THE DECLINE OF TUBERCULOSIS AND THE INCREASE IN ITS MORTALITY DURING THE WAR.

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(With 11 Figures.)

CONTENTS.

Introduction.

It is greatly to be desired that the causes of the decline of tuberculosis, which has been so striking a feature in the history of that disease in recent times, should be clearly ascertained; for only through an understanding of their nature and relative importance can our efforts to accelerate that decline hope to succeed.

During the period of the war, or rather from 1915–18, there was, as is well known, a great increase in the mortality from tuberculosis of the lungs. And since the changes in social conditions produced by the war are known it seemed probable that a study of that increase might throw light on its cause, and so contribute something to the etiology of the disease.

The following pages then are devoted mainly to an investigation of the causes of the rise in the mortality from tuberculosis during the war. But before we enter on this, the principal part of our subject, it may be desirable

briefly to discuss the causes of the decline which has been taking place since the middle of last century.

Diseases come and go. Leprosy, once common in western Europe, is all but extinct there. It is the march of civilisation which has swept it away, far more than any direct medical control; and so too have disappeared many other diseases.

Enteric fever, indeed, has retreated before the engineer, and it would be absurd to deny the part played by scientific discovery and sanitary control in the campaign against malaria, yellow fever and sleeping sickness. But, for the most part, the infections now obsolete have gone of their own accord, that is to say without intentional effort on our part to drive them out. Tuberculosis too, in almost all civilised lands, has for many years steadily declined; and though it still destroys over 36,000 victims yearly in England and Wales[1], we may perhaps look forward to some distant day when it will, like leprosy, be extinct.

Like leprosy too, tuberculosis seems to have declined without any definite or obvious cause and, certainly in the earlier half of its fall at least, not in response to any direct effort to control it. Rather it seems to be disappearing like the mists at sunrise, driven out by the advancing rays of social amelioration[2].

It has been said that if the decline be studied one will see no sign of the influence of any event in its history; neither the discovery of the tubercle bacillus in 1882, or the sanatorium campaign at the beginning of the present century, having made any mark on the curve which has continued the even tenor of its way.

I do not entirely agree with this view, as will be seen (p. 86); but in any case the influence of such things must necessarily be gradual, and there are moreover many overlapping influences at work which tend to obscure one another. It is therefore not reasonable to expect that they should make an obvious change in the direction of the curve, and it would be ungenerous to affirm that all the various efforts which have been made, especially in recent years, to combat the disease have been without effect.

[1] There were in 1928, 36,623 deaths from tuberculosis of all kinds, including 29,799 classified as respiratory and 6824 as due to all the other varieties of the disease. *Statistical Review*, Text, p. 9 (1928).

[2] There is of course another view which, without denying the influence of the amelioration of social conditions, attributes the decline of tuberculosis very largely to an increasing immunisation of the population which has resulted from the rise of industrialism and the growth of large cities, and which has been brought about by the consequent more frequent opportunities for infection *pari passu* with the increased density of the population.

Paradoxical though this view may seem at first sight it is rendered more reasonable by the fact, which was somewhat late in being recognised, that small doses of bacteria do not produce progressive disease but tend to immunise. The rule seems to be of general application, and it is probable that a community is resistant to its indigenous diseases, in proportion to their prevalence and the density of the population. It may be argued in favour of this thesis that it is in harmony with the general law that to all disturbing innovations nature tends to make corresponding adjustments.

But, without in the least wishing to belittle the value of these efforts, I think we must conclude that, in the main, as has been said already, the decline of tuberculosis is to be credited to the general march of civilisation and the amelioration of social conditions which it has brought about, rather than to any deliberate attempt to put down the disease. It began as far back as we have any reliable records, namely the middle of the last century, and it had already made considerable advance before Koch's great discovery had been made, sanatoria built or tuberculosis officers and dispensaries thought of.

Let us agree then that tuberculosis has declined, in the main, in consequence of the amelioration of social conditions. But this granted it is nevertheless important to know which of the various factors of this general amelioration has been specially concerned in bringing it about. Is it, for example, better housing and sanitation, or more abundant and more nourishing food and the higher wages which has enabled the working man to supply his dietetic needs in a manner which was not possible before?

It is particularly upon the question of the importance of food in the tuberculosis problem that the experience during the war promises to throw a light.

The decline of tuberculosis has been going on for nearly three-quarters of a century. Its amount may be roughly measured by the fact that in the decade 1851–60 the mortality from tuberculosis of all sorts stood at 3478 per million and in 1928 at 909 per million[1]. Thus the decline amounts to nearly three-quarters of what it was in the middle of last century, or, to be more precise, to 73·8 per cent. of this figure.

IS THE DECLINE REAL?

So great a decline may seem too good to be true; and we must not forget that the figures upon which it is based, though issued on the highest authority, are after all derived, as it is obvious they must be, from individual death certificates. It is therefore not unreasonable to enquire how far they are to be trusted; for the most careful clerical work cannot neutralise the errors of diagnosis, nor correct those which are due to progressive change of fashion in medical nomenclature.

It is said that statistics may be made to prove anything, but, on the other hand, it would be difficult to prove many things without them. The better course is, not to leave them alone, but to make sure that you use them properly.

Turn for a moment to the statistics of cancer. The figures show a great increase, yet many refuse to believe in a real increase of the disease. Better diagnosis, they say, leads to its more frequent recognition, and if it be more frequent, it is only because more people live to reach the age most liable to its attack.

I do not think this is the true view, but it has been put forward by respectable authorities, and I mention it here simply to show that one cannot

[1] Standardised rates. See *Statistical Review*, Text, pp. 49, 50 (1921) and Pt I, Tables, p. 35 (1928).

accept statistics of disease at their face value without enquiring as to whether various causes may not have gravely distorted them. Now I fully admit that diagnosis, especially in the past, is not to be implicitly relied upon. But if the decline in the death-rate is not real, some 2400 deaths per annum per million living, which would have been attributed to tuberculosis some 50 or 60 years ago, must now be put down to some other cause or causes.

To what other cause or causes could they be ascribed? Take pulmonary tuberculosis which accounts for over 81 per cent. of the deaths attributed to tuberculosis of all kinds. I suppose the disease most likely now to receive

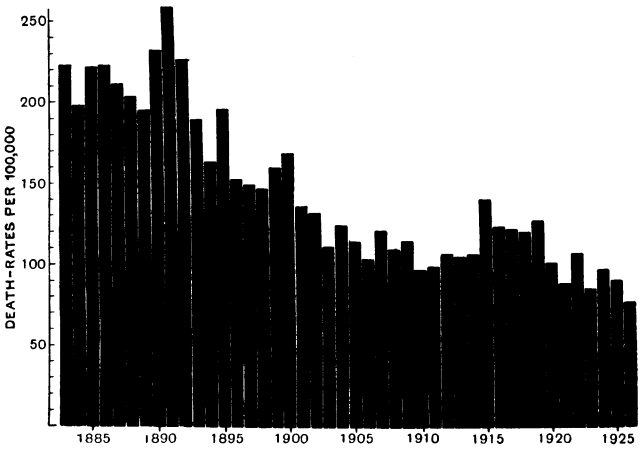

Fig. 1. Bronchitis. Crude death-rates, England and Wales.

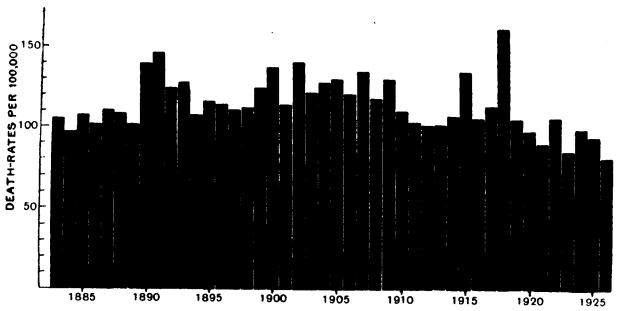

Fig. 2. Pneumonia. Crude death-rates, England and Wales.

deaths which would formerly have been attributed to pulmonary tuberculosis is bronchitis, and after that pneumonia. Do the records of these diseases show any evidence of such transference? The answer is definitely—No. The death-rate of bronchitis (Fig. 1) has declined even more than that from respiratory tuberculosis itself, while that from pneumonia (Fig. 2), after rising a little about the beginning of the century, is now considerably lower than it was 50 years ago. We must therefore conclude, either that there has been no transfer of the kind contemplated from respiratory tuberculosis to bronchitis

and pneumonia, or, if there has, that the real gain in the two latter diseases is nearly double what the figures show, great as this is in the case of one of them.

With respect to the other kinds of tuberculosis, alimentary and meningeal, I will only point out that the decline has almost all taken place since the beginning of this century, and that therefore it is unlikely that it has been greatly influenced by changes in the fashion of nomenclature.

THE MAGNITUDE OF THE DECLINE OF TUBERCULOSIS AND ITS RATE AT DIFFERENT PERIODS.

Having shown reason to believe that the official death-rates correspond with reasonable closeness to the real decline of the disease we may now enquire into the amount of that decline a little more fully.

Fig. 3 records the death-rates per 100,000 inhabitants from pulmonary tuberculosis and all other kinds of tuberculosis from the year 1867 to 1928.

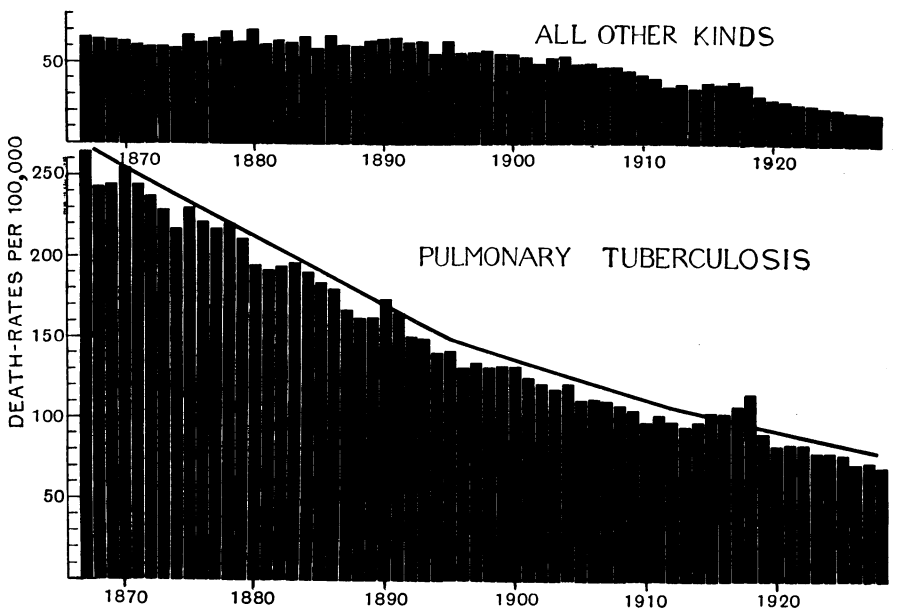

Fig. 3. The decline of tuberculosis. Standardised death-rates, England and Wales.

For the figures on which this diagram is based see *Statistical Review*, Text, Table XXXIII, p. 49 (1921); and Pt I, Tables, Table 6, p. 35 (1928). The rates are standardised, and are (throughout, *i.e.* including the war years) based on total deaths and total population, including non-civilians.

Standardised rates have been preferred to crude rates for this purpose because it is intended to compare years separated by wide intervals of time during which considerable changes in the age constitution of the population have taken place.

The extent of the decline of tuberculosis since the period when we began to have reliable statistics, namely, the middle of last century, has already

been given. We have seen that since then nearly three-quarters of the mortality from tuberculosis has been wiped out. The period 1851–60 to 1927 may be reckoned as 72 years, and the decline during that period, namely, 72·6 per cent., at a rate a little more than 1 per cent. per annum.

But what we want more particularly to know is the rate of that decline at different periods, and whether the rate of diminution is now increasing or decreasing. And this raises the question: What is to be considered a uniform rate of decline?

This may seem simple, but the fact is that our idea of a uniform rate of decline when a disease is in question differs from that of a more mechanical conception such as the gradient of a road.

Let us consider the decline of a disease during which the actual number of deaths per 1000 in any given year was less than those of the previous year by a constant figure. Such a decline when set out geometrically would be a straight line, like that of a stairway which descends by equal steps; in ordinary language this would be considered a uniform rate of decline. But in another sense it is an increasing rate; for though the decline at each step is the same as at any other step, the steps themselves are constantly diminishing in their height above the ground level, so that if there were 100 steps each a foot high the decline at the first drop would be 1 per cent., but at the last but one it would be 50 per cent. and when the last drop of all takes one to the floor it would be 100 per cent. of the height from which the drop proceeded.

By a uniform rate of decline then, when we are speaking of a disease, I take it we mean one where the diminution at each step bears a constant ratio to the height of the preceding step. Thus a decline from 100 to 90 would represent the same rate of decline as one from 10 to 9, though in the one case there is a drop of 10 points and in the other only of one.

A curve based upon a decline such as this would tend to flatten out as it proceeded; it would show a downward convexity; and if one were to draw successive tangents to it at regular intervals each would make a smaller angle with the base line than its predecessor, and would cut that line at a greater distance.

If we examine the actual curve of pulmonary tuberculosis (see Fig. 3), smoothing out in imagination the irregular ups and downs of individual years, and draw a line corresponding as fairly as possible with that curve we see that it approximates closely to a straight line. Yet it is not quite a straight line, but tends to flatten out so that the angles made by successive tangents with the base line continually diminish.

Let us see how this works out in figures. With this aim I attempted to compare the rates of decline in successive decades by working out the percentage which the actual decline in each period bore to the figure at which the rate stood at the beginning of the period, and dividing by ten to get the mean annual rate.

It was obvious at the outset that I must avoid the years of the war; I

therefore chose my decades so that one of them began in 1914 and ended in 1924.

But individual years, may, for various reasons, have a death-rate above or below the mean height of the curve at that year. For this reason instead of taking the actual death-rates for the years 1864, 1874, 1884, etc., I have preferred the average of the death-rates of the five years centring about each year in question. This was done in every case except 1914, where it was obvious that to take an average would have brought in two of the war years and would have given a false value. I was therefore in this case obliged to take the actual death-rate of the year. But this was of no great consequence because that year, judging from those which immediately preceded it, was not exceptional.

The results of this calculation are given in Tables I and II. From Table I

Table I. *Pulmonary tuberculosis* (*England and Wales*). *Mean annual rate of decline in successive decades.*

Decade	Death-rate at beginning and end of each decade* (average of 5 years)	Decline in each decade	Mean annual decline per cent.
1864	2634	352	1·3
1874	2282		
1874	2282	380	1·7
1884	1902		
1884	1902	462	2·4
1894	1440		
1894	1440	256	1·8
1904	1184		
1904	1184	192	1·6
1914	992†		
1914	992†	199	2·0
1924	793		

* Standardised mortality. Taken from *Statistical Review*, Text, Table XXXIII, p. 49 (1921); and Pt I, Tables, Table 6, p. 35 (1928).

† Not an average, but the actual death-rate for the year.

Table II. *All other kinds of tuberculosis* (*England and Wales*). *Mean annual rate of decline in successive decades.*

Decade	Death-rate at beginning and end of each decade* (average of 5 years)	Decline in each decade	Mean annual decline per cent.
1864	681	48	0·7
1874	633		
1874	633	−12	−0·2
1884	645		
1884	645	30	0·5
1894	615		
1894	615	91	1·5
1904	524		
1904	524	169	2·6
1914	355†		
1914	355†	115	3·2
1924	240		

* Standardised mortality as in Table I.

† Not an average, but the actual death-rate for the year.

it will be seen that the decline of pulmonary tuberculosis was greatest in 1884–94. This we may reasonably associate with Koch's discovery of the tubercle bacillus which was first announced in Berlin in 1882. After this decade the rate of decline fell off, and before the war it was less than it had ever been since 1874. Between 1914 and 1924 the decline was again very rapid, namely, at the rate of 2 per cent. per annum; but allowance must be made for the elimination from the years 1922–6 (from which the average for 1924 is calculated) of deaths which normally would have occurred then but which, in consequence of the war, actually took place earlier.

Since 1924 this rate has been more than maintained.

Turning now to "other kinds of tuberculosis," which is mainly made up of meningitis, abdominal tuberculosis and general tuberculosis, deaths from which largely occur in infancy or childhood, and include practically all those caused by the bovine type of bacillus, we see, in Fig. 3, that up to 1894 there was very little improvement, and, in one decade, 1874–84, actually a slight increase. In 1894–1904 the decline was considerably greater, almost as rapid as that of pulmonary tuberculosis at the same period. And from that time onwards there has been a great acceleration, so that the decline of all other kinds of tuberculosis now greatly exceeds that of pulmonary tuberculosis, being more than half as rapid again.

This great improvement in forms of tuberculosis which mainly occur in infancy and childhood has coincided with an even greater decline in the mortality from all causes of children under five years.

The increase in the death-rate of pulmonary tuberculosis during the war.

Let us now turn to the period of the war and consider the increase in the death-rate from pulmonary tuberculosis which then occurred; but first let us try to ascertain its true magnitude for, as we shall see, it is greatly exaggerated by the official figures published at the time.

Having ascertained the true magnitude of the increase in our own country we will then turn to foreign nations, and see to what extent they suffered from this cause, and, finally, we will consider how the two sexes and the various classes of the people were affected.

With this object I have studied the figures published by the Registrar-General in his *Annual Reports* and *Statistical Reviews*, and have compared them with those of foreign countries both belligerent and neutral[1].

My investigations throughout have been greatly assisted by Dr T. H. C. Stevenson of the General Register Office, Somerset House, whose kind help on many occasions I cannot sufficiently acknowledge.

[1] For the latter I have consulted the *Preliminary Report on the Causes of the Recent Decline in Tuberculosis Mortality* written by Yves M. Biraud, M.D., for the League of Nations and published at Geneva in 1925. For the German figures I am indebted to Dr Stevenson of the General Register Office, Somerset House. They are taken from *Die Bewegung der Bevölkerung* (1922 and 1923) and *Die Ursachen der Sterbefälle* (1920 to 1923).

In order to form a just opinion of the extent to which the fatality of tuberculosis was increased by the war, and especially of the relative extent to which it affected men and women, it is necessary to look into the origin of the figures, and to learn how the normal method of their computation was modified during the war, otherwise we might be led to compare things which are not really comparable and fall into very grave error. It will not do to take the figures for the war years (1915–18) published at the time[1], and to compare them with those which went before and come after, for the method of computation of the male mortality was then fundamentally different from that used in normal times. In the latter the rate was, and now again is, based on total population both civil and military; but in the war years it was based on civil population only. This change left the female rate unaffected, but it so altered the male rate as to make it not comparable with that of normal years; and, of course it similarly affected the rate for both sexes combined.

The extent of the change produced in the male rate by the alteration of the basis of its computation will be seen as we proceed. Its explanation is simple enough. The basing of the rate on civilians only, instead of on total population, military and civil, at once excluded large numbers of healthy young men who had joined the army after passing the medical examination and who were therefore free from active tuberculosis at the time. Or, at all events, if some who joined were already affected they were in so early a stage of the disease that few could have been likely to die from it during the period of the war; for pulmonary tuberculosis is for the most part a slow disease, and does not often prove fatal until several years have elapsed.

This exclusion of very large numbers of healthy young men from the population for which the death-rate was calculated at once automatically raised that rate. The rise in the rate therefore did not necessarily indicate an increase of deaths from tuberculosis; for a death-rate is, of course, a ratio, the ratio of deaths from any cause to population, and if we diminish the denominator the rate goes up, even if the numerator remains the same. As a matter of fact the number of male deaths from pulmonary tuberculosis did increase, as we shall see, but to a much less extent than the official death-rate from that cause. The rise in the male rate during the war *as shown by the figures published at the time* is therefore largely fictitious.

On the other hand, the basis of computation of the female rate having remained unaltered by the conditions imposed by the war, that rate is consistent throughout, and the figures from 1915–18 may safely be compared with those before and after that period. It also rose during the war, but not nearly to the extent that the male rate rose. The real extent to which males shared in the general rise we shall see as we proceed. It did in fact approximate to, but did not quite equal, the increase among females.

[1] New figures, based throughout on total population and therefore free from these defects have recently been published. But they are for both sexes combined and the male and female mortalities are not given separately. See *Statistical Review*, Pt I, Tables, p. 35 (1928).

The change in the basis of the computation of the male rate from 1915 to 1918, which was made necessary by the war, was, of course, duly pointed out by the Registrar General in his *Annual Reports*, and a warning was issued that these rates were not comparable with those of pre-war years. It was also recommended that for purposes of comparison, the female rate should be preferred to that for both sexes combined. But how large a difference was made in the male rate by the new computation must be seen to be believed; and I for one had no adequate conception of its importance until I began to examine the figures set out in graphic form, and to compare these rates with the actual number of deaths which occurred in each year.

Comparison of death-rates with deaths.

Male rates published during the war for* 1915–18 *not comparable with those of previous or subsequent years.

Figs. 4 and 5 record the death-rates from pulmonary tuberculosis drawn from the official figures. They are intended to show the error that would arise if the death-rates of males during the war were compared with those before or after, or with the female rates.

The vertical columns, as before, represent death-rates, the horizontal line deaths.

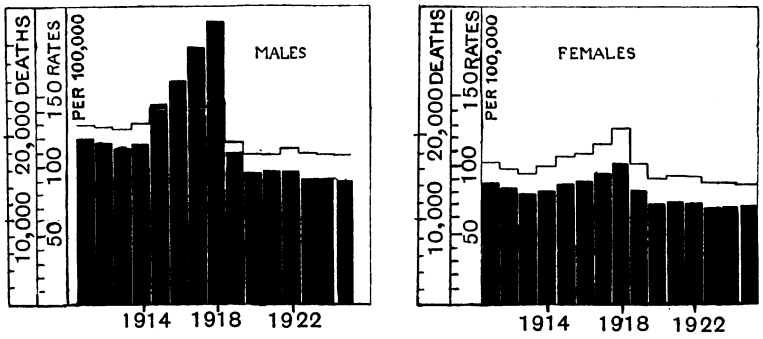

Fig. 4. Standardised rates.

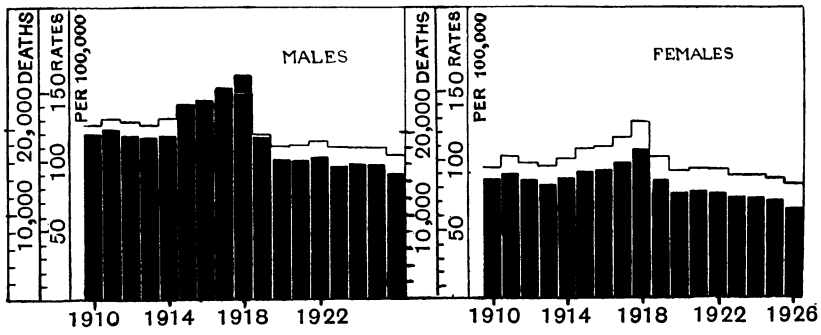

Fig. 5. Crude rates.

Figs. 4, 5. Pulmonary tuberculosis, England and Wales. Showing the exaggeration of the male rates during the war. For the war years the rates are based on civil population only, for the other years on total population, civil and military.

For Fig. 4 standardised rates have been used and for Fig. 5 crude rates[1].

If the female charts be examined it will be seen that the death-rates, as indicated by the columns, correspond closely with the actual numbers of deaths, shown by the line. This, of course, is what they should do, only slowly falling relatively to the deaths as the population increases.

But in the male charts there is no such correspondence. The scales for deaths and death-rates have been selected so that the line showing the deaths should in normal years lie close to and just above the columns showing the rates. This it does do before and after the war. But from 1915 to 1918 the rates rise out of all proportion to the deaths, so that the line showing the latter cuts right through the columns which indicate the former.

The extent to which the columns representing the male rates rise in the war years out of all proportion to the rise in the number of deaths gives a very clear demonstration of the error which would arise were we to use these figures for comparative purposes.

New figures for the male rates during the war.

What then was to be done? One might fall back on the annual number of deaths ignoring rates altogether, and this probably gives a very fair measure of the extent to which the fatality of the disease really increased. It somewhat under-estimates it, because it includes for the period of the war civilians only; but soldiers who died of tuberculosis before they were invalided out of the army must have been comparatively few, and their exclusion therefore probably makes only a trifling difference to the curve. But death-rates which were reasonably comparable were to be desired if they could be obtained, and at this point Dr T. H. C. Stevenson of the General Register Office, Somerset House, very kindly sent me a new series of male rates calculated for the war years based on total male population including both soldiers, sailors and civilians at home and serving abroad. They did not include deaths which occurred abroad, and this of course introduces a slight error, and somewhat underrates the increase in the mortality which actually took place. The error however is only a small one; for very few of the soldiers who contracted tuberculosis abroad could have died of it before they had time to return home.

The new figures provided by Dr Stevenson are given in Table III, those for 1914 being added for comparison.

Table III. *Pulmonary tuberculosis—males, England and Wales. Crude mortality of total male population per million at home and on active service abroad.*

Year	Mortality
(1914)	(1197)
1915	1286
1916	1267
1917	1293
1918	1362
1919	1081

[1] For the figures on which these diagrams are based see *Statistical Review*, Text, pp. 49, 50 (1921), and subsequent *Reviews*.

Fig. 6 shows, on the right, the rise in the male mortality from pulmonary tuberculosis as indicated by the figures in Table III, and contrasts it with the fictitious rise, as shown on the left by a repetition of the male part of Fig. 5 which is based on the older figures.

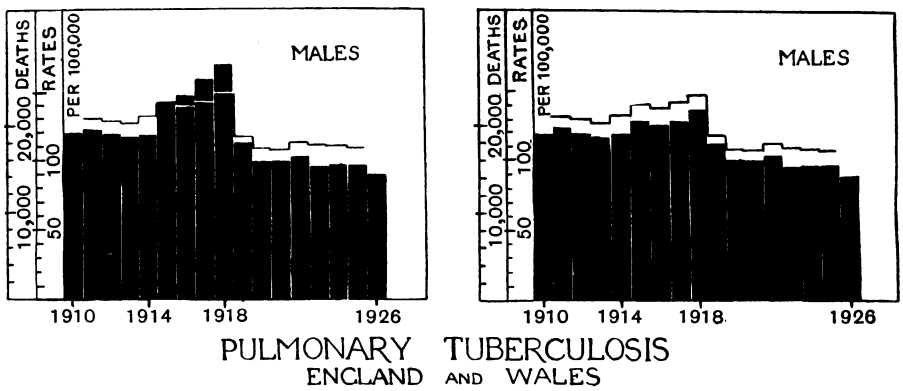

Fig. 6. Pulmonary tuberculosis, England and Wales, showing how much more closely the newly calculated death-rates, based on total population, correspond with the deaths, than the older death-rates, based on civilian population only do.

The male rate based upon these newly calculated figures will be seen to follow closely the line which indicates the deaths. For this and other reasons given it may be accepted as fairly comparable with the female rate and with the male rate before and after the war. It has therefore been set out in Fig. 7

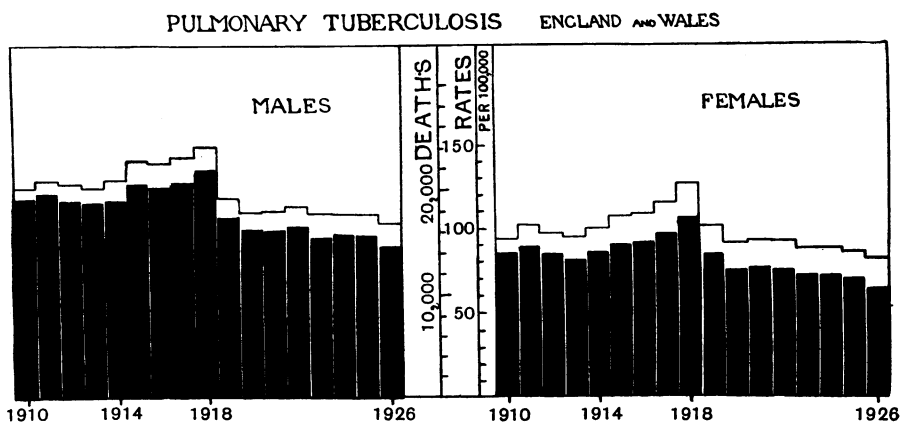

Fig. 7. Pulmonary tuberculosis, England and Wales, crude rates, showing the true rise in the death-rate during the war in males and females.

Based on the figures published annually by the Registrar-General, except the male figures for the war years which are based on the revised figures contributed by Dr Stevenson and given on p. 89.

along with the female rates, the deaths being added as before. This diagram is used as the basis of the discussion which follows.

The first point which comes out is that the rise in the male rate, instead of being, as Figs. 4 or 5 (p. 88) might have led us to suppose, much greater than that of the female rate, is, on the contrary, a little smaller. To this we shall return.

To what extent did soldiers contribute to the increase in the mortality from pulmonary tuberculosis?

The number of soldiers who died of pulmonary tuberculosis *during the war* is, I believe, easily exaggerated. When first I began to consider the question I was not of this opinion. On the contrary I was ready to believe that no inconsiderable contribution to the rise in the mortality which occurred had been made by soldiers who had broken down under the conditions of active service at the front, and perhaps, after being invalided out of the army, had died in England and so helped to swell the civilian death-rates as published by the Registrar-General.

For have we not all been taught for many years to believe that the disease is often the result of the reactivation of some old infection, and that "every man has in him a trace of tuberculosis" only awaiting favourable conditions to develop into active disease. Thus it seemed to me highly probable that the demands made on the soldier under conditions of war—by forced marches, such, for example, as the retreat from Mons, by the supreme exhaustion of battle, the unparalleled hardship of the trenches, and the effects of exposure to poison gases, etc., would have caused many men to break down and develop active tuberculosis. No doubt many did so; but it is improbable that they contributed much to the rise in the mortality from this disease *during* the war. The latter did not last long enough for many of those who developed active tuberculosis while it was going on to die of it before it was over. For pulmonary tuberculosis, in the European at least, is as we have said before a somewhat chronic disease, and does not usually prove fatal until several years have elapsed since it was first recognised.

THE RISE IN THE MORTALITY FROM PULMONARY TUBERCULOSIS DURING THE WAR CAUSED BY THE DEATHS OF THOSE SUFFERING FROM DISEASE ALREADY ACTIVE WHEN THE WAR BEGAN, AND NOT BY THE CREATION OF NEW CASES.

I think it will readily be admitted that the striking thing about this mortality, both of males and females, is that it not only ceased to increase after 1918 (the year of the Armistice) but actually fell in 1919, in spite of the influenza which raged in the early spring of that year, to a point lower than that at which it had stood at the beginning of the war; and by 1920 had fallen to the very same level it would (as indicated by the trend of the pre-war curve) have reached by then if there had been no war, and the conditions had

remained unaltered[1]; and, moreover, that it remained low in the years which followed. In short the fall in the mortality from pulmonary tuberculosis after the war was, in this country, profound, immediate and persistent.

Now if the war had created new cases of active respiratory tubercle the additional deaths thus prepared for would have fallen, not within the period of the war, but in the years which followed shortly after its termination.

The fact then that the increased mortality occurred during the war and not afterwards shows clearly that it was due, in the main, to the premature deaths of those who had already been affected by active tuberculous disease, and who died between 1915 and 1918 instead of between, let us say, 1919 and 1925, as they would have done had it not been for the war.

Whatever effect hardship and privation may have on the inception of infection and the origin of the disease, there can be no doubt that, pushed to excess, they greatly influence its course and hasten the deaths of those already consumptive.

Let us take an extreme instance which illustrates this point in a striking manner. I refer to the Siege of Paris in 1870–1. Though the siege lasted less

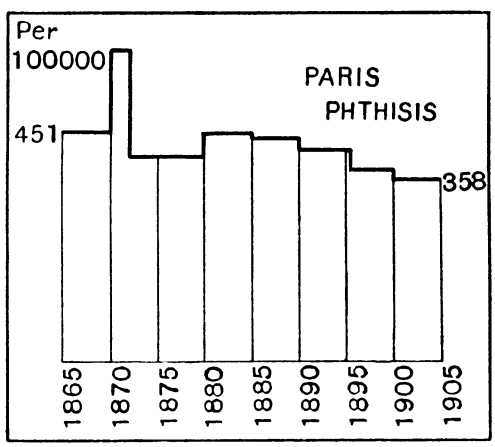

Fig. 8. Pulmonary tuberculosis, Paris, showing the death-rate during the siege of 1870–1 and following years.

than five months the mortality from pulmonary tuberculosis during the whole of the two years which included it rose 35 per cent. By the end of that time so many consumptives had perished, who would otherwise have died in the years which immediately followed, that the death-rate from this cause remained low for nearly a decade, and it was not until the quinquennium, 1880–5, that it regained the position which it would probably have reached had there been no war and no siege.

In this striking instance the shortness of the period of privation, and the limitation of the rise to the two years which include it, is sufficient to show,

[1] See *Statistical Review*, Text, Table XXXIX, p. 53 (1927).

without doubt, that the rise was due to the deaths of those already actively diseased, and not to the creation of new cases.

It was probably much the same during the great war. We have seen that the rise in the mortality from pulmonary tuberculosis was immediate. It was already well marked, in males at least, in 1915. It steadily progressed and culminated in 1918; it ceased abruptly with the cessation of the war.

Now though the view we have put forward seems sufficiently proved by these considerations, we nevertheless may find additional support for it in the fact that there were signs shortly before the war terminated that increase in the mortality from pulmonary tuberculosis had already reached its maximum. As Dr Stevenson was very particular to point out in one of his reports[1], the culmination of the annual death-rate from respiratory tuberculosis in 1918 really took place in the latter part of that year and coincided with the great epidemic of influenza which killed off large numbers of consumptives. The death-rates for the first two quarters of that year had been actually lower than those of the corresponding quarters of 1917, and he was of opinion that if it had not been for the influenza the death-rate for the whole year would actually have been less than that of the preceding year.

Now if it be true that the increase in the mortality from pulmonary tuberculosis during the war was in the main caused by the killing off prematurely of many of those already affected by the disease, it follows that the supply of such cases would sooner or later have come to an end, and that the mortality would have fallen again before the end of the war, had the latter lasted long enough. Dr Stevenson's evidence which we have just quoted is consistent with the view that this period was approaching, and the supply of consumptives whose lives so hung in the balance that they were liable to be fatally affected by the adverse conditions caused by the war was already beginning to diminish.

I do not wish to appear to take too absolute a position when I say that in my opinion the war increased the mortality from respiratory tubercle by killing off those already actively diseased, rather than by causing new cases. I believe that this was by far the most important cause of the increase which took place during the war; but I would not deny that new cases arose in the army and elsewhere as a consequence of the war. I only point out that there was not time for many of these to die before the war was over; and that such as died afterwards were not sufficiently numerous to raise the death-rates of those years which were already relieved of many deaths which would have taken place then had they not occurred prematurely.

[1] *Registrar-General's Report*, p. lxxv (1919). See also *Statistical Review*, Text, p. 55 (1921). Dr Stevenson's inferences were based on the mortality of females as being for that period more reliable than that of both sexes combined. But there is no reason to suppose that if we had the true figures for males these inferences would not be found to apply to them also.

Tuberculosis in the army.

How far new cases occurred in the army is difficult to determine. Prof. Lyle Cummings writes: "So far as concerns the actual incidence and mortality during the period of active service at the front tuberculosis is almost a negligible disease.... The ictus of tuberculosis on the army is to be found not in the records of the actual theatre of war but in the terrible additions to the pensions list," etc., etc.[1], and he adds: "At a rough estimate based on very incomplete figures it may be estimated that about 6000 pensions were granted for tuberculosis as the result of the war by the end of March 1921: and the number has since been added to and is not yet complete. It is probable that about one man in every hundred of those who served in the war came to manifest tubercular disease during or after his time in the army." I cannot however help thinking that this is an over-estimation. Dr Redman, of Hull[2], has drawn attention to the large number of men who, in his opinion, were receiving pensions for tuberculosis and who had "not got the disease, and probably never had it". "We are all familiar," he says, "with the ease with which a positive sputum could be produced in the army and with the numbers of men who 'got their ticket in this way'"; and he adds: "I think it was Osler who said that half (or was it 75 per cent.) of the men who were discharged from the army with tuberculosis as their disability never had the disease."

I asked Dr Stevenson for his opinion as to the effect of the war on pulmonary tuberculosis on soldiers, and he replied: "So far from the war causing phthisis to our men (on active service) he believed it did their health a lot of good. For, notwithstanding many war invalids who must have been dying off since 1918, the mortality for males has fallen relatively to that of females since then, at ages affected by war service. When bullets or gas did no harm, exercise and fresh air did much good."

On this point opinions may differ. But meanwhile I think the main thing to remember is that the rise in the mortality from pulmonary tuberculosis was limited to the period of the war. It fell immediately afterwards to a low point and remained low afterwards.

Such cases of tuberculosis as were produced by the conditions caused by the war had scarce time to die ere the war was over, and their deaths afterwards, be they few or many, did not suffice to swell the mortality of the years in which they occurred, being as I have said more than counterbalanced by the omission from the records of those years of the deaths of those consumptives who died prematurely during the war—and who but for it would have died a few years later.

For Germany (Table IV) we have figures giving the military deaths from pulmonary tuberculosis during the war years[3]. These though not inconsiderable are a mere fraction of those which occurred in the whole population.

[1] *Lancet*, i, p. 845 (1922).

[2] *Brit. Med. Journ.* **2**, 868 (1925).

[3] From *Ergebnisse der Todesursachenstatistik im Deutschen Reiche*, 1914–19.

Table IV. *Germany. Number of military deaths from pulmonary tuberculosis.*

1914	160
1915	2121
1916	3217
1917	4783
1918	6035
1919*	3397

* Excluding the Province of Posen.

A very striking point about these figures is the extraordinarily sudden increase from a mere 160 in 1914 to over 2000 in 1915. This at least could not have been due to the creation of new cases, but could only have been brought about by the deaths of men already tuberculous when the war broke out.

Civilians mainly affected.

Neutral States involved.

Apart from what has been said already there is evidence that the increased fatality from pulmonary tuberculosis during the war years fell mainly on civilians. In the first place, while other belligerent countries were affected in the same manner as, and sometimes much more severely than ourselves (*e.g.* Germany and Austria, but not France), neutral states did not escape. In

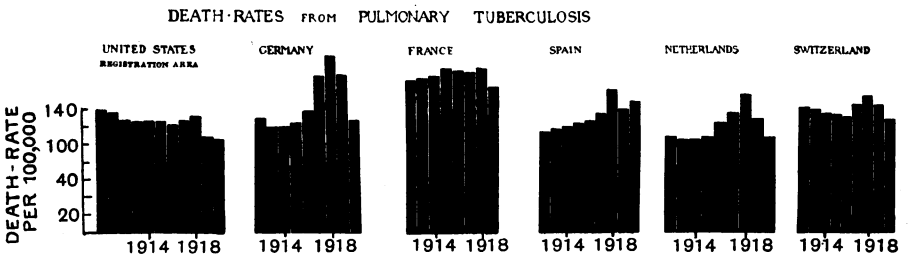

Fig. 9. Comparative mortality from pulmonary tuberculosis, during the war, in various countries. Based on figures given in Dr Y. M. Biraud's paper, *Causes of the Recent Decline of Tuberculosis Mortality*, published in 1925 at Geneva for the League of Nations.

Spain there was a marked increase, but in 1918 only, and this was probably due to the influenza; but in Switzerland there was a distinct rise extending from 1917 to 1919, and even in the U.S.A. there was some increase during the same period. But of all neutral countries Holland was the one which suffered most from pulmonary tuberculosis during the period of the war; and though her losses from this cause were less than those of Germany they greatly exceeded our own.

Females suffered more than males.

Again it was not the males who were most affected by the war but the females. This was pointed out on p. 90 so far as our own country was concerned. The rise at first was greater among the males, but it continued at a faster rate among the females, so that their maximum in 1918 was 23·8 per cent. above the rate for 1914, while that for males was only 13·8 per cent.

In Germany during the same period while the male rate (including military and civilian) rose by over 60 per cent., the female rate rose by more than 71 per cent. In Holland the rise was 41 per cent. among men and 53 per cent. among women. In Switzerland too women suffered more than men.

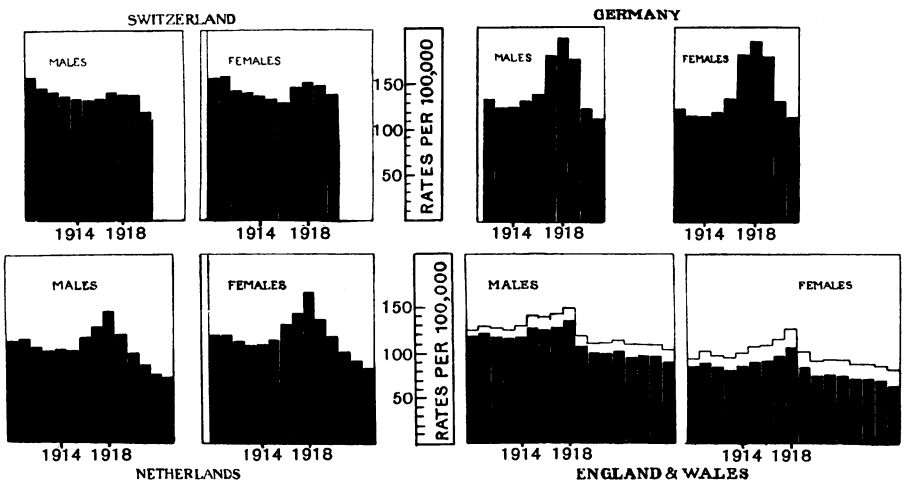

Fig. 10. Comparative increase in the mortality from pulmonary tuberculosis among males and females in various countries during the war. Based on figures given by Y. M. Biraud for Switzerland and the Netherlands (see legend, Fig. 9), Dr Stevenson for Germany, *Statistical Review* for England and Wales females, and Dr Stevenson for England and Wales males (see Table III, p. 89).

But probably the best way to assess the shares in the increased mortality of the two sexes is to calculate the total numbers by which the deaths during the war years exceeded those of 1914. This method does less than justice to the number of deaths caused by the war; for the deaths were steadily diminishing each year before the war and but for it would doubtless have continued to do so. But the error thus introduced is not a great one, and it does not affect the comparison of the male and female contributions. Table V gives the results of such a calculation.

Table V. *Excess of deaths from respiratory tuberculosis of each sex over those of the same sex in* 1914 *in England and Wales.*

	Males		Females	
Date	Deaths*	Excess over 1914	Deaths*	Excess over 1914
1914	21,412	—	16,414	—
1915	23,156	1744	17,626	1212
1916	22,848	1436	17,918	1504
1917	23,274	1862	19,058	2644
1918	24,369	2957	20,967	4553
Total	—	7999	—	9913

* From the *Eighty-second Ann. Rep. Registrar-General for* 1919, Table IX, p. 10. Including the deaths of non-civilians at home, but excluding those which occurred abroad.

From it we see that the females made a considerably larger contribution to the increase in the mortality than the males. For every 100 additional deaths contributed by the males the females contributed nearly 123.

Let us now briefly summarise the conclusions at which we have arrived:

(1) The war caused a great rise in the mortality from pulmonary tuberculosis. This affected some neutral as well as belligerent countries, Germany and Holland being special sufferers.

(2) The rise in the mortality culminated in the last year of the war, and there was a great fall when peace was restored. The fall was somewhat tardy in Holland and, especially, in Germany where the restoration of economic conditions was slow; but in England and Wales it was rapid, so much so that it was almost completed in the year which followed the war.

(3) The post-war fall reduced the mortality in our own country in 1920 to a point as low as that which it would have reached by then (if we may judge by the direction of the pre-war curve) had there been no war.

(4) The increased mortality from pulmonary tuberculosis during the war was caused mainly by the deaths of those already consumptive when the war broke out, and new cases of disease caused by the war conditions were relatively few.

(5) In the increased mortality from pulmonary tuberculosis women suffered even more than men, and this disparity was particularly great in neutral Holland.

WHAT WERE THE CONDITIONS CREATED BY THE WAR WHICH CAUSED THE DEATHS OF SO MANY CONSUMPTIVES?

While the conditions which, in a time of war, may affect adversely the consumptive, or bring about an increase of tuberculosis, are doubtless complex, so that it is difficult to disentangle them, yet it seems that there are two which stand out prominently from the rest as the most important. These are:

(1) Increased occupation in phthysogenic trades.

(2) Impairment of nutrition.

Increased occupation in phthysogenic trades.

It is, of course, well known that certain trades and occupations are associated with a high mortality from pulmonary tuberculosis. Some of these are such as attract the delicate and those already consumptive, as for example, the trades of hairdresser, hatter, tailor, and particularly, hotel servant. But other occupations which are associated with a high mortality from tubercle present no soft-options to weaklings, but demand the strong and vigorous. Such may be said actually to predispose to pulmonary tuberculosis. Among these latter tin and gold mining, tool-grinding, quarrying and dressing of silicious stone, flint-knapping, pottery making and, formerly, milling. All these occupations are marked out as exposing those who follow them to the

risk of inhaling silica dust, for even potters support their pots whilst they are in the kiln with flint dust, and millers used to dress their own mill stones, and since they have substituted steel rollers for them no longer suffer exceptionally from phthisis.

It is generally agreed then that it is the silica dust in such trades that predisposes to what, among those employed in them, is known as fibroid phthisis. But this, emphatically, is not tuberculosis, though tuberculosis often gets implanted on an old fibrosis, and the conditions have been much confused. The process, however, is an exceedingly chronic one, and it usually takes many years before it is firmly established and leads on to tuberculosis, so that it seems unlikely that it can have played any considerable part in causing the rise in the death-rate from pulmonary tubercle which occurred during the war.

But many other occupations, not generally regarded as directly phthysogenic, may doubtless react harmfully on those with incipient tuberculosis, and the enormous demands which were made for munitions of war probably caused larger numbers of persons to engage in them.

The mere increase in the number of persons employed in such trades would, of course, cause a rise in the death-rate from pulmonary tuberculosis. But if the new employees were, to a great extent, unsuited to the work, if women undertook men's jobs, and country people were drafted into towns and worked in factories; if, moreover, there was considerable overwork, long hours and high pressure, men and women striving their hardest to serve their country, or to earn as much as they could while the opportunity lasted—if such were the state of things it cannot be wondered that many succumbed to tuberculosis of the lung who otherwise would not have done so.

But we have seen that the increase in deaths from pulmonary tubercle was mainly caused by the premature decease of those already infected with the disease, and it may seem unlikely that many persons in this condition could have taken part in such arduous employments. Some no doubt did, and as the war lasted over four years there was time before it was over for a number of them to die of the disease although it was in a very early stage when they commenced their new work. Others may even have *contracted* tuberculosis and died within the period. Some part of the increased mortality, then, is I believe to be attributed to this cause. It seems probable too that it may account largely for the excess of deaths among women as compared with men. But I cannot believe that such employment can be the cause of the greater part of the increased mortality that actually occurred.

Shortage of food.

It will not be necessary to remind the reader that throughout the war food was not plentiful, and that during much of 1917 and 1918 there was serious scarcity owing to the frequent sinking of our foodships by the enemy's submarines.

The effect of the war on the food supply was felt at once, and it will be

remembered that the outcry against hoarding occurred in very early days; but the interference with importation was progressive, rationing was begun in December 1916 and the supply of food was probably at its lowest in the winter of 1917–18.

Cream disappeared, except from some out-of-the-way country places, butter was almost unknown. Meat, no longer seen in butchers' windows, was often replaced by a vase of flowers. People jested to keep up their spirits, and it was remarked that "the time was out of joints," but the stringency was serious.

There was, however, nothing like starvation at any time, such as occurred in Paris during the siege of 1870–1, and few people failed seriously to get sufficient quantity of food, though many would have liked more. But the quality was often defective, and there was a definite shortage of animal fats. The use of margarine became universal, but, as Punch pointed out "C'est magnifique, mais ce n'est pas le beurre."

This being the actual state of things it may well be asked whether so limited an interference with the nutrition of the people could be responsible for any considerable proportion of the additional deaths from pulmonary tuberculosis which occurred during the war[1]. It may be hard to believe, but I think the evidence that I shall bring forward shows that it was so. Remember it was mainly those already consumptive who were carried off, whose lives hang in a delicate balance that it is easily upset. When every circumstance is favourable they usually gain ground, and sometimes recover, but it is difficult to guard them from mishaps, and their history is too often one long account of periods of slow improvement punctuated by distressing relapses, each of which reduces them to a level lower than they had ever reached before and in one of which they die.

One is forced, I think, to believe that diet is of the utmost importance in these cases. It has long been recognised as such by the medical profession, and especially has attention been given to fats.

Think too of the Siege of Paris. Is it possible that any other cause than insufficient and improper food can have been the main cause of the enormous mortality from respiratory tuberculosis that then occurred?

Let us turn again to Holland. In that neutral country the death-rate from respiratory tubercle began to rise in 1916, and in 1918 was half as high again as it had been before the war. Females suffered more than males, the increase in the latter being 41 per cent. and in the former 53 per cent. Work in munition factories probably had a share in this increase, as it had over here; it may account for the excess of deaths among women; but I cannot doubt that shortage of food, or of certain food constituents, was its main cause.

It is true that Holland is mainly an agricultural country producing in peace times more food than it consumes. But during the war the demand from Germany for that food was insatiable, and the price rose accordingly. While

[1] They numbered about 18,000 (see Table V, p. 96).

farmers and tradesmen made fortunes the unfortunate people had to witness the steady flow of their food over the frontier, and to pay exorbitantly for that which was left[1]. From this cause the consumptives suffered grievously, and many succumbed who otherwise would have lived for some years longer.

The experience of Holland then affords reason to think that shortage of food was the main cause of the increase in the tuberculosis mortality.

But there is even stronger evidence of this view, to be obtained at home from the experience of our county and borough lunatic asylums, where change of occupation and making of munitions could have played no part.

Tuberculosis in county and borough lunatic asylums.

For some reason, not easy to understand, tuberculosis is always a frequent cause of death in these institutions. During the war the deaths from this

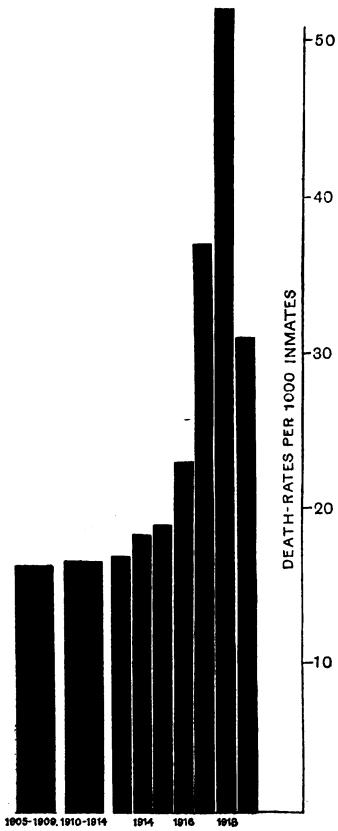

Fig. 11. The rise in the death-rate of tuberculosis of all kinds (90 per cent. is pulmonary) in county and borough lunatic asylums during the war.

[1] Since this was written I have heard a graphic account given, quite spontaneously, by a sailor of the state of hunger produced by the war in neutral Norway, and of how, though the people were enriched, the children in the ports there would scramble and fight like wild beasts for a biscuit if it were thrown among them.

disease[1] became far more than doubled although the number of inmates declined; in 1914 they were 1871; in 1918 they had risen to 4685, an increase of 2814, or more than 150 per cent.

Now in the whole of England and Wales the annual number of deaths from tuberculosis of all kinds had only increased from 50,286 in 1914 to 58,071 in 1918, that is to say by 7785, or 15 per cent.

But the rise in 1918 in the death-rate from tuberculosis was partly due to the epidemic of influenza which raged in that and the following year, and if we are to ascertain the true relative importance of the contributions made by the asylums to the increased fatality of tuberculosis in the whole country, we had better not rest content with comparing 1918 with 1914, but examine the excess of each year over that which prevailed before the war.

Now in the three years ending in 1914 the deaths in the asylums referred to tuberculosis were 1741, 1889 and 1871[1] respectively, which gives an average of 1834. If then we take the year 1914 as our test year we shall not be choosing an exceptionally low basis for our calculation.

In Table VI the excess of deaths each year from tuberculosis in asylums over those recorded in 1914 is given, and this is contrasted with the excess of deaths from this cause over those in 1914 in the whole of England and Wales.

Table VI. *Deaths from tuberculosis of all kinds in county and borough lunatic asylums compared with those in England and Wales during the war.*

	England and Wales		Asylums	
Year	Deaths*	Excess over 1914	Deaths†	Excess over 1914
1914	50,285	—	1871	—
1915	54,282	3,997	1955	84
1916	53,855	3,570	2327	456
1917	55,931	5,646	3664	1793
1918	58,071	7,785	4685	2814
Total	—	20,998	—	5147

* *Registrar-General's Report*, p. 10 (1919).
† *Sixth Ann. Rep. Board of Control for* 1919, Pt I, p. 29.

From this table the extraordinary fact stands out that while in the whole country with a population of 45,000,000 the excess of deaths from tuberculosis during the period of the war, over what the number would have been had the annual contribution remained what it was in 1914, was just under 21,000, while in the asylums, with a population of about 100,000 persons, the excess was over 5000. Thus nearly one-quarter of the additional deaths from tuberculosis which may be put down to the war was contributed by the county and borough lunatic asylums with an average population of about 1/450 of that of the whole country.

Other diseases, especially dysentery, had increased enormously in the asylums during the war, and a Commission was appointed to enquire into the

[1] *Sixth Ann. Rep. Board of Control for* 1919, p. 29. Tuberculosis of all kinds is chosen rather than respiratory tubercle because the figures are more accessible, but it makes little difference since 90 per cent. of the tubercle deaths in the asylums were from phthisis.

reason for the general increase in the death-rate. They found that there were various causes at work: shortage of male nurses, some degree of overcrowding owing to closure of a few of the institutions for war-hospital purposes, greater age of the patients, etc.; but in their opinion "the main factors in determining the great increase of mortality" was "the unavoidable reduction in the quantity and deterioration in quality of the food supplied to the patients[1]."

With respect to the defect in quality they attributed it—I think mistakenly, at least so far as tuberculosis was concerned—to the flour. It is more likely to have been shortage of fats, perhaps, lack of some fat-soluble vitamin[2].

The fact that a deficiency of fat-soluble vitamins causes experimental animals to become highly susceptible to accidental bacterial infection has been noted by several observers[3], but so far no great success has attended experiments which attempt to increase by feeding on a diet poor in vitamins the susceptibility of animals to tuberculosis, nor to those which attempt to protect them by giving a diet rich in vitamins. My own experiments (unpublished) in which I attempted to make rabbits succumb to a progressive infection with tubercle bacilli of human type, a thing which they occasionally but very rarely do under ordinary diets, have had no such results. But herbivorous animals are not well adapted to experiments of this kind. Better results might be looked for if carnivores were used.

Conclusions.

1. The rise in the mortality from pulmonary tuberculosis during the late war was considerable in many nations, amounting in the case of Germany to 60 to 70 per cent.

2. Neutral countries suffered as well as belligerent. Holland in particular being more severely affected than England and Wales, or France.

3. The rise in both belligerent and neutral countries was even greater among women than men.

4. The soldiers on the whole contributed but little to this rise.

5. The limitation of the rise to the period of the war and the sharp fall which followed proves that in the main the additional deaths caused by the war conditions were those of persons already infected, and that new cases of active disease had only a small share in it. The low death-rate in the years

[1] *Fifth Ann. Rep. Board of Control for* 1918, p. 24. In their *Report* for 1917 the Board had said that there was "a fairly general consensus of opinion amongst the Medical Superintendents... that the food restrictions...were accompanied by a lowering of the weight of patients and a general loss of nutrition." This they thought "must have induced a lessening of vital resistance, which would go far to explain the increased liability to infection in the case of such communicable diseases as dysentery and tuberculosis," *loc. cit.* p. 23.

[2] In the *Sixth Ann. Rep. Board of Control for* 1919, p. 35: the importance of a dietary which includes a sufficiency of such food accessories, as animal fats—notably milk and butter—"from lack of which the vulnerability to tuberculosis is admittedly enhanced" was clearly recognised.

[3] Green and Mellanby, *Brit. Med. Journ.* **2**, 691 (1928); and *Report on Accessory Food Factors*, published by the Med. Res. Committee, 1919.

which followed the war showed that the deaths of such new cases as occurred were more than counterbalanced by the premature deaths of consumptives who under normal conditions would have died in those years.

6. The main causes of the rise were (i) disturbance of industrial conditions causing large numbers to be employed in injurious trades, and (ii) interference with the food supply. Of these two the latter, in the opinion of the writer, was the more important.

7. The experience of the county and borough lunatic asylums, which contributed an enormous proportion of the additional deaths, and in which the quantity and quality of the food supplied during the war is officially stated to have been unsatisfactory, supports this conclusion.

(*MS. received for publication* 8. XI. 1929.—Ed.)