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Prevalence study of tuberculous infection over fifteen years, in a rural population in Chingleput district (south India)

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As in the earlier BCG trial against tuberculosis conducted in Chingleput district in south India (in 1969), the entire study population was tuberculin tested (Survey I), a study was undertaken subsequently to see whether in this population there was any change in the tuberculosis situation in terms of prevalence of infection in children. For this purpose, in two of the panchayat unions, in a random sample of panchayats, tuberculin testing was repeated twice at an interval of 10 yr (Survey II) and 15 yr (Survey III) after the initial testing in children aged 1-9 yr. High coverages were obtained for tuberculin testing and reading. Data from 8,703 and 9,709 children at Surveys I and II respectively was used for comparing the prevalence of infection over a period of 10 yr and from 4.808, 4,965 and 4,889 children at Surveys I, II and III respectively for comparing the prevalence of infection over a period of 15 yr. The results showed that although the prevalence of infection varied in the two panchayat unions, within each panchayat union it did not differ significantly at the three surveys. The overall prevalence of infection at the three surveys was 9.0, 10.2 and 9.1 per cent respectively. The average annual risk of tuberculous infection was estimated to be 1.7, 1.9 and 1.7 per cent at the three surveys respectively. Thus, the results clearly showed that, over a period of 15 yr, there was no change in the tuberculosis situation, in terms of prevalence of infection, in the study population.

Prevalence of tuberculous infection obtained through repeated tuberculin testings in children, 'over a period of time. is recognised to be a reliable indicator for evaluating the tuberculosis situation and its trend in a community[1,2]. It expresses the direct impact of tuberculosis in the community and, unlike tuberculosis morbidity which is based on the number of cases detected annually in the tuberculosis programme, is independent of the efficiency of case finding in the programme[1]. A WHO study group has recommended that such surveys can be undertaken once in five years[2]. As a part of the BCG trial against tuberculosis, conducted in the Chingleput district of Tamil Nadu, the entire study population was tuberculin tested'. After the initial tuberculin testing, repeat tuberculin testing was carried out twice at intervals of 10 and 15 yr among children aged 1-9 yr residing in a random sample of panchayats in two panchayat unions. The objective of the study was to see whether, over the long follow up period of 15 yr, there was any change in the tuberculosis situation, in terms of prevalence of infection in children, in the study population.

Material & Methods

In the BCG trial[3], the entire population, in five panchayat unions (PU) in Chingleput district of Tamil Nadu. aged 1 yr and. above was tested with 3 IU of PPD-S at the time of intake (Survey I:

1969). The present study was conducted in two of the panchayat unions, viz., Kadambathur and Thiruvalangadu. In a random sample of 15 of the 42 panchayats in Kadambathur PU and 15 of the 39 panchayats in Thiruvalangadu PU, all children aged 1-9 yr were tested with 3 IU of PPD-S ten years after the first testing (Survey II 1979). Again, in a subsample of 8 panchayats, of the 15 panchayats included for Survey II, in each of the two panchayat unions, all children aged 1-9 yr were tested with 3 IU of PPD-S 15 yr after the first testing (Survey III: 1984). Thus, the children included for tuberculin testing at 10 and 15 yr were born after the intake phase of the BCG trial.

Standard testers and readers were used throughout, employing the same tuberculin product (from Statens Seruminstitut, Copenhagen) and same dosage. It was ensured that the potency of the different lots of PPD-S used was uniform. Details regarding the tuberculin used as well as the procedures for standardisation of tuberculin product and readers have been published elsewhere[3]. The tuberculin test was given intradermally in the mid-dorsal aspect of the left forearm and the transverse diameter of the induration, in millimetre, recorded 72 h later.

The area is one with a high prevalence of non-specific sensitivity[3]. This makes the interpretation of the tuberculin test results in older age groups unreliable. Therefore, the tuberculin testing at Surveys II and III was confined to the age group 1-9 yr. As the infection rates were similar in the two sexes in this young age group, the results have been combined for the two sexes and presented.

Statistical analysis : Chi-square test was employed for comparing proportions infected. For estimating the average annual risk of infection, the relationship[4] between the prevalence of infection [P(a, b)] in a cohort and the risks of infection experienced by the cohort (p), expressed in the form $Q(a, b)=(q)^a$, was used, where Q(a, b) = 1-P (a, b), q = 1-p, b = beginning of year in which the cohort was born and a = age of cohort at which examined. For example, let the estimated prevalence of infection, P(a, b), in a cohort of children aged 5-9 yr be 11 per cent. That is, Q(a, b) = 0.89 and a = 7.5, average age of the cohort. Then, q = 0.9846 and the average annual risk of infection to which the cohort has been subjected to during their lifetime (1-q) is 0.0154 or 1.54 per cent.

Results

Study population : Number of children included for the study and coverages obtained at each of the three surveys are shown in Table I. Of the total population registered at the various surveys, about 1-4 per cent were temporary visitors and are not included for the analysis. Of the *dejure* population, 83-90 per cent were tuberculin tested and read. Of these, 1-4 per cent had a scar suggestive of previous BCG vaccination and were excluded from the analysis. Thus, for comparing the prevalence of infection at Surveys I and II (i.e.. over a period of 10 yr) data from 8,703 and 9,709 children was available for analysis at the two surveys respectively. Similarly, considering the 16 panchayats included for all the three surveys, data from 4,808, 4,965 and 4,889 children at Surveys I, II and III respectively was analysed for comparing the prevalence of infection over a period of 15 yr.

Criterion for defining infection : The distribution of children; by size of reaction to PPD-S is shown in the Fig., separately for two age groups, 1-4 and 5-9 yr, and separately for 30 (2 surveys) and 16 (3 surveys) panchayats. It can be seen from the figure that the distribution at each survey is bimodal and

Table 1. Study population

Particulars	Survey I (1969)	Survey II (1979)	Survey III (1984)
At 10 yr (30 panchayats) :			
Population registered	10923	11556	–
Dejure population	10521	11415	–
No. tested and read	8778	10172	
No. with BCG scar	75	463	–
No. included for analysis	8703	9709	–
At 15 yr (16 panchayats) :			
Population registered	5934	5759	5839
Dejure population	5732	5707	5755
No. tested and read	4852	5146	5075
No. with BCG scar	44	181	186
No. included for analysis	4808	4965	4889

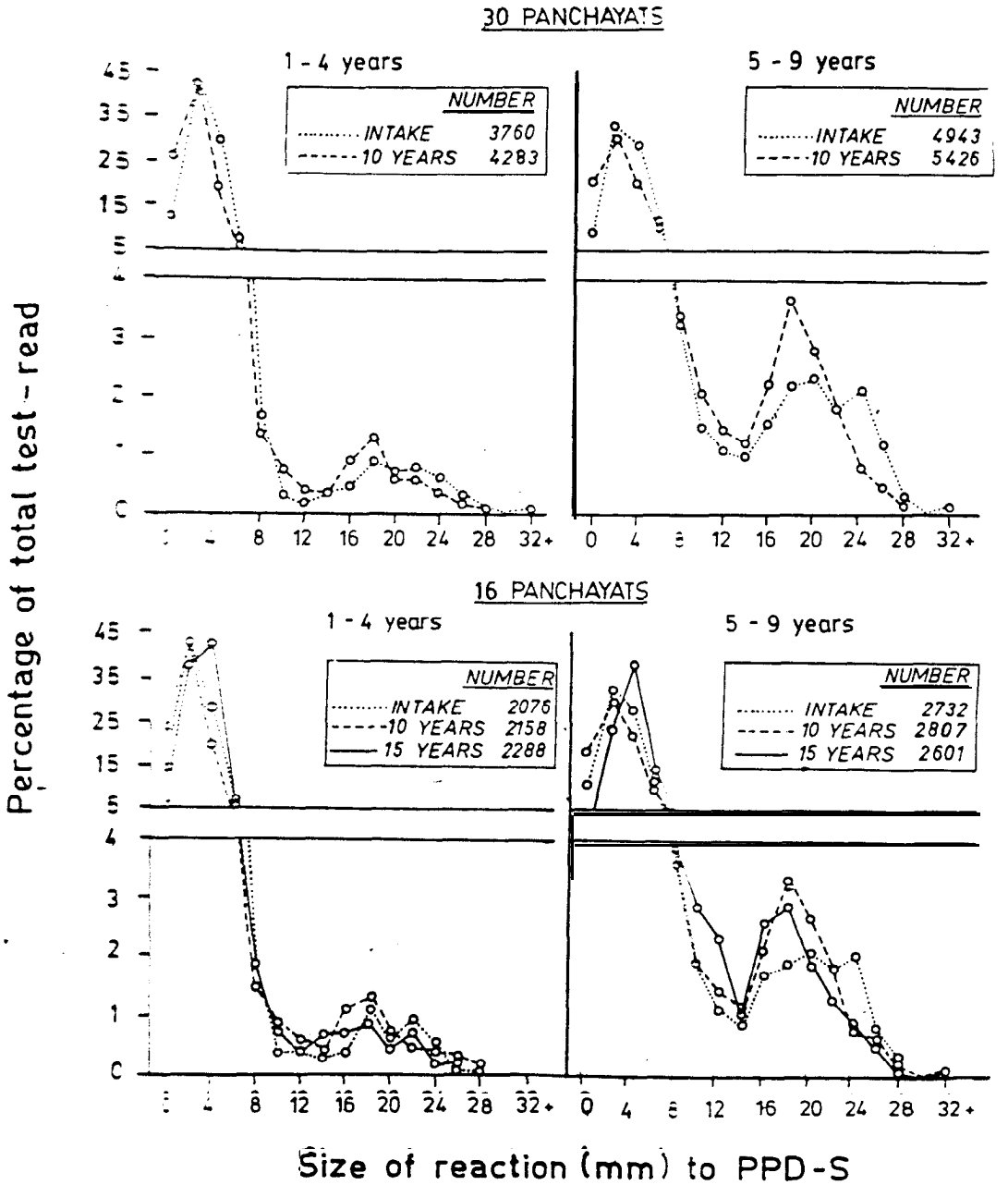

Fig. Distribution of reactions to PPD-S in children belonging to age groups 1-4 and 5-9 yr

the dividing line between the uninfected (left hand distribution) and the infected (right hand distribution). although not very sharp, is around 12 mm. Therefore, 12 mm. was taken as the limit for defining 'reactors' to PPD-S on the expectation that with this limit the numbers of 'false positives' and 'false negatives' will tend to cancel each other. This definition is the same as the one used in the BCG trial report[3].

Comparison of prevalence of infection at Surveys I and II : At each survey and for each panchayat union, the prevalence of infection was consistently higher (about 3 times) among children aged 5-9 yr as compares to that among those aged 13 yr ($P< 0.001$; Table II). Also, it was consistently higher (about 1.5 times), for each age group at each survey, in Thiruvalangadu PU as compared to that in Kadambathur PU. In all cases, except for

age group 1-4 yr at Survey I, this difference was statistically significant ($P < 0.02$). However, within each panchayat union, the prevalence of infection at the two surveys, for each of the two age groups, did not differ significantly ($P > 0.3$). That is, there was no difference in the prevalence of infection in children aged 1-9 yr over a period of 10 yr in the study population.

Comparison of prevalence of infection at Surveys I, II and III : The prevalence of infection at each of the three surveys, separately for two age groups and the two panchayat unions is given in Table III. The observations made over a period of 10 yr remained unchanged over the next 5 yr. That is, the prevalence of infection increased with age, was higher among children in Thiruvalangadu PU as compared to that among those in Kadambathur PU and did not differ significantly at the three surveys suggesting that it had remained more or less constant over the period of 15 yr in the study population. This conclusion remained the same even when 14 mm was taken as the limit to define 'reactors' to PPD-S (data not presented). This is also evident from the Fig., wherein it is seen that the distributions of reactions at the three surveys are almost coinciding.

Table II. Proportion (%) infected (12 mm or more to PPD-S) at Surveys I and II

Age group (yr)	Survey I (1969)			Survey II (1979)		
	No. exam.	No. inf.	Rate (%)	No. exam.	No. inf.	Rate (%)
Kadambathur PU (15 panchayats) :						
1-4	2145	87	4.1	2509	106	4.2
5-9	2792	323	11.6	3128	384	12.3
1-9	4937	410	8.3	5637	490	8.7
Thiruvalangadu PU (15 panchayats) :						
1-4	1615	84	5.2	1774	106	6.0
5-9	2151	345	16.0	2298	395	17.2
1-9	3766	429	11.4	4072	501	12.3
Total (30 panchayats) :						
1-4	3760	171	4.5	4283	212	4.9
5-9	4943	668	13.5	5426	779	14.4
1-9	8703	839	9.6	9709	991	10.2

Risk of tuberculosis infection : Annual risk of tuberculous infection (usually expressed as a percentage) is defined as the probability that an individual, not previously infected, will be infected during the ensuring period of 1 yr. Techniques for

Table III. Proportion (%) infected (12 mm or more to PPD-S) at Surveys I, II and III

Age group (yr)	Survey I (1969)			Survey II (1979)			Survey III (1984)		
	No. exam.	No. inf.	Rate (%)	No. exam.	No. inf.	Rate (%)	No. exam.	No. inf.	Rate (%)
Kadambathur P. U. (8 panchayats) :									
1-4	1098	36	3.3	1141	47	4. I	1233	45	3.6
5-9	1424	136	9.6	1404	154	11.0	1387	154	11.1
1-9	2522	172	6.8	2545	201	7.9	2620	199	7.6
Thiruvalangadu PU (8 panchayats) :									
1-4	978	54	5.5	1017	69	6.8	1055	53	5.0
5-9	1308	206	15.7	1403	235	16.7	1214	195	16.1
1-9	2286	260	11.4	2420	304	12.6	2269	248	10.9
Total (16 panchayats) :									
1-4	2076	90	4.3	2158	116	5.4	2288	98	4.3
5-9	2732	342	12.5	2807	389	13.9	2601	349	13.4
1-9	4808	432	9.0	4965	505	10.2	4889	447	9.1

converting information on prevalence of infection into annual rates of tuberculous infection have been developed[4-7]. Briefly, the relationship between the prevalence of infection in a cohort and the annual risk of infection to which that cohort has been subjected is expressed in terms, of the proportion of the cohort which has remained uninfected and the annual risk of escaping infection[4].

The estimates of the average annual risk of tuberculous infection at the three surveys are given in Table IV. The risk of infection, in each PU, increased with age. It was, on an average, 1.6 and 1.9 per cent for age groups 1-4 and 5-9 yr, respectively. Also, it was higher for Thiruvalangadu PU (2.2%) as compared to that for Kadambathur PU (1.4%). However, it is seen that the average annual risk of infection, for each age group and panchayat union, was more or less constant over the three surveys, the overall estimates being 1.7, 1.9 and 1.7 per cent at the three surveys respectively.

Table IV. Average annual risk of tuberculous infection (%) at Surveys I, II and III

Age group (yr)	Survey I (1969)	Survey II (1979)	Survey III (1984)	Total
Kadambathur PU (8 panchayats) :				
1-4	1.11	1.39	1.23	1.24
5-9	1.33	1.54	1.56	1.47
1-9	1.28	1.48	1.43	1.40
Thiruvalangadu PU (8 panchayats) :				
1-4	1.88	2.31	1.70	1.96
5-9	2.26	2.41	2.31	2.33
1-9	2.17	2.41	2.08	2.23
Total (16 panchayats) :				
1-4	1.47	1.82	1.45	1.58
5-9	1.77	1.97	1.90	1.88
1-9	1.70	1.93	1.73	1.79

Discussion

In the present study, estimates of prevalence of tuberculous infection at three points of time over a period of 15 yr were compared to see whether there was any change in the tuberculosis situation in the study population. It has been shown from the BCG trial data that although the relationship between tuberculous infection and disease was not amenable to any simple mathematical quantification, the prevalence of one varied directly with the prevalence of the other in the community[8]. It is known that prevalence of infection estimated at different points of time could be influenced by several factors such as the type of tuberculin used, its dosage, variation in reading of reactions etc., and therefore, when used as a measure to evaluate the trend of tuberculosis in a community, it would be difficult to draw valid conclusions unless the variations due to these factors are kept within reasonable limits. In the present study, care was taken to keep these. variations to the minimum. The usual pattern of an increase in the prevalence as well as in the risk of infection with age was clearly seen. The prevalence of infection was, on an average, 4.3 and 13.4 per cent for the age groups 1-4 and 5-9 yr respectively. Similar figures for the estimated annual risk of infection were 1.6 and 1.9 per cent.

The results consistently showed that, in terms of prevalence of infection, the problem of tuberculosis was higher in Thiruvalangadu PU as compared to that in Kadambathur PU, the overall infection rates, in the age group 1-9 yr, being 10.9 and 7.6 per cent respectively. The annual risk of infection for children in Thiruvalangadu PU was 1.6 times higher than that experienced by children in Kadambathur PU. This finding is in conformity with the higher prevalence and incidence of tuberculosis disease in Thiruvalangadu PU as compared to that in Kadambathur PU (unpublished data). Possible reasons for this discrepancy could be differences in socio-economic status and living conditions in the two populations or any other unknown reason.

The results of the study have clearly shown that the risk of tuberculous infection remained unchanged over the period of 15 yr in the study population. That is, the risk of new infection experienced by a child, aged 1-9 yr, in 1984 was the same as that experienced by his counterpart 15 yr earlier.

During the period of the study, since a BCG trial was on. the case finding efficiency in the

study population was high. But the delivery of drugs to the patients through the existing Primary Health Institutions (PHI) in the area as well as the regimens prescribed by the Medical Officers of the PHI were as per the procedures of the District Tuberculosis Programme. The most often used regimen was the daily oral regimen of isoniazid and thiacetazone to be collected once a month by the patient for self-administration for a period of 12 months. With the given regimen and the procedures for case holding. the case holding efficiency in this area was not different from that usually obtained under programme conditions (about 25-30%). The results of the study showed that although there was an improvement in case finding efficiency, the impact of the overall control programme was not sufficient to make any dent on the chain of transmission of infection in the community over the period of 15 yr as seen by the constant risk of infection in children during the above period.

The findings of the present study are in conformity with those reported from studies carried out in a neighbouring state and in other parts of the country[9-12]. Gothi *et al*[9] have reported that the prevalence rates of infection up to 19 yr age group were similar over a period of 12 yr (1961-73) in Tumkur district of Karnataka. No decline in the prevalence rates of infection was seen in children aged 0-9 yr over a period of 5 yr (1974-79) in Doddaballapur taluk of Bangalore district[10]. In a longitudinal study[11], conducted in three taluks of Bangalore district, infection rates at five surveys over a period of 16 yr (1961-77) in children aged 0-14 yr, though fluctuating, did not change appreciably. It was 6.48 and 6.43 per cent at Surveys I and V respectively. In a study[12] in Delhi city, over 15 yr (1962-77). no appreciable change in respect of any important epidemiological index was noted. Reviewing the various studies carried out in different parts of the country, Gothi[13] has reported that there does not appear to be any discernible change in the overall prevalence of the disease.

It is stated that the existing structure of health services and their developmcnt, delivery of general health care and that of anti-tuberculosis services in particular, socio-economic and nutritional conditions of people and the nature and extent of their participation in the programme all influence the general health of people and natural trend of tuberculosis in the community[9]. The results of the present study reiterate that unless there is a drastic improvement in the efficiency of the various components of the tuberculosis programme coupled with an improvement in the quality of life in the community, no significant downward trend in the tuberculosis problem can be expected in the near future.

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