

# ***Historical declines in tuberculosis in England and Wales : improving social conditions or natural selection?***

R P O Davies\*, K Tocque +, M A Bellis +, T Remington +, P D O Davies \*

## **Summary**

*A reinvestigation of the relationship between the decline of tuberculosis and improvement in social conditions in England and Wales during Victorian times.*

*Design: A retrospective study using data published in the annual reports of the Registrar General from 1853 to 1910. The diseases studied, in addition to tuberculosis were, dysentery and cholera including their total and infant mortality. Social conditions were evaluated from earnings and population density per house. Tuberculosis mortality declined at an annual average rate of 1.71% (95%CI 0.77 to 2.63) whereas total mortality, infant mortality and mortality from cholera and dysentery and house population density showed no statistically significant decline over the same period. Real earnings increased by 1.05% (C.I. 0.29 to 1.81). Improving social conditions do not provide the total explanation for the decline in tuberculosis during Victorian times. Other factors, principally natural selection, probably played a role. Part of the current increase in tuberculosis may be caused by effective drug therapy eliminating natural selection.*

## **Resume**

*Ce travail est une nouvelle approche de l'explication sociologique au declin de la tuberculose en Angleterre et en Ecosse a l'epoque Victorienne.*

*L'etude a ete retrospective en faisant appel aux donnees publiees dans les releves annuels du "Registrar General" entre 1853 et 1910. Le recensement incluait non seulement la tuberculose mais aussi la dysenterie, le cholera, y compris la mortalite totale et infantile. Ainsi, la tuberculose diminuait annuellement de 1,7% (95 % intervalle de confiance: 0,77 a 2,63) alors que la mortalite restait inchangee, qu'elle soit generatee, infantile ou due au cholera, a la dysenterie ou a la surpopulation. Lorsque les salaires ont augmente de 1,05% (IC 0,29 a 1,81), les conditions de vie se sont ameliorrees mais cela n'explique pas la regression de la tuberculose a l'epoque Victorienne. D'autres facteurs ont probablement joue un role, notamment la selection naturelle et, inversement, les nouvelles therapies ont supprimee cette selection naturelle et ceci peut contribuer a la resurgence de l'affection.*

## **Introduction**

With the exception of the years during the World Wars, mortality from tuberculosis has

steadily declined since records began in 1850. Because of the close association between tuberculosis, poverty and crowding, an association still found to be present today, most observers assumed that improving social conditions alone were responsible for improved mortality. An improvement which continued up to the time when specific chemotherapy and immunisation became available in the 1950s. (1,2,3,4)

*\*Tuberculosis Research Unit, Cardiothoracic Centre, Thomas Drive, Liverpool, L14 3PE.  
+CDSC (North West), Public Health Laboratory, Fazakerly Hospital, Lower Lane, Liverpool, L9 7AL.  
Correspondence to PDODavies.*

Table 1 Relative changes of death rates and socioeconomic factors

	Mean change / year	95% CI
<b>Total mortality</b>	<b>-0.80 %</b>	<b>-2.13 to 0.54 %</b>
<b>TB mortality</b>	<b>-1.71 %</b>	<b>-2.63 to -0.77 %</b>
<b>Infant mortality</b>	<b>-0.58 %</b>	<b>-2.62 to 1.15 %</b>
<b>Cholera mortality</b>	<b>-1.07 %</b>	<b>-14.1 to 11.95 %</b>
<b>Dysentery</b>	<b>0.009</b>	<b>-38.9 to 38.9 %</b>
<b>Real earnings</b>	<b>1.05 %</b>	<b>0.29 to 1.81 %</b>
<b>Overcrowding</b>	<b>-0.05 %</b>	<b>-0.41 to 0.30 %</b>

However, the possible effects of acquired immunity by successive generations by a process of natural selection, and selective mortality of susceptible individuals or families on the pattern of disease is generally overlooked in studies of historical tuberculosis rates.(5) (D'Arcy Hart, personal communication).

If natural selection had played a part in the improvement of tuberculosis mortality before chemotherapy, the current increase in tuberculosis being experienced by many countries at present, (6,7,8) may be partially due to the absence of natural selection caused by the new and beneficial chemotherapeutic era.

The aim of this study is to reinvestigate the association between changes in mortality from tuberculosis on the one hand, and mortality from other poverty related diseases and socioeconomic conditions and measures in Victorian England on the other.

## Methods

Mortality statistics for England and Wales from 1853 to 1910, after which date World War I disrupted the steady downward trend, were obtained from the Registrar General's Annual Reports(9). These publications include data on

tuberculosis, cholera and dysentery. Infant mortality and total mortality rates were taken from the same source. Data on other diseases over the same period of time were not as complete.

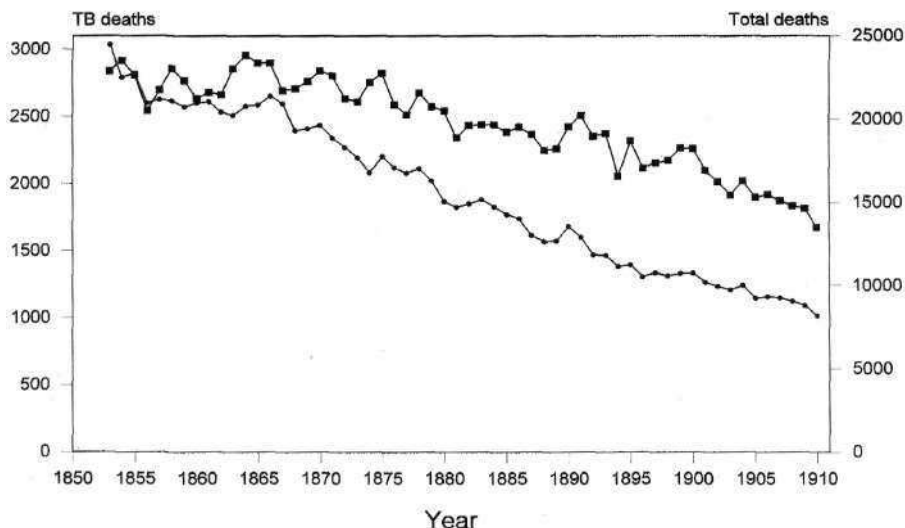
Socioeconomic measures for the same period were also obtained from the Registrar General's Reports. Measures of overcrowding were calculated using the decennial census data from statistics on the number of habitable houses and the size of the resident population. Statistics on average real earnings, also available from the Reports, were used.

The rates of change of each of these variables were calculated as the average percentage change per year and are given together with the 95% confidence intervals.

## Results

The crude annual death rates for both sexes, for all causes and age groups combined and for tuberculosis for all age groups and both sexes combined are shown in Fig 1. The mean annual change for each measure is shown on Table 1. Total mortality rates declined by 0.80 per year (CI -2.13 to 0.54) whereas tuberculosis mortality declined by 1.71 (-2.63 to -0.77). The average

Fig. 1. Death rates for tuberculosis per million per annum, left hand scale (circles) and all causes per million, right hand scale (squares), for England and Wales, 1853-1910.



annual decline for tuberculosis was therefore twice that for all causes. In fact decline in mortality for all causes, calculated on an annual basis did not achieve statistical significance.

Infant mortality, which might be expected to be a closer indicator of improvement in social deprivation, than mortality for all age groups combined declined even more slowly, by 0.58 per year (-2.62 to 1.15) again not achieving statistical significance. Fig 2 and Table 1. Secondly whereas tuberculosis deaths showed a steadily improving trend over the 60 years studied, infant mortality apparently only improved from approximately 1900.

Dysentery mortality fluctuated widely and showed no evidence of decline at all during the period. In fact there was a marginal increase of 0.009 (CI -38.9 to 38.9) Fig 2 and Table 1. Fluctuations were marked as the disease tended to occur in epidemics. Cholera mortality decline was present but fluctuations were also marked and statistical significance in decline was not achieved, -1.07 (CI -14.1 to 11.95)

Overcrowding showed a trend towards improvement -0.05 (CI -0.41 to 0.03) but surprisingly did not achieve statistical significance on an annualised basis. Real earnings were the only factor studied, other than tuberculosis, to show a statistically significant change over the

period, rising by an average annual rate of 1.05 (CI 0.29 to 1.81). Table 1. This was in contrast to a decline in tuberculosis mortality of 1.71 per year. The decline in tuberculosis mortality exceeded by 63%, the increase in real earnings on an annual basis.

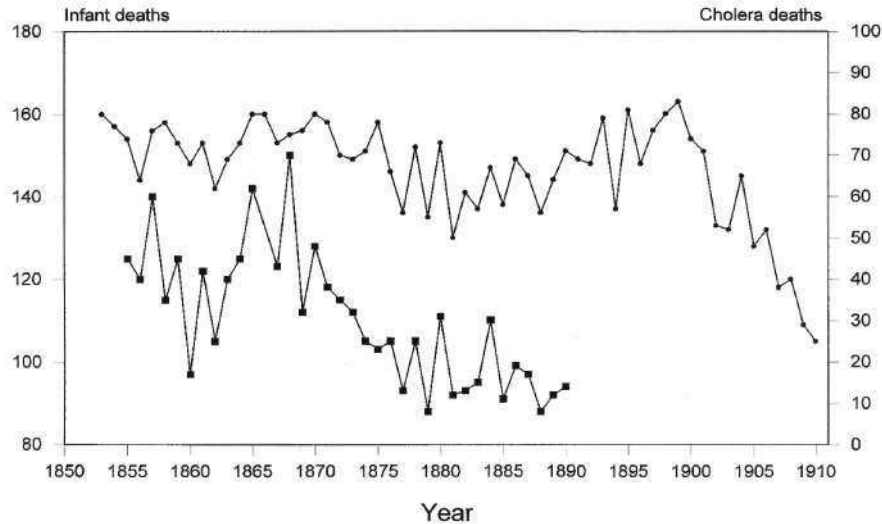
### Discussion

The study has shown that tuberculosis mortality declined at a very much faster rate than any indicator of social deprivation improved for the period 1853 to 1910. In particular mortality rates, both for infants and all age groups declined by less than half the tuberculosis mortality rates. It is therefore unlikely that social improvement alone was responsible for the remarkably steady decline in tuberculosis mortality.

Other diseases thought to be poverty related such as diphtheria and cholera showed no similar decline. Simple measures of social improvements such as overcrowding showed no relationship to tuberculosis mortality improvement. Though real earnings were one factor which did show steady improvement, the average annual improvement was considerably less, approximately two thirds less, than the rate of the decline in tuberculosis mortality.

Had the mortality of tuberculosis been closely related to poverty during this period, the steady

Fig.2. Death rates for infants per 1,000 live births, left hand scale (circles), and cholera per million, right hand scale (squares).



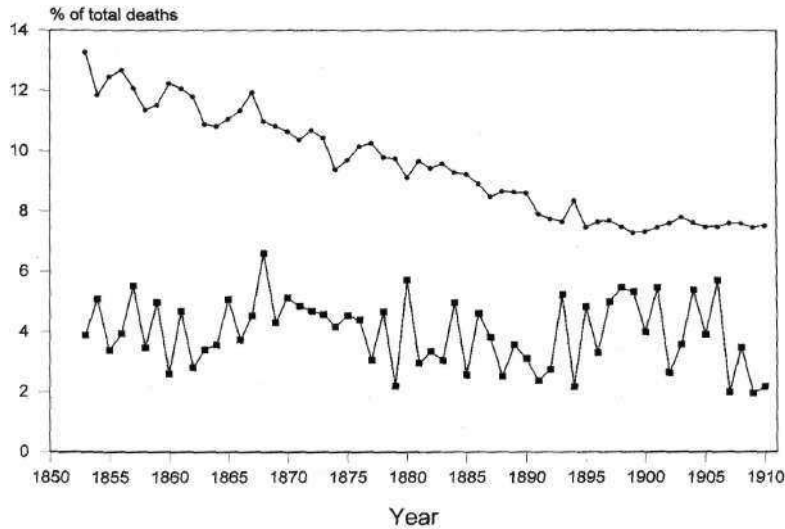
improvement of 1.71 % a year, which showed a remarkable consistency (Fig 1), would have been most unlikely to have occurred. That tuberculosis is associated with poverty there can be no doubt as both early and later studies have shown (1,3,4,10). What this study has shown is that the decline in tuberculosis mortality far exceeded improvements in social conditions and other disease markers of poverty over the period studied. Some other factor or factors are likely therefore to have been playing a part, of which the most important is probably the process of natural selection.

Historical studies have shown that in any age cohort tuberculosis rates are highest in the young adult group (11). Individuals susceptible to tuberculosis are therefore most likely to develop disease around the time when they would expect to be child bearing and child rearing. The morbidity and mortality of tuberculosis at this time of life would therefore tend to restrict the number of children born to sufferers, or by depriving the children of parents in infancy and early childhood lead to greater mortality in children of tuberculosis sufferers. In either event fewer children of tuberculosis sufferers would reach child bearing age than of those who remained free from disease. Thus a process of reduced fertility of tuberculosis susceptible families would occur leaving those that were naturally resistant to produce children.

If this were the case then the introduction of chemotherapy in developed countries for the past 50 years might well have resulted in the natural selection process being removed so that a new generation of children with a higher proportion of susceptible individuals, perhaps by possessing a phenotype with a weaker ability to acquire immunity, would have been born. Tuberculosis rates might then cease declining or even increase in younger age groups exposed to infection. The fact that tuberculosis rates have shown no decline among the White population of England and Wales between the national notification surveys carried out in 1988 and 1993 (12,13) either for all ages combined, or more significantly in males aged 15-24 years, lends some support to this theory.

The concept that natural selection might have had a major part to play in the decline of tuberculosis during Victorian times, and that its absence due to chemotherapy is currently contributing to the present increase, is essentially a hypothesis of default, the data shown here suggesting that improvement of social conditions alone was not sufficient to account for the decline in tuberculosis mortality. The fact that it is sustainable on the present evidence reinforces the need to continue protection of uninfected individuals by BCG until tuberculosis poses far less of a threat internationally than it does now (14).

Fig.3. Relative proportion of deaths to total deaths fom tuberculosis (circles) and dysentery (squares).



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## Biography

Dr P.D.O. Davies, educated St Thomas's Hospital and University College Oxford qualifying 1973, training jobs in London and Cardiff in general and respiratory medicine DM 1986 in the epidemiology of tuberculosis in England and Wales. Consultant Physician, Cardiothoracic Centre and Aintree University Hospital 1988. Director of Tuberculosis Research Unit 1990.