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TUBERCULOSIS IN NORTH ARCOT DISTRICT OF TAMIL NADU - A SAMPLE SURVEY

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Summary : A sample survey was carried out in the North Arcot district of Tamil Nadu with the objective of finding out the prevalence of bacteriologically positive and radiologically active pulmonary tuberculosis among persons aged 15 years and above using two screening methods *viz*.. elicitation of suggestive symptoms and chest X-ray examination. Another objective was to estimate the prevalence of tuberculosis infection in children aged below 10 years.

A population of 1,05,339 persons was registered in a random sample of 35 villages from the rural areas and 102 town streets from the urban sector. All children aged 0-9 years were tuberculin tested with ITU RT23. Persons aged 15 years and above were screened for suggestive symptoms. and one-third of the sample was screened by X-ray of chest as well. Sputum specimens from the symptomatics and/or X-ray abnormals were subjected to bacteriological examination.

The prevalence of infection among 'below 10 years old' children without BCG scar was 6.7%. The prevalence of disease by sputum smear and/or culture among symptomatics was 4.3 per thousand in population aged 15 years and above. The prevalence rate of bacteriological positives based on symptoms and X-ray screening, in the one-third sample was 7.9 per thousand. The prevalence of X-ray positive cases was 17.0 per 1000.

Information available from similar other studies in the country has been reviewed.

Key Words: *Tuberculosis Sample Survey: Epidemiology of Tuberculosis*

INTRODUCTION

Epidemiological data on tuberculosis in India is somewhat scanty. With the exception of the National Sample Survey (NSS)[1] done in 1955-58, virtually no other information is available at the national level. However, many studies carried out in different parts of India have provided various estimates of disease prevalence and its trend since then [2-6]. Government of India had introduced Short Course Chemotherapy (SCC) in 18 districts, initially, before its extension in District Tuberculosis Programme (DTP) in general, and given the responsibility to monitor the activity in them to Tuberculosis Research Centre (TRC) . It was considered useful to know the present epidemiological situation of tuberculosis in some of the districts where SCC had been introduced early. Accordingly, a sample survey was undertaken in North Arcot district, being the first district in the country where SCC had been introduced, to obtain estimates of the prevalence of bacteriologically positive and radiologically active cases and the prevalence of tuberculosis infection in children. The value of the Ziehl-Neelsen (ZN) smear technique in case detection was also assessed.

MATERIAL AND METHODS

Study area and population

The undivided district of North Arcot in Tamil Nadu has an area of 12,268 sq.km. Its population was estimated to be about 5 million (at the time of the survey, in 1989) spread over 13 taluks, including 34 towns and 1873 villages. The main occupation of the people is agriculture. The terrain is mostly flat, with some hilly areas in the western part. The district is bounded on the north by Chittoor district

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of Andhra Pradesh , on the south by South Arcot district, on the west by Dharmapuri and Chittoor districts and on the east by Chingleput district (former district). The climate is generally moderate.

Sampling method

The sample size estimate was about 54,000 persons, aged 15 years and above, assuming prevalence of infectious cases to be 4 per 1000, and precision of 20% of the prevalence at 5% significance level, after adjusting for design effect of 2 and minimum coverage of 90% for examination. The population of the North Arcot district was estimated from the sampling frame available from the 1971 and 1981 censuses. A stratified cluster sampling method was used to define the study sample. The rural and urban areas were sampled separately. For the rural sample, the district was stratified taluk-wise and a simple random sample of villages was selected from each taluk proportional to the number of villages in the taluk. The 34 towns were stratified according to population size into 5 strata, and 25% of the towns (two each) were selected from each stratum. A random sample of streets was then selected from each of the selected towns. Thus, 35 villages and 102 town-streets constituted the sample (Fig.1). One-third of this sample was randomly selected for screening by MMR.

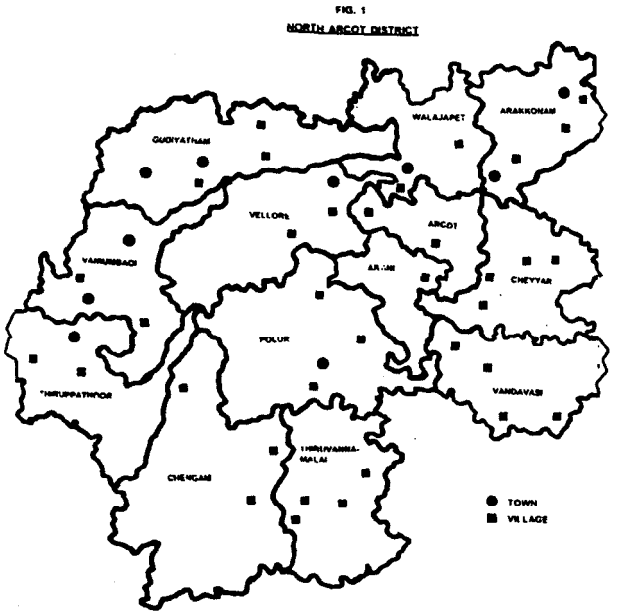

Fig.1 Map of North Arcot district showing sample towns as • and villages as •

Field procedures

All permanent residents of the selected villages and town streets were registered in a house to house census, between December 1989 and October 1990. Children below 10 years of age were skin tested with ITU RT23 with Tween 80, after recording the presence or absence of BCG scar. Reaction sizes were measured after 72 hours of the test without knowledge of BCG scar status. All persons aged 15 years and above were questioned by field investigators for symptoms suggestive of tuberculosis, as defined below. In addition, all persons aged 15 years and above in the selected one-third sample were subjected to MMR. The chest x-rays were read independently by two readers and classified as tuberculous (eligible for sputum collection), non-tuberculous or normal. Disagreements were adjudged by a third reader and the opinion of two out of three was taken as correct.

Sputum examination

All persons who were symptomatic* and/or had an abnormal chest x-ray in villages and towns screened by MMR were eligible for sputum collection. Two specimens of sputum, one spot and one overnight, were collected from each.. Smears from these specimens were stained with ZN technique and read in the field itself. Later, the specimens were brought to the laboratory at TRC for examination by fluorescence microscopy (FL) and culture. All sputum positive cases were given anti-tuberculosis treatment.

Statistical analysis

The statistical significance was tested by using Trend χ^2 and differences in proportions by using χ^2 test. The prevalence of bacteriologically as well as radiologically positive cases and the 95% confidence interval were obtained by using the appropriate formula on stratified sampling.

RESULTS

In all, 1,05,339 persons were registered, of whom 68,887 (65.4%) were aged 15 years and above and 24,614 (23.4%) were children 0-9 years old. From among 64,077 persons (93.0%) interviewed,

*Symptomatic - A person having cough of two weeks' duration or more/chest pain of 1 month's duration or more/fever of 1 month's duration or more/haemoptysis within 6 months.

8,229 (12.8%) were symptomatic and, thus, eligible for sputum collection. Sputum was collected from 8,032 (97.6%) of the symptomatics. In the one-third sample, 28,802 persons were eligible for X-ray examination (and symptom-screening) , of whom 25812 were examined by X-ray (and symptoms) and 6,204 eligibles were subjected to sputum examination.

The coverages obtained were 90% for tuberculin testing, 92% for elicitation of symptoms, 90% for X-ray examination and 97% for sputum collection. Generally, coverages were higher in females compared to males, and did not show much change for different age groups, except for the low coverage of 86% got among persons aged 65 years and above.

Prevalence of BCG scar and tuberculosis infection

The proportion of children having BCG scar was 34.4%. The distribution of reaction sizes, obtained separately for those with and without BCG scar is shown in Fig.2. Because a majority of the children (65% with scar and 79% without scar) had reaction sizes < 6 mm, this proportion of children is not shown in the figure. The proportion of children having 8-16 mm reaction sizes was higher among those with BCG scar compared to those without BCG scar, in both the age groups examined. This appears to be due to the previous vaccination producing a larger proportion of intermediate reactions. mostly in the 8- 16 mm category. Figure 2 also shows that the antimode among the 5-9 years old non-vaccinated children could be at 14 mm (confirmed by extending the right and left arms, to cross at 14 mm). As regards the 0-4 years age group. the number of non-vaccinated infected children is so small as to produce just a suggestion of a mode, yet the antimode can be seen to be lying between 16 and 18 mm .

Table 1 shows the infection rates among children for different age groups, with or without a BCG scar. The proportion of infected children increased with age in both the groups. Among children with BCG scar, the proportion of children showing a reaction size of 14 mm or more was 8.6% due to previous vaccination compared to 5.6% among those without scar.

Prevalence of bacteriologically positive cases

A person was considered to be suffering from bacillary tuberculosis if his/her sputum was positive by smear ($\geq$ 1 AFB on ZN and/or $\geq$ 4 AFB on FL) and/or yielded *M. tuberculosis* by culture. The overall prevalence of such cases among symptomatics in the entire sample was 4.3/1000 (Table 2) and this rate was not changed after adjusting for age and sex. The prevalence was higher (P<0.001) among males (6.0 per 1000) compared with females (2.7 per 1000) and it increased with age (P < 0.001) upto the age group 45-54 years and decreased thereafter (decrease not statistically significant). In the one-third sample, out of the 6,204 eligibles, sputum was collected from 6,007 persons and from them, 203 sputum positives were detected giving the prevalence rate of 7.9/1000.

Table 1. Distribution of tuberculin positive children according to age and BCG scar status

Category	Age (years)	No. tested/read	No. infected ($\geq$ 14 mm)	%
With scar	0 - 4	4339	259	6.0
	5 - 9	3307	398	12.0
	0 - 9	7646	657	8.6
Without scar	0 - 4	6054	168	2.8
	5 - 9	8519	648	7.6
	0 - 9	14573	816	5.6

FIG. 2

FREQUENCY DISTRIBUTION OF CHILDREN BY SIZE OF TUBERCULIN REACTION

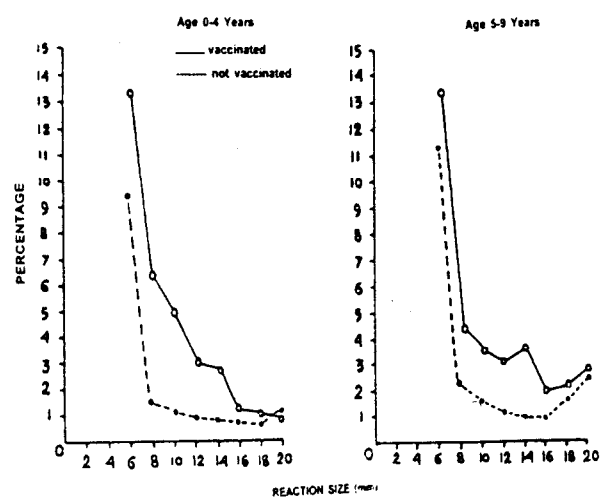

Fig.2 Frequency distribution of children by size of tuberculin reaction

Prevalence of radiologically active cases

An individual was considered to have radiologically active disease when his/her X-ray was interpreted as such (abacillary x-ray cases) by at least

Table 2. Distribution of sputum positive cases according to age and sex among persons interviewed

Age years)	Sex	Number interviewed	No. of Cases	Rate per 1000
15-24	M	8712	11	1.3
	F	9653	12	1.2
	T	18365	23	1.3
25-34	M	6692	24	3.6
	F	7483	16	2.1
	T	14175	40	2.8
35-44	M	5290	28	5.3
	F	5889	21	3.6
	T	11179	49	4.4
45-54	M	4328	44	10.2
	F	4794	15	3.1
	T	9122	59	6.5
55-64	M	3146	50	15.9
	F	3474	15	4.3
	T	6620	65	9.8
65+	M	2231	25	11.2
	F	2385	13	5.5
	T	4616	38	8.2
Total	M	30399	182	6.0
	F	33678	92	2.7
	T	64077	274	4.3

Based on symptom screening in the entire sample

two readers and sputum was negative by smear and culture. The overall prevalence of abacillary X-ray cases was 17/1000 (Table 3). The prevalence of abacillary cases increased with age (P<0.001) upto the age group 55-64 years and was twice (P<0.001) as high among males (22.6/1000) compared with females (11.8/1000) (Table 3).

Field of cases by bacteriological examinations

Table 4 gives the age-sex distribution of symptomatics and the case yields by different bacteriological examinations. The yield of cases from spot sputum specimens from symptomatics on ZN microscopy, as recommended in DTP, is shown while the 70 cases diagnosed after X-ray examination of the asymptomatics are not presented. Besides, each subsequent column gives the additional cases detected by that method not detected by the preceding method. Thus, 79 out of total of 274 cases (28.8%) were detected by ZN microscopy of spot specimens, 33 additional cases (12.0%) came from overnight specimens meaning that ZN microscopy detected only 40.9% of the total infectious cases (112 out of 274), 49 additional cases (17.9%) were detected through fluorescence microscopy while 113 (41.2%) cases were detected on culture, and were negative by smear. This pattern was similar in all the age-sex groups , except for 15-24 years age group.

A quality check was undertaken in the TRC

Table 3. Distribution of radiologically active cases according to age and sex among persons x-rayed

Age (years)	Sex	No.* X-rayed disease	No. with radiological	Rate per 1000
15-24	M	3408	7	2.1
	F	3842	15	3.9
	T	7250	22	3.0
25-34	M	2670	23	8.6
	F	3042	15	4.9
	T	5712	38	6.7
35-44	M	2098	37	17.6
	F	2418	39	16.1
	T	4516	76	16.8
45-54	M	1746	68	38.9
	F	1947	36	18.5
	T	3693	104	28.2
55-64	M	1217	75	61.6
	F	1363	25	18.3
	T	2580	100	38.8
65+	M	879	64	72.8
	F	855	29	33.9
	T	1734	93	53.6
Total	M	12018	274	22.8
	F	13467	159	11.8
	T	25485	433	17.0

* Excluding 124 persons who were absent for sputum collection and 203 sputum positive cases.

Table 4: Distribution of cases by various methods of bacteriological examination according to age and sex

Age (years)	Sex	No. examined for		Number sputum positive					
		Symptom	Sputum	ZN (sp)	ZN (ov)	FI (sp)	Fl (ov)	S - C +	Total Cases
15-24	M	8712	835	2	3	4	1	1	11
	F	9653	619	3	1	1	1	6	12
	T	18365	1454						23
				(21.7%)	(17.4%)	(21.7%)	(8.7%)	(30.4%)	(100.0%)
25-44	M	11982	1655	13	8	4	5	22	52
	F	13372	1652	9	3	2	4	19	37
	T	25354	3307	22	11	6	9	41	89
				(24.7)	(12.4)	(6.7)	(10.1)	(46.1)	(100.0%)
45-64	M	7474	1482	34	11	6	7	36	94
	F	8268	1079	7	2	6	2	13	30
	T	15742	2561	41	13	12	9	49	124
				(33.1)	(10.5)	(9.7)	(7.3)	(39.5)	(100.0%)
65+	M	2231	450	6	4	2	2	II	25
	F	2385	260	5	1	I	1	5	13
				11	5	3	3	16	38
	T	4616	710	(28.9)	(13.23	(7.93)	(7.1)	(42.1)	(100.0%)
Total	M	30399	4422	55	26	16	15	70	182
	F	33678	3610	24	7	10	8	43	92
	T	64077	8032	79	33	36	23	113	274
				(28.8)	(13.0)	(9.5)	(8.4)	(41.2)	(100.0)

Figures in bracket indicate percentage to the total cases in that age group

ZN = Ziehl Neelsen FL = Fluorescence SP = spot OV = overnight S = smear C = culture

laboratory on all positive smears and a random sample of negative smears received from field laboratory. The proportions of positives as obtained in either laboratory were not different. showing that the standard of field laboratory was good.

Relationship of bacillary positivity to duration of cough

The yield of bacillary cases according to nature and duration of symptoms is shown in Table 5. It is seen that 211/274 cases (77.0%) came from those who had cough : 37.2% from those with duration 2 weeks to 6 months and the remaining with duration of more than 6 months. Sixty three (23.0%) cases did not have cough but had chest pain (20.4%) or some other symptoms (2.6%).

DISCUSSION

The present sample survey was the second cross sectional sample study carried out by our Centre to estimate the prevalence of bacteriologically positive and radiologically active cases among the population aged 15 years and above, as well as the prevalence of tuberculosis infection in children. The first survey' was conducted in Raichur district of Karnataka where inquiry for symptoms was the screening method used. In the present study, the entire sample was similarly screened but, additionally, one-third of the sample was covered by X-ray examination also. This was done to reduce the work load of subjecting all the people to X-ray examination. keeping in mind that prevalence of radiologically active cases is about 3 times that of bacteriologically positive cases. Besides, the study included prevalence of infection in children as it is considered to be the tool for assessing the tuberculosis situation in 3 community.

The proportions of children without BCG scar considered infected ($\geq$ 14 mm) were 2.8% and 7.6% in the 0-4 and 5-9 years age groups respectively.

Table 5. Distribution of sputum positive cases according to symptom duration and nature of positivity

Symptom	Sputum Examined		Sputum Positive			Total	
	No.	%	S+C+	S+C-	S-C+	No.	%
Cough							
14 days - 6 m	2548	31.7	51	16	35	102	37.2
> 6 months	2384	29.7	52	21	36	109	39.8
Cough (all)	4932	61.4	103	37	71	211	77.0
Chest Pain (without Cough)	2790	34.7	4	16	36	56	20.4
Fever (without Cough & Chest pain)	69	0.9	0	0	2	2	0.7
Others	241	3.0	1	0	4	5	1.8
Total	8032	100.0	108	53	113	274	100.0

S = Smear C = Culture

The infection rates (≥ 12 mm in these age groups in Tumkur survey[8] conducted in 1961 were 2.5% and 13.1 % respectively, while the rates (≥ 14 mm) in a repeat survey in the same area after twelve years were 2.9% and 11.9% respectively. A.K. Chakraborthy[9] had observed rates of 2.1% and 5.7% respectively in a Bangalore rural population taking 10 mm as the cut off point for defining infection.

In the Chingleput Trial[10], the proportions of children who were considered infected using PPD-S were 5.1% and 14.9% respectively in the age groups 1-4 and 5-9 years.

Overall, 61% (4,932 out of 8,032) of the symptomatics reported cough as symptom , of whom about 50% had durations ≥ 6 months, yielding 77% of sputum positive cases, in the study. The corresponding proportions for chest pain were 35% and 20% respectively showing the relative importance of cough as against chest-pain for screening populations for detection of tuberculosis. The relative importance of cough for purpose of screening has been stressed by Baily et al[3] and Gothi et al[6] as well as in the Centre's Raichur Survey[7] . The optimum duration of cough was more than a year in 43% (211/274) cases diagnosed from symptomatics reporting cough as symptom.

The prevalence of bacteriologically positive tuberculosis based on symptom screening in the North Arcot district, after adjusting for stratification, was estimated to be 4.2 (95% CI; 3.7-4.7) per 1000 population, aged 15 years and above. However, in the Nelamangala taluk of Bangalore district, among population aged 5 years and above, chest X-ray and/ or symptom[6] screening showed the prevalence rate of sputum positive cases to be 2.1 per 1000 compared with 1.82 per thousand in the sample survey conducted in Wardha district[11] , during 1982-88. In the Raichur district of Karnataka, where symptom elicitation was the only screening method used for detection of the disease, the prevalence rate was 10.9 per 1000 in population aged 15 years and above[7].

The estimated prevalence of the disease based on X-ray and symptom screening was 7.9 per 1000 (95% CI; 6.8 to 9.0) in the present study; the prevalence based only on X-ray examination was 5.6 per 1000 population. The prevalence rate of bacteriologically positive disease observed in NSS[1] varied from 2 to 8 per 1000 while Gothi *et al*[6] reported an average prevalence rate of 3.2 per 1000 population but observed that addition of symptom screening did not improve the prevalence rate; In the Chingleput trial[10], the prevalence was 10.8 per 1000 among those aged 10 years and above; Goyal

Table 6-a. Prevalence rate of bacteriologically positive pulmonary tuberculosis in previously reported studies according to various criteria

Study	Rural/ urban	Period of study	Age (years)	Screening method used	Prevalence* per 1000
New Delhi[4,12]	Urban	1962	5+	X-ray	4.0
		1977	5+	X-ray	3.2
Tumkur[2,8]	Rural	1961	10+	X-ray	4.1
		1973	10+	X-ray	4.4
Bangalore[6]	Rural	1975	5+	Symptom & X-ray	3.2
				Symptom	2.1
Chingleput[10]	Rural	1968-71	10+	X-ray	10.8
Madanapalle[15]	Semi-Urban	1961	15+	X-ray	9.3
		1968	15+	X-ray	9.8
Bangalore[9]	Rural	1961	5+	X-ray	4.0
		1977	5+	X-ray	4.9
Wardha[11]	Rural	1982-88	5+	Symptom	1.8
Bangalore[14]	Rural	1984-86	10+	Tuberculin Test	4.4
Raichur[7]	Rural	1988-89	15+	Symptom	10.9
North Arcot (Present Study)	Rural	1989-90	15+	Symptom	4.3
			15+	Symptom & X-ray	7.9

Table 6-b. Prevalence rates of infection in children in previously reported studies according to various criteria

Study	Period of study	Cut-off level (mm) to define infection	Prevalence of infection rate	
			0-4 years	5-9 years
Tumkur[2,8]	1961	≥ 12	2.5	13.1
	1973	≥ 14	2.9	11.9
Bangalore[9]	1961	> 10	2.1	5.7
	1977		1.5	6.0
Chingleput[10]	1968-71	≥ 12	5.1	14.9
North Arcot (Present Study)	1989-90	≥ 14	2.8	7.6

*Smear and/or Culture

et al[12] reported prevalence rate of 4.0 per 1000 bacteriological positivity in the first survey conducted in 1962 and 3.2 per 1000 in the resurvey conducted in 1977, based on X-ray screening among Persons aged 5 years and above; Gothi et al[8] reported the prevalence rate of 4.1 per 1000 in Tumkur district and observed no appreciable change in the overall prevalence rate there, among persons aged 10 years and above, over a period of 12 years (4.4 per 1000 in 1973); the prevalence rate remained

unchanged among 5 years and older people in five surveys[9] *viz.,* 3.96 to 4.92 per 1000 from first to fifth survey conducted during 1961-77 in a rural population of Bangalore district while in another study[14] conducted in rural Bangalore district during 1984-86, using tuberculin testing as the screening method, the prevalence rate observed was 4.4 per 1000 population among those aged 10 years and above. In a study[15] of the effect of domiciliary treatment in a rural community (Madanapalle in south India) the prevalence of bacillary tuberculosis observed in the treatment group was 9.3 and 9.8 per 1000 population aged 15 years and above, initially and at the end of the survey (1961 and 1968). The prevalence rate of radiologically active tuberculosis was 17.0 per 1000; the rate showed an increase with increase in age. A similar rate of 16.7 per 1000 population aged 15 years and above was observed in Chingleput trial[10]. It will be appreciated that all the surveys reviewed in Table 6-a and 6-b were not uniform and hence not strictly comparable. The disparity in prevalence rates reported, perhaps, reflects either different tuberculosis situations or the varying methodology used. Hence, the use of the observed rates for purposes other than epidemiology has to be considered with great care.

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