early adult life is forthcoming by comparing the course of tuberculosis mortality at different age-periods since 1851 with the index of real wages (fig. 9).

FEMALE MORTALITY FROM RESPIRATORY TUBERCULOSIS, PER 100,000 LIVING, AT CERTAIN AGE GROUPS.

INDEX OF REAL WAGES.

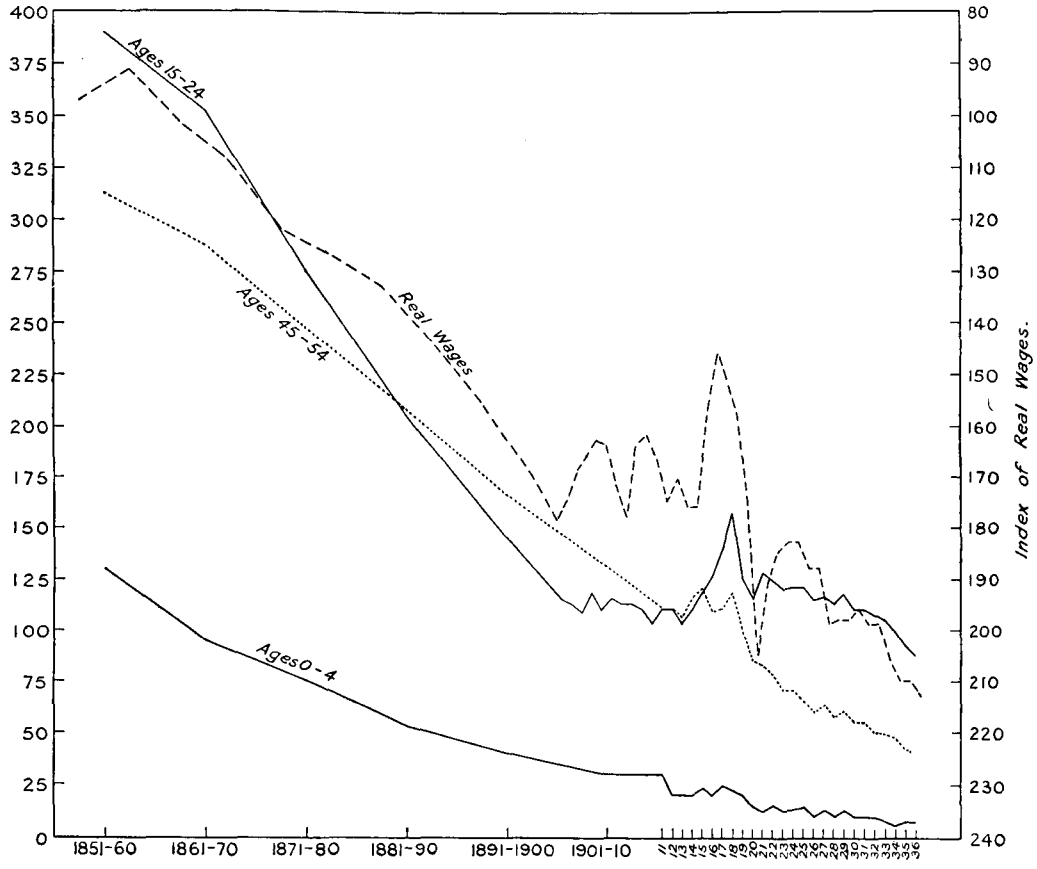

Fig. 9.

This index represents the value of wages in pounds sterling after allowance has been made for variations in the purchasing power of money at different times. It is

closely associated with the capacity to buy food which, after air and water, is the great necessity of life.

The mortality for *females*, at the three selected age-groups, has been chosen, because that for males cannot be relied upon for the War years owing to military service.

The scale for the curve representing Real Wages has been reversed, so that a drop in this curve indicates an improvement in earnings, and a rise in the curve indicates a fall in earnings. This device allows the simultaneous moves in (a) real wages, and (b) the mortalities at the three selected age-groups, to be more easily followed.

A fairly close accord is seen only between alterations in the curves for real wages and for age-group 15-24. (Hart and Wright) [6].

MORTALITY FROM INFLUENZA 1918

Epidemics of influenza in England and Wales of which there are records since 1847–48, have caused mortality the rates of which when expressed in a curve have conformed in shape to a 'normal' mortality curve (*vide* Table VII and graph for 1890–91 in fig. 10).

TABLE VII

MORTALITY FROM INFLUENZA, ENGLAND AND WALES, PER 1,000 LIVING

	Females only		Males and Females				
Ages	1918	1914–17	1901–10	1890–91	1881–90	1848–72	1847–48
0–	15·17	0·10	0·16	0·31	0·03	0·15	0·71
5–	6·41	0·02	0·03	0·06	0·004	0·01	0·08
10–	4·90	0·03	0·02	0·05	0·003	0·01	0·05
15–	8·32	0·04	0·05	0·12	0·01	0·01	0·05
20–	12·73	0·04					
25–	17·83	0·03	0·09	0·20	0·01	0·01	0·08
30–	15·37	0·05					
35–	9·76	0·07	0·15	0·35	0·02	0·02	0·14
40–	7·53	0·10					
45–	7·89	0·14	0·26	0·60	0·03	0·04	0·28
50–	8·43	0·21					
55–	7·50	0·32	0·57	1·06	0·05	0·13	0·81
60–	8·76	0·51					
65–	11·93	0·85	1·33	2·00	0·08	0·44	2·37
70–	11·53	1·62					
75–	11·51	2·57	2·93	3·36	3·52	0·19	1·10	1·12	5·51	5·88
80–	11·14	4·36							
85 and over	13·42	6·74		4·82			1·82		11·24	

The records for the great epidemic of 1918 display the mortality altered in age distribution; the alteration occurred during the last eight days of June, 1918. Until June 22, the distribution of deaths agreed with the normal type of age-incidence; thereafter it suddenly seized upon young adult life. 'It may be doubted whether so sudden and so complete a change of age-incidence can be paralleled in the history of any other disease—yet all the weight of medical testimony goes to show that the influenza of 1918 was essentially the same as that of former years' [4].

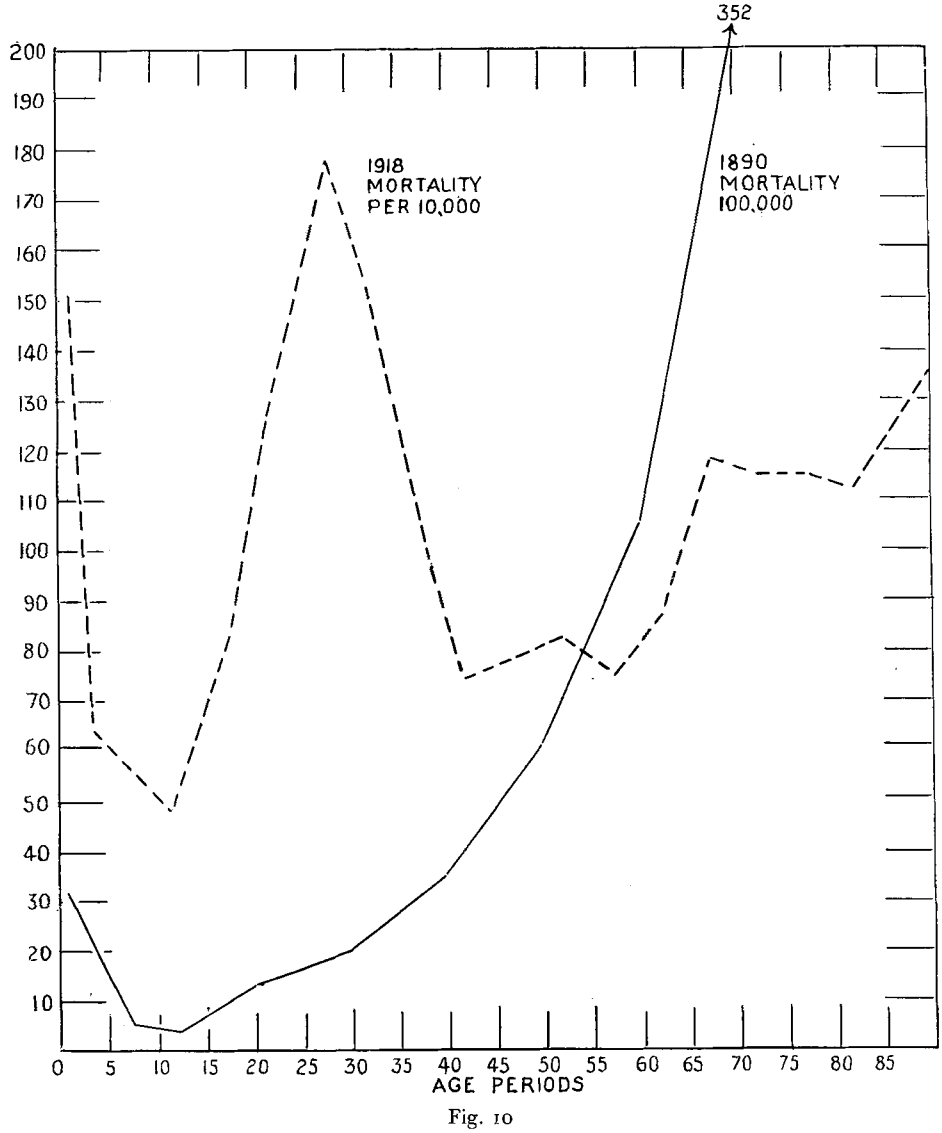

Fig. 10

An indication of how great and unusual was the mortality caused by this epidemic may be gathered from the following figures [5]:—

DEATH-RATES PER MILLION LIVING FROM INFLUENZA
ENGLAND AND WALES

1890	160	1900	504	1910	172
1891	582	1901	173	1911	113
1892	540	1902	222	1912	137
1893	329	1903	187	1913	161
1894	222	1904	166	1914	148
1895	426	1905	199	1915	257
1896	122	1906	178	1916	210
1897	196	1907	256	1917	174
1898	331	1908	275	1918	3,024
1899	390	1909	241	1919	1,169
				1920	267

Modification of the previous age-incidence of influenza mortality persisted for years after the great epidemic; even in 1927 the influenza mortality still affected later life relatively less than before 1918.

A further peculiarity of the 1918 epidemic was that only in that year has the mortality rate of the latter part of the year greatly exceeded that of the first three months, thus:—

MORTALITY RATES FROM INFLUENZA
ENGLAND AND WALES

	1912	1913	1914	1915	1916	1917	1918	1919	1920
Jan.-Mar.	311	310	281	691	226	528	169	4,016	435
Apl.-Dec.	93	130	122	144	238	83	3,939	260	233

The epidemic was world-wide. It is known to have slain millions in India, where owing to bad harvests for several years, food scarcity was pronounced. No record of the age-incidence of the epidemic there is available.

The attack was suddenly concentrated at those ages upon which tuberculosis had been hammering harder and harder during the previous four years. This altered age-incidence of mortality from influenza was not peculiar to England and Wales. It occurred in other countries; records for Victoria, Australia, and U.S.A., may be found in the Harben lectures (Collis, 1924) [3]. Evidence in favour of the epidemic being affected by food scarcity comes from a large American Insurance Company: 'The better circumstanced policy-holders as represented in the Ordinary Department of that Company suffered least. The group of lives insured on intermediate plans, representing the working men able to afford insurance where premiums are paid quarterly, semi-annually or annually, showed a high influenza mortality, and the industrial group insured on weekly premium plans had the highest rates during the principal period of epidemic prevalence. The heavier epidemic damage among the wage-working population probably arose out of the economic and social disabilities under which this group lives.'

This extraordinary change of age-incidence gives food for thought, even to reviewing the plagues of Egypt. Their sequence indicates that, except for the district inhabited by the Hebrews, there must have been famine in the land—the locusts would settle that—before the 'first-born' were slain. Surely here is an ancient record of some famine-pestilence, possibly influenza, to which the rising generation of Egypt fell victim. ('First-born' can hardly be read literally. If so, it would include any age, both old and young, and have no significance.) Moses, in that he foretold this last of the plagues, was surely no mean epidemiologist ! (Exodus xi, 4-7.)

DISCUSSION

Tuberculosis is accepted to be a social disease, i.e. an infection which depends upon social conditions for its spread. Its quota of victims rises or falls as these conditions are favourable or the reverse. The same probably holds good for other infectious diseases—of which influenza is an example—if only the true hygiene of these infections were fully known.

The war period, 1914–18, altered social conditions especially with regard to food. Resistance to the infection of tuberculosis was thereby steadily undermined at

those ages when the body is being built up and consolidated. The rising mortality rates at these ages were warning us, year by year, of what was threatening.

Then came the great influenza epidemic—a veritable famine pestilence—of which this warning was the forerunner; and it fell with deadly strength upon the affected ages.

Two factors, acting either together or alone, may have determined the change of age-incidence of attack for both influenza and tuberculosis. First and the surest, the resisting power of the host at the ages concerned was weakened by food shortage. Second, the capacity of the infecting agent to attack at these ages may have gathered strength through initial successful attacks at these ages. The tendency for the mortality from these infections in post-war years, long after food scarcity had passed, to exhibit echoes of the storm suggests the existence of such an alteration of virulence.

What is the conclusion of the matter? Watch closely the mortality records due to tuberculosis. Here, during the last war, was the signpost to the road down which we were travelling; and, above all, prepare for a sudden epidemic—a famine pestilence —*if we can*. It may not be influenza this time; who knows? It may be pneumonia, or it may be cerebrospinal fever, or what?

SUMMARY

The war years, 1914–18, saw the mortality from tuberculosis—a great social barometer—steadily rising, but only in early life.

Suddenly, in 1918, came the great influenza epidemic, as a famine pestilence, which struck at the same period of life, previously selected by tuberculosis.

Warning should be taken from these occurrences as to what it is reasonable to expect as 1939 passes on to 194?.

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