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Changes in tuberculosis notification rates in the white ethnic group in England and Wales between 1953 and 1983

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SUMMARY Since the early 1960s notification rates for tuberculosis in England and Wales for the whole population have been influenced by high rates in certain ethnic groups. Using data based on country of birth from the British (Thoracic and) Tuberculosis Association surveys of 1965 and 1971, and based on ethnic origin from the Medical Research Council surveys in 1978/79 and 1983, rates for the white ethnic group have been estimated at those four times, and compared with the published rates for the whole population in 1953, when only a very small proportion was of non-white ethnic origin.

Between 1953 and 1983 the notification rate for the white ethnic group fell from 122·2 to 11·3 per 100 000 for males, an annual decline of 7·7%, the corresponding rates for females being 90·1 and 5·8, an annual decline of 8·8%. The greatest annual declines occurred between 1953 and 1965, 9·4% for males and 11·2% for females. The annual declines in the most recent period, 1978/79 to 1983, were 6·9% for males and 7·3% for females. In both sexes the decline was greatest in the 15–24 year age group and least in the oldest age group, and this has led to a change in the age pattern of annual notification rates. The highest rates in both sexes occurred in young adults in 1953 but in the oldest age groups in 1983. There is however no evidence of any cohort experiencing an increase in notification rate with increasing age.

By the early 1960s annual tuberculosis notification rates for the whole population of England and Wales were beginning to be influenced by the high rates in relatively small groups of recent immigrants.[1 2] In consequence it has become desirable to separate the rates for the white ethnic group. The notification rates for an individual ethnic group can be studied only in years in which special surveys of notifications have been performed, such as those undertaken by the British (Thoracic and) Tuberculosis Association in 1965[3] and 1971,[4] and by the Medical Research Council's Tuberculosis and Chest Diseases Unit in 1978/79[5] and 1983.[6] For this reason 1983 has been chosen as the endpoint of the study.

The year 1953 has been taken as the starting point of the study mainly because it was before national notification rates could have been influenced to an important extent by high rates in any immigrant group. Back estimation from a recent population survey[7] shows that large scale immigration of non-white ethnic groups from the Caribbean and Indian subcontinent began in the mid 1950s. Further, the earliest reports of an increase in the number of immigrants with tuberculosis in England relate to the year 1954.[8–10] Also the scheme for BCG vaccination of 13 year old schoolchildren was introduced in 1953.

Methods

This study compares the annual percentage decline in tuberculosis notification rate for the white ethnic group in four time intervals between 1953 and 1983. Information is not available on a uniform basis for the whole period and differences in the criteria for estimating the population of white ethnic origin and the notifications for this group are therefore described below. Different notification rates are sometimes shown for the same year, but each is the best estimate available for the comparison in which it is used.

POPULATION DATA FOR THE WHITE ETHNIC GROUP

For 1953 and 1965 the Registrar General's mid year estimates of the "home" population of England and

Wales have been used. [11 12] For 1971 a white ethnic population born and resident in England was estimated from census data on the basis of the place of birth of individuals and their parents.[13]

The population estimates for 1978/79 are based on the 1978 National Dwelling and Housing Survey (NDHS)[14] and are for England only. The 1983 estimates are based on the 1983 Labour Force Survey (LFS) (Office of Population Censuses and Surveys, unpublished findings), for England only for the comparison with 1978/79, and for England and Wales for the comparison with 1953. Although comparisons[15] between the NDHS and LFS population estimates for certain ethnic groups have shown discrepancies, there is no reason to believe that the estimates for the white ethnic group are seriously affected, as this group represents about 95% of the total population (LFS, unpublished data). Complete information was not obtained for about 2% in each population survey and the population estimates for the individual ethnic groups have been increased in proportion to the numbers for whom complete information was obtained.

NOTIFICATIONS IN THE WHITE ETHNIC GROUP

The same criteria which were used to estimate the white population in each survey have been applied to the notifications (except for 1965, see below). Where appropriate, notifications have been restricted to residents of England only.

For 1953, all notifications recorded in the Registrar General's reports have been included. For 1965, the number of notifications has been estimated by reducing the totals published in the Registrar General's report by proportions based on a re-analysis of the results of the 4 month survey of notifications by ethnic group in 1965.[3] This has been done separately for age groups of each sex, to include as white those patients born in Europe, Oceania and the Americas (excluding the Caribbean area) and to exclude those born in Africa, the Caribbean, the Indian subcontinent and the rest of Asia. Thus for 1965 the rate for whites has been calculated using total population, but the degree of underestimation in the rates is small and can be ignored.

The numbers of notifications for 1971, 1978/79 and 1983 are derived from notification surveys [4–6] in which information about place of birth or ethnic group or both was obtained. Duplicate notifications and those for individuals receiving only chemoprophylaxis have been excluded, but renotifications and those subsequently denotified have been retained. The rates therefore differ from those in previous publications[6 16] in which some categories of patients, namely previously treated patients, renotifications and denotifications, were excluded.

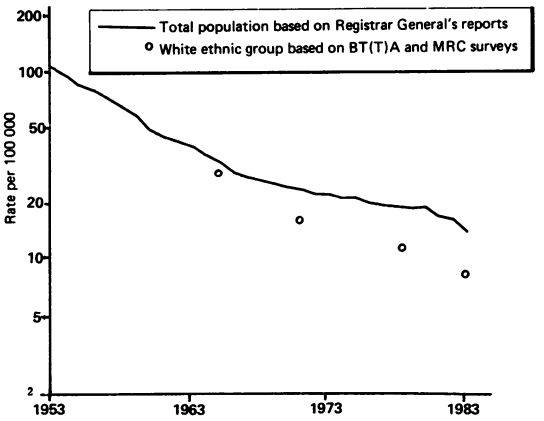

Fig 1 *The annual tuberculosis notification rate per 100 000 for England and Wales, 1953–1983, and the estimated rate for the white ethnic group from 4 surveys (the estimate for 1978/79 is for England only).*

Results

The need to separate the rates for the white ethnic group is demonstrated in fig 1, which shows the total notification rate for England and Wales from 1953 to 1983 in comparison with the estimated rates for the white ethnic group in the four surveys.

CHANGES OVER THE WHOLE PERIOD 1953 TO 1983

In males the notification rate per 100 000 for all ages fell from 122·2 in 1953 to 11·3 in 1983, an annual rate of decline of 7·8%. In females the notification rates were lower in both years and the annual rate of decline was greater, 8·8% These changes are shown in table 1.

In children (aged 0–14 years) there is little difference between the sexes in the annual rate of decline, 10·3% per year in males and 9·8% per year in females. The most rapid falls in rate occurred in young adults of each sex, the annual rate of decline at age 15–24 years being 11·7% for males and 12·6% for females. In older age groups of each sex the decline in rate diminishes with increasing age, although less steeply in males than in females; at age 45 years and over the decline in rate was greater in males than females. The smallest annual rate of decline, 2·8%, was for females aged 65 years and over. The declines for both sexes combined are shown in fig 2.

CHANGES IN PERIODS WITHIN 1953 TO 1983

The annual percentage declines in notification rate for each sex by age are shown for the various time periods in table 2; the declines over the whole period are also shown for comparison.

Table 1 *Changes in annual notification rates for the white ethnic group resident in England and Wales: 1953-1983. Brackets denote numbers of patients, annual notification rates and annual rates of decline based on data for the whole 12 month period*

Age group (years)	1953			1983			Annual decline in rate (%)
	Population (thousands)	Patients notified in 12m	Annual rate per 100 000	Population (thousands)	Patients notified in 6m (12m)	Annual rate per 100 000	
Males							
0–14	5042	3639	72·2	4567·5	80(129)	3·4(2·8)	9·8(10·3)
15–24	2718	4688	172·5	3700·3	91(150)	4·8(4·1)	11·3(11·7)
25–34	3185	4582	143·9	3149·3	128	7·9	9·3
35–44	3151	3815	121·1	3058·2	159	10·2	8·0
45–54	3023	4259	140·9	2612·6	146	10·9	8·2
55–64	2095	3147	150·2	2650·0	259	19·0	6·7
65 and over	1999	1797	89·9	2860·8	449	30·6	3·6
All ages	21 213	25 927	122·2	22 598·7	1312	11·3	7·7
Females							
0–14	4817	3468	72·0	4320·9	74(142)	3·3(3·3)	9·8 (9·8)
15–24	2850	6374	223·6	3573·4	73(142)	4·0(4·0)	12·6(12·6)
25–34	3230	5108	158·1	3146·1	79	4·9	11·0
35–44	3245	2682	82·7	3033·6	88	5·7	8·6
45–54	3189	1480	46·4	2646·8	86	6·3	6·5
55–64	2596	852	32·8	2883·5	102	6·9	5·1
65 and over	2950	655	22·2	4358·0	213	9·5	2·8
All ages	22 877	20 619	90·1	23 962·3	715	5·8	8·8

Table 2 *Annual percentage decline in tuberculosis notification rates for the white ethnic group in England and Wales over the different calendar periods*

Age group (years)	Calendar periods and intervals in years				
	1953 to 1965	1965 to 1971	1971 to 1978/79*	1978/79 to 1983*	1953 to 1983
	12·00	5·75	7·75	4·25†	29·75†
Males					
0–14	13·7	8·7	8·4	6·2	10·3
15–24	15·3	10·1	10·4	8·3	11·7
25–34	10·8	13·4	7·3	6·3	9·3
35–44	8·4	9·4	9·6	7·5	8·0
45–54	7·9	9·8	5·9	12·3	8·2
55–64	6·4	9·3	2·9	12·4	6·7
65 and over	3·7	6·0	1·7	3·8	3·6
All ages	9·4	9·4	5·1	6·9	7·7
Females					
0–14	13·0	9·7	7·5	4·7	9·8
15–24	16·1	11·8	7·5	13·5	12·6
25–34	11·5	12·4	12·5	6·2	11·0
35–44	8·2	11·4	7·7	8·7	8·6
45–54	6·9	7·2	4·5	7·9	6·6
55–64	5·8	7·4	+ 1·3	10·7	5·1
65 and over	2·9	4·5	0·8	4·3	2·8
All ages	11·2	9·8	5·1	7·3	8·8

* England only
† For age groups up to 24 years the intervals for the calendar periods 1978/79 to 1983 and 1953 to 1983 are 4·50 and 30·00 years, respectively
\+ Indicates an increase in rate

The most rapid declines in rate occurred between 1953 and 1965 among children (aged 0–14 years) and young adults (aged 15–24 years), with slower rates in the three subsequent periods under study. At age 25–44 years and 45–64 years the pattern varies less during the 30 year period apart from an apparent acceleration in the rate of decline in the older age group in the most recent period 1978/79 to 1983. At age 65 years and over the rates of decline were low throughout.

The changes between 1978/79 and 1983, shown in more detail in table 3, are of special interest because

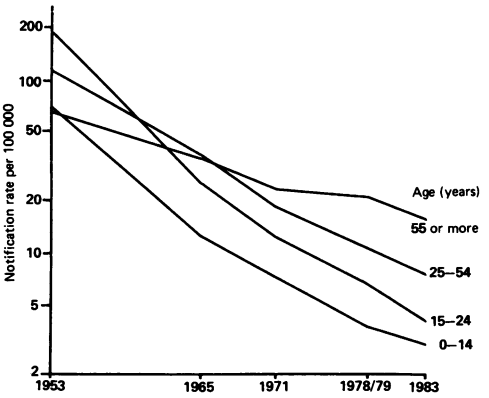

Fig 2 *The decline by age group in the annual tuberculosis notification rate per 100 000 between successive surveys for the white ethnic group (both sexes combined)*

this is the most recent period for which information is available. For age groups up to 34 years (except for females aged 15–24 years) the decline in rates between 1978/79 and 1983 was less than in earlier periods. For males aged 15–24 years the annual decline between 1978/79 and 1983 was less than that for females, 8·3% compared with 13·5%, but in the preceding period the rate of decline for males was greater.

In view of the current interest about the future use of BCG vaccination in schoolchildren, the changes in rates in children and young adults are of particular interest. Combining the figures for males and females, the annual rates of decline between 1971 and 1978/79 were 7·9% for children aged 0–14 years, 8·9% for persons aged 15–24 and 9·7% for those aged 25–34 years. The corresponding annual rates of decline between 1978/79 and 1983 were 5·3%, 11·1% and 6·1% respectively.

In the period 1978/79 to 1983 rapid annual rates of decline were recorded for males aged 45–54 years (12·3%) and for both males (12·4%) and females (10·7%) aged 55–64 years. For these age groups, relatively low rates of decline were recorded for the preceding period 1971 to 1978/79 with a small increase for females aged 55–64 years.

In summary, the most rapid decline in the rates for young adults occurred in the early years of the period under review, and towards the end of the period their rates of decline became slower, especially in males. In the age group 55–64 years for each sex the most rapid declines in rate occurred between 1978/79 and 1983. However, there had been little or no decline in this age group in the period 1971 to 1978/79.

CHANGES IN THE AGE DISTRIBUTION OF NOTIFICATION RATES

From table 1 it can be seen that the more rapid fall in notification rates in young adults than in the older age groups has led to a change in the age distribution of the annual notification rates. In 1953 the highest rates occurred in young adults of each sex, the rates declining more rapidly with increasing age in females than in males, whose rates showed a second peak at age 55–64 years. In 1983 there was a progressive increase in notification rate from the youngest to the oldest age group in each sex; the rates were similar in the two sexes up to age 24 years, but over that age the rates for males were greater than those for females, the difference increasing with age.

The rates experienced by the older age groups in 1983 were, however, much less than the rates experienced by the same cohorts of individuals when younger. Thus the rate of 19·0 per 100 000 for males aged 55–64 years in 1983 was considerably less than the rate of 143·9 per 100 000 for this cohort when aged 25–34 years in 1953. There is no evidence of any cohort showing an increase in notification rate with age.

Discussion

This analysis has shown that tuberculosis notification rates for the white ethnic group in England and Wales declined by about 8% per year between 1953 and 1983. The greatest decline occurred in the young adult age groups, in whom the rates were highest in 1953. The rate of decline has been a little less in children, and has been least in the oldest age groups, amongst whom the highest notification rates now occur.

There was a relatively rapid fall in rate in both men and women aged 55–64 years between 1978/79 and 1983. This may have been due to high rates occurring by chance in 1978/79. Those concerned, however, would have been young adults 40 years earlier. They would have been experiencing all the problems of wartime, but would also be subjected to routine medical examinations, including, for many, chest radiography on entering or leaving the Armed Forces, or while working in factories. After 1947 they would have had the benefit of chemotherapy for any lesions detected. It is possible that there are fewer persons in this and more recent cohorts with previously undetected and untreated tuberculosis lesions liable to breakdown in later life.

A decline in notification rate must be due either to a declining risk of infection with *M. tuberculosis* or to a decreased risk of developing notifiable disease after infection, or a combination of the two. General improvement in living standards would contribute to both. The moderate decline in notification rate prior to the Second World War was predominantly due to

Table 3 *Changes in annual notification rates for the white ethnic group resident in England by age and sex: 1978/79–1983. Brackets denote numbers of patients, annual notification rates and annual rates of decline based on data for the whole 12 month period.*

Sex and age group (years)	1978/79			1983			Annual decline in rate (%)
	Population (thousands)	Patients notified in 6m	Annual rate per 100 000	Population (thousands)	Patients notified in 6m (12m)	Annual rate per 100 000	
Male							
0–14	4963	84	3·6	4290	74(117)	3·4(2·7)	1·3 (6·2)
15–24	3139	87	5·9	3474	84(139)	4·7(4·0)	5·2 (8·3)
25–34	3150	155	10·4	2971	120	7·9	6·3
35–44	2519	165	13·9	2882	148	10·0	7·5
45–54	2607	242	19·6	2459	141	11·2	12·3
55–64	2437	378	32·8	2492	239	18·7	12·4
65 or more	2553	425	35·2	2690	342	29·9	3·8
All ages	21 369	1536	15·2	21 259	1218	11·2	6·9
Female							
0–14	4609	90	4·1	4058	71(134)	3·4(3·3)	4·3 (4·7)
15–24	3059	111	7·7	3351	70(134)	4·1(4·0)	13·8(13·5)
25–34	3176	100	6·7	2970	77	5·1	6·2
35–44	2535	94	7·8	2859	78	5·3	8·7
45–54	2708	116	9·1	2493	82	6·4	7·9
55–64	2658	142	11·3	2712	97	7·0	10·7
65 or more	3840	204	11·2	4091	194	9·3	4·3
All ages	22 585	857	8·0	22 535	669	5·8	7·3

general rather than specific measures, but by 1953 two specific measures had been introduced, namely chemotherapy and BCG vaccination, and these have contributed to the much steeper declines in notification rate reported here.

Chemotherapy, by shortening the duration of infectivity of the individual, reduces the risk of infection in the community and this leads to a reduction in future notifications, and so to a steepening of any existing downward trend in notification rate. There is good evidence of the decline in the risk of infection from tuberculin surveys in 1951 and 1972.[17] During this period the annual risk of infection was estimated to have halved every 5 years. This is equivalent to an annual rate of decline of 13%, which is similar to the observed annual declines in notification rate for young adult males and females aged 15–24 years in the first two periods of this study (from 1953 to 1971), but is rather greater than the declines in notification rate recorded for children and much greater than that for older age groups. Solely on the grounds of the reduction in risk of infection, the rate of decline in the notification rate for children would be expected to be about the same as that of the annual risk of infection, and for the notification rate in young adults. Some delay in the full effects of falling risks of infection is to be expected in older age groups if it is accepted that some cases at these ages are due to late breakdown from infection acquired in childhood or young adult life.

There is also good evidence that BCG vaccination as used in England and Wales reduces the chance of developing notified tuberculosis.[18 19] The effect of BCG vaccination on the notification rate is more complex than the effect of chemotherapy. The introduction of BCG vaccination has the primary effect of reducing the number of notifications that would otherwise have occurred among those vaccinated, and so of steepening any downward trend in notification rate. This reduction in notifications has the secondary effect of reducing the risk of infection in the community, and this leads to a further reduction in future notifications. The primary and secondary effects of introducing BCG thus both lead to a steepening of any existing downward trend in the notification rate. It is important to appreciate that these effects will occur in a population group only while the proportion of vaccinated subjects in that group is increasing. If the proportion vaccinated remains constant, at whatever level, the continued use of BCG vaccination in this constant proportion has no effect in reducing the notification rate further. Conversely, if the proportion vaccinated in a population group decreases, there will be primary and secondary increases in numbers of notifications, and any downward trend of the notification rate will become less steep.

It is not possible to quantify the contribution of chemotherapy to the observed downward trends in notification rate, but the contributions attributable to

the introduction and expansion of the scheme for BCG vaccination of schoolchildren can be estimated. From the serial records of the scheme, it appears that for the age group 15–24 years, BCG vaccination coverage of 50% was first achieved in 1968 and 70% coverage in 1979, since when the proportion vaccinated has stabilised at just under 75%. BCG vaccination is known to be about 75% effective in this age group, and for any given increase in proportion vaccinated the reduction in notification rate due solely to the primary effects of introducing BCG vaccination can readily be calculated. For the periods studied in this paper, the primary effects at ages 15–24 years of the increasing coverage of the BCG vaccination scheme are annual reductions in notification rate of 3·1% between 1953 and 1965, 4·1% between 1965 and 1971, 1·6% between 1971 and 1978/79, and 1·0% between 1978/79 and 1983. For the 30 year period from 1953 to 1983, the average annual rate of decline in notification rate in the 15–24 year age group, due to the primary effect of the increasing coverage of the scheme, is 2·6%. The additional secondary effects of introducing the BCG scheme must be less than the primary effects but are not as readily quantified. The general decline in notifications due to causes other than BCG means that the prevention of one primary notification prevents less than one secondary notification; and in addition, the secondary notifications prevented will not all be in the age group 15–24 years. In this age group, the total effects of the expanding BCG vaccination scheme between 1953 and 1983 are thus an annual decline in notification rate of the order of 4%. In the four separate periods, the total effects will have been of the order of 4–5%, 5–6%, 2–3% and 1–2% respectively. These are all substantially less than the decreases recorded for males and females age 15–24 years, indicating that influences other than BCG vaccination were responsible for the major part of the declines in rate, even in this age group in which the effect of BCG vaccination could be expected to be maximal.

If a 4% annual decline for the whole period, attributable to the BCG vaccination scheme, is discounted from the figures for males and females aged 15–24 years, the estimated declines due to other causes are similar to the observed values for children age 0–14 years (males 8·0% compared with 10·3%, females 9·0% compared with 9·8%). This is consistent with the concept that the greater rate of decline in young adults than in children is due to the introduction of BCG vaccination. Moreover, the greatest differences between the rates of decline for children and young adults occur in the earlier parts of the 30 year period, as would be expected if the difference is due to the introduction of BCG vaccination at age 13 years.

For the future, it is reasonable to expect that decline in notification rate in the white ethnic group in England and Wales to continue, though possibly not so rapidly as in the 30 year period 1953–1983, in the early part of which the benefits of new methods became apparent. It is not yet possible to assess what effect, if any, the spread of human immunodeficiency virus (HIV) will have on tuberculosis notification rates at different ages. In the absence of any major change in the trend of tuberculosis notification rates due to cases in HIV infected individuals, the rates for children seem likely to continue to decline by about 6–7% per year, those for young adults by about 8–10% per year (assuming no further change in BCG scheme), and those for age group 25–44 years by about 8–9%, based on rates since the early 1970s. For the age group 45–64 years, the recent steepening of the decline is likely to be maintained. The present slow decline in those aged more than 64 years seems likely to increase similarly in the future, as steep reductions begin to occur in the proportion of this age group who were infected in childhood.

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