

PREVALENCE AND DETERMINANTS
OF TUBERCULOUS INFECTION
IN CHILDREN IN BALE REGION

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Prevalence and Determinants of Tuberculosis
Infection in Children in Bale Region

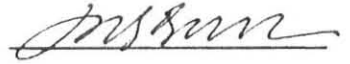
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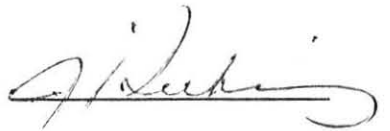
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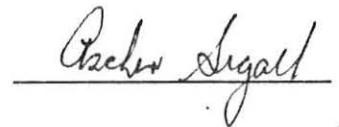
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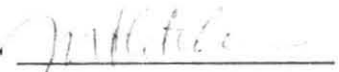
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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
SUMMARY	viii
INTRODUCTION	1
LITERATURE REVIEW	5
MATERIALS AND METHODS	11
RESULTS	16
DISCUSSION	30
CONCLUSIONS AND RECOMMENDATIONS	35
BIBLIOGRAPHY	36
ANNEXES	
ANNEX 1	38
ANNEX 2	39

LIST OF TABLES

TABLE I	Characteristics of Surveyed Children	18
TABLE II	Prevalence of PPD Positivity By Age Group	22
TABLE III	Prevalence of PPD Positivity By BCG Scar	24
TABLE IV	Prevalence of PPD Positivity By Exposure to Cattle	25
TABLE V	Prevalence of Tuberculosis Infection By Sex	26
TABLE VI	Relationship of BCG Scar With Age	27
TABLE VII	Relation of BCG Scar with Exposure to Cattle	29

LIST OF FIGURES

FIGURE 1. Frequency Distributions of Diameters Induration of BCG Scar positive Children	20
FIGURE 2. Frequency Distributions of Diameters Induration of BCG Scar negative Children	21
FIGURE 3. Percentage Distribution of PPD Positivity	23
FIGURE 4. Percentage Distribution of BCG Scar in Each Age Group	28

SUMMARY

The determination of the prevalence of tuberculosis infection within age groups and the relation of infection to factors under study, i.e., previous BCG vaccination, raw milk consumption, and intimate exposure to cattle were evaluated in a cross-sectional community-based tuberculin skin test survey, and case-control analysis of the relation of infection to the factors under study in Mendeyo Awraja, Bale region (south-east Ethiopia), in children 6 months to 15 years of age. A survey consisting of an interview, examination of BCG scar on the right shoulder, and tuberculin skin testing and reading was conducted on 1892 children, identified by systematic household survey from ten randomly selected peasant villages in Mendeyo Awraja.

Out of the total 1892 children surveyed 1002 (53%) were males and 890 (47%) were females. 1028 (54.3%) had a BCG scar and 864 (45.7%) had no BCG scar; the prevalence of tuberculosis infection in these groups was 11.8% and 15.3% respectively. The overall prevalence of tuberculosis infection was 13.4%. The mean age of the surveyed children was 6 years. Prevalence of infection was low in infants and children under 5 years of age and increases with age, being high in 12 to 15 years old. There was a significant association between infection and previous non-BCG vaccination, and intimate exposure to cattle, as determined by chi square statistics ($p < .05$). There was no significant association between infection and raw cow's milk consumption ($p > .05$).

The average annual risk of infection as calculated from the results of the study in non-vaccinated children was 2.73%. Incidence of smear-positive pulmonary tuberculosis cases was calculated to be about 397 cases per 290,000 population (the settled awraja's population). The study has enabled us to determine the annual risk of infection and incidence of smear-positive pulmonary tuberculosis cases in the community (awraja).

INTRODUCTION

Tuberculosis is a disease that has long been an associate of man. However, it is only recently, during the last century that major breakthroughs have been made in its control. The causative agent, *M. tuberculosis*, was discovered in 1882 by Robert Koch. Bacillus-Calmette-Guerin (BCG) vaccination was only introduced sixty nine years ago, and effective chemotherapy has been introduced for a little over 35 years. World wide rates, particularly in the developed countries, decreased long before the advent of effective antibiotics, indicating the major role of socioeconomic factors in the occurrence of the disease. Yet tuberculosis today remains a major health problem in all developing countries.

According to the World Health Organization, in 1967 there were over 3.8 million cases, which corresponds to more than 100 cases of pulmonary tuberculosis per 100,000 population globally. By 1977, ten years later, there were estimated to be about 4 to 5 million cases of smear positive and about 4 million cases of smear negative². By 1982 there were between 15 - 20 million cases of active tuberculosis worldwide with an annual incidence rate of about 10 million and 3 million deaths yearly .³

The incidence of infection depends on the prevalence of the sources of infection, with on average ten people infected during one year by one unknown smear-positive case of pulmonary tuberculosis. With as few as one-third of smear-positive cases being currently diagnosed in developing countries, the actual number of cases in these countries is much greater

than reported and is increasing quickly. The incidence of risk of infection is the best indicator to evaluate the tuberculosis problem and its trend. In areas with low access to health services, poor diagnosis and inadequate reporting, risk of infection continues to be the best parameter.

For countries in which notification is unreliable, determination of the annual risk of infection is often used to indicate the extent of the health problem. This index, which is derived from tuberculosis surveys of representative population samples who haven't been vaccinated, indicates the proportion of the population which has been infected or reinfected with the tubercle bacilli in the course of one year . ⁴From the calculated annual risk of infection, the incidence of smear-positive pulmonary tuberculous cases in a given year can be calculated. Tuberculin skin test surveys therefore are used as a basis for determining the magnitude of the problem and trends over time.

In Ethiopia, despite under diagnosis, tuberculosis is among the top ten diseases, which are reported from outpatient visits in 1984, and the second leading cause of hospitalization during the same year . ⁵Analysis of more than 6200 hospital deaths revealed that tuberculosis was the most common cause of death in 1984 . ⁶

For the 330,000 people in Mendeyo awraja, Bale region, the disease remains a major public health problem. According to 1987 data from the one hospital and two health centers, tuberculosis stood among the leading causes of morbidity in the district . ⁷The Regional Integrated Basic Services survey carried out in Bale region by UNICEF in 1986 revealed that

tuberculosis was the fourth most common cause of illness in the region⁸.

To determine the magnitude of tuberculosis in children in the awraja, a tuberculin skin test survey was conducted on a representative sample of children aged 6 months to 15 years of age. Prevalence was determined, using PPD positivity as an indication of TB infection. Children between 6 months to 15 years, both those who had BCG vaccination and those who had not been vaccinated were included. In addition, an attempt was made to estimate the relation between infection, previous BCG vaccination, consumption of raw milk, and intimate exposure to cattle as defined by living in a room with them.

OBJECTIVES

The objectives of this study are: one, to determine the prevalence of tuberculosis infection by year of age group, and see the change or increase within age groups in children 6 months to 15 years of age. Analysis of factors under study are: previous BCG vaccination, consumption of raw cow's milk, and intimate exposure or living in a room with cattle, which may be related to infection rates.

LITERATURE REVIEW

Tuberculosis has been known as a disease since 1000 B.C. Despite being a serious disease with a known natural history, and available effective therapy, the disease still remains a major health problem, one of the leading causes of morbidity and mortality in the developing countries .⁹

The concept of a comprehensive tuberculosis control program on a country-wide scale was introduced by the WHO Expert Committee on Tuberculosis in 1964. Much effort and resources have since been invested in the implementation of the recommended control program policies . Yet progress in developing world countries remains slow in both controlling current disease and decreasing the number of new cases.

Bulla has attempted to estimate the worldwide incidence of tuberculosis based on the available morbidity and mortality recording and reporting systems in the world. According to his estimates and extrapolations, the world wide incidence of tuberculosis was over 3.8 million cases in 1967 and more than 3.5 million in 1971, with about 600,000 deaths. The majority of the morbidity and the mortality was in the developing countries .¹

Six years later, in 1977, the incidence of smear-positive pulmonary tuberculosis was calculated to be 24 per 100,000 in Europe, 7 per 100,000 in the U.S.A and Canada, 165 per 100,000 in Africa, 80 per 100,000 in Latin America, and 110 per 100,000 population in Asia excluding China. Four to five million cases of smear-positive pulmonary tuberculosis, and

almost an equal number of smear-negative cases, with 2 and 3 million deaths have been estimated in 1977³.

Four years later in 1981, the global yearly incidence of tuberculosis cases was estimated to be 4 to 5 million and the prevalence to be about 10 million.

Such figures do not truly reflect the actual situation of the problem as reporting and recording is not complete in the developing countries. Yet the data reveals how grave the tuberculosis problem is in developing countries. The complex interaction of malnutrition, poor sanitation, bad housing and underdevelopment that prevails in developing countries is likely to allow the problem to continue at least for the foreseeable future.

In the developing countries, where the notification of tuberculosis cases and data on morbidity and mortality are unreliable, the annual risk of infection rate is often used to indicate the prevalence of tuberculosis infection in a community and can be established relatively accurately from prevalence surveys using tuberculin skin tests.

In a survey carried out in South India from 1969 to 1971 in all age groups, 49.9% were found to be positive reactors to tuberculin. In 1971, a survey conducted in all age groups in east central Nigeria, showed the prevalence of tuberculosis infection to be 27.4%. Age specific rates in both countries were approximately equal. ¹⁰

Tuberculin skin test surveys carried out in various parts of Africa

in children 0 to 9 years old have revealed rates as high as 23.6% in urban Sierra Leone and as low as 6.3% in rural Zanzibar, with 11.2% rural and 10.8% urban in Gambia, 15.4% rural and 14.9% urban in Ghana, 9.7% rural and 8.1% urban in Kenya, 8.0% rural and 9.2% urban in Liberia, 19.0% in rural Sierra Leone, and 10.0% in urban Zanzibar .⁹

While it was suggested that the prevalence of tuberculosis infection is constantly higher in urban areas than in rural areas in developed countries, the difference between urban and rural areas with regard to the prevalence of infection is variable, with most African countries showing little difference .¹⁰

In many developing countries the annual risk of infection is estimated to be in the range of 2 to 5 % .¹¹ For every 1% risk of infection, there are about 50 smear-positive pulmonary tuberculosis cases per 100,000 population.

While success in control programs can be followed by serial determination of risk in infections over time, it has been done relatively rarely in developing countries. In African countries where temporal trends have been followed, such as Lesotho, Uganda and Morocco, the annual risk of infection remained high at 3% in Lesotho, and 2.3% in Uganda even after 8 to 12 years. Morocco was one exception, reporting a decrease in a rural area from 3.1% in 1950 to 2.3% in 1971 and a decrease from 4.8% in 1950 to 1.6% in 1971 in Kenitra city was observed¹¹.

In Ethiopia several tuberculin skin test surveys have been done to determine the magnitude of tuberculosis infection in various communities,

since 1938 . ¹²The annual risk of infection in Ethiopia excluding Addis Ababa was estimated at 3% in 1988 or 150 to 180 new sputum-positive cases of pulmonary tuberculosis per 100,000 population per year. Such a rate is equivalent to at least 70,000 new pulmonary tuberculosis cases for 1988 in a total population of 46 million . ¹³

A 1938 survey in Shoa region carried out in the 5 to 12 year age group of children showed the prevalence of tuberculosis infection to be 28.2% . ¹³A survey conducted by D'Archangelo from 1940 to 1943 on 700 children of all ages, in nine regions of Ethiopia in rural and urban communities reported tuberculosis infection to be as high as 71.8% in rural Dire Dawa and as low as 25.8% in rural Sidamo . ¹²

The only Tuberculosis Control Campaign was launched in Ethiopia from 1953 to 1955, when a total of 600,000 children were vaccinated with BCG all over the country. At the same time, Mantoux testing was carried out among more than half a million people between the ages of 0 to 20 years, in the eleven regions of the country. All regions except Bale, Gamo Gofa, and Illubabor were covered. Overall the positive reactors were about 50%, with a rate of 32.4% in the 7 - 14 year olds .^{12,14}

Ten years later, in 1963 - 64, a survey in 5 to 9 year olds in urban Addis Ababa showed a prevalence rate of 32%, while rural children in the same study had a rate of 22% ¹⁵.

A study carried out by Fuller in 1979 in south western Ethiopia, in children 6 to 10 years of age showed the prevalence of tuberculosis infection to be 23% . ¹⁶

On the basis of the above studies in Ethiopia, determination of the annual risk of infection has been attempted. The calculated risk of infection was estimated to be 3.3% for Shoa region in 1938, 3% for the eleven regions surveyed in 1953-55, 4.5% for Addis Ababa in 1963-64, and 3.5% for Wellega region in 1979. Compared to other countries on the continent, Ethiopia has one of the highest rates of tuberculosis in Africa

. 12

While inhalation is by far the commonest mode of transmission, in areas where there is no pasteurization of cow's milk, and bovine tuberculosis is common, the disease may also be transmitted by ingestion of raw cow's milk. Bovine tuberculosis is an important factor in the epidemiology of tuberculosis. The magnitude of tuberculosis infection in cattle in Ethiopia is not well known. However, the existence of bovine tuberculosis in man is a significant problem in the country . 12

In some parts of the world, the risk of tuberculosis in man has been noted to increase with an increase in tuberculous cattle. In other areas, where there is little cattle tuberculosis, there may still be a high tuberculosis mortality in man, and vice versa. One explanation of these findings is that long term protection against adult infection with human tubercle bacilli may be conferred by bovine infection in childhood . 17

The use of BCG vaccination in preventing tuberculosis was introduced in 1920. BCG has been found effective in preventing severe cases of tuberculosis in children, particularly tuberculous meningitis, septicemia,

and military TB, but it is not generally considered to offer much protection against other forms of TB, although this appears to vary from country to country .¹⁸ In an assessment of the efficacy of BCG vaccination, several studies have been undertaken throughout the world of which the Indian Chingleput district and the Lome (Togo) studies are two examples.

In the South Indian study, those who received BCG had no different incidence of TB disease than those who did not receive BCG, when all forms of tuberculous disease were considered together .²⁰ When this study was reviewed by the S.E. Asian Region Research Study Group Meeting on TB in 1981, it was felt that there might be several reasons why the study failed to show any benefit from BCG. These reasons were:

- 1) there was a high prevalence of environmental mycobacteria in the study area.
- 2) even though there was a high risk of annual infection, about 2%, there were very few cases of tuberculosis arising from such infections.
- 3) the South Indian strain of tubercule bacilli isolated from the patients might indeed be less pathogenic in man. Infection by this strain might give rise to tuberculin conversion but no primary disease.

However, the preliminary results of the survey on BCG efficacy in 0 to 6 years old children born in Lome Hospital, Togo, 1984 have shown that the protection afforded against all forms of tuberculosis, during the first 8 months was as high as 71.8%²¹.

absence of a BCG scar. In the presence of BCG scar, positivity was defined as an area of induration measuring 15 mm. or more in its widest diameter after the intradermal injection of 2 Units or 0.1 ml Purified Protein Derivative (PPD). Readings were done 48 to 72 hours post injection. In the absence of a BCG scar, positivity was defined as areas of induration measuring 10 mm or more in their widest diameter. The 15 mm cut point was set for BCG scar positives in order to exclude skin sensitization due to previous BCG vaccination.

Controls were children selected from the same villages and same age group, but who were Mantoux negatives.

The determination of the sample size required was done for each age group, i.e., 6 months to 3 years, 4 to 7 years, 8 to 11 years, and 12 to 15 years. Based on previous Ethiopian studies, the infection rate was estimated to be between 15 - 30%. A $\pm 5\%$ was set to be a maximum discrepancy between sample and population percentage in infection rate. Alpha was set at 0.05 so that we could be 95% certain that the true population value was within these limits.

Using the formula

$$n = \frac{(Z)^2 (pq)^2}{y^2}$$

where p = estimated true population proportion

y = absolute confidence limits

Solving for n yields:

$$n = (196/5)^2 (1 -) \quad \text{when} \quad = 0.15 \quad n = 196$$

$$= 0.3 \quad n = 332$$

For the analysis of factors in the study, the sample size required was determined for the cases and controls, i.e. PPD positives and negatives. This was based on the following assumptions:

P_1 = probability of exposure to cattle given that PPD positive was assumed to be 0.8

P_2 = probability of exposure to cattle given that PPD negative was assumed to be 0.6.

Then a value of $\alpha = .05$ and $B = 0.2$ was setted. From the table of estimation of sample size, 91 PPD positives and 91 PPD negatives or 91 cases and controls are needed.

If we assume that PPD positives are 15% of the study population then we need 610 children to be surveyed to get 91 positives.

THE SAMPLING TECHNIQUE

(a) First Stage : The list of kebeles and peasant villages in the awraja was taken to form the sampling frame. Of the total of 172 villages, 10 were selected by a random sampling method.

(b) Second Stage : Using an estimation of about 200 households in each of the ten selected villages, a sampling interval was selected to allow about forty household to be visited in each village. Every 5th house was then visited .Thus, a total of approximately 450 children were obtained for each age group. All children within the age group 6 months to 15 years of age,who did not have chronic illnesses, and were permanently living in the selected house were included in the appropriate sample for their age group.

DATA COLLECTION

The pilot phase: - The pilot phase took place during October 1988. 10 interviewers and 2 field supervisors were selected from health assistants in the district health units and were trained for 5 days in the technique of intradermal injection of PPD and of reading the tuberculin skin test, and in administering the questionnaire. Detailed instruction was given to the interviewers

A pilot study was then conducted on 100 children attending the Robe Health Center polyclinic. Results were read and recorded by two different interviewers for each child between 48 to 72 hours after the injection,inorder to educate interviewers on the technique of injecting and reading the test.

The main survey: - Prior to arrival of the field survey team, a letter was sent to the chairperson of each selected village to inform them of the purpose of the study and to seek the cooperation of the leaders of

the village. The field survey was conducted in the 10 randomly selected villages by two teams of five interviewers, each team having one field supervisor. At the time of the initial visit, questions were asked about exposure to a coughing person for at least a month in the past year, consumption of raw milk etc. (see Annex 1), examination of the right shoulder was done for the presence of BCG scar and tuberculin testing was administered on the antevolar aspect of the right forearm. Reading and recording of the size of the skin reaction to PPD was carried out on return visit to the village 48 hours later. Names of subjects who were absent from their home but who were attending school, were recorded and were then traced in their respective schools that day. Children who could not be traced after 72 hours or 3 days were excluded from the analysis.

The survey within the village was conducted with assistance of one village member, usually the village's community health agent. The parents and older children were briefed about the study and were asked to be available during a revisit of the field survey team two days after the skin test. For respondents under the age of 7 years the questionnaire was answered by the mother or father.

RESULTS

A total of 2050 children were tested for tuberculin skin sensitivity. 1892 (92.3%) of the total children surveyed had their results read. The others were unable to be traced.

Overall 13.4% of the children were positive on PPD testing when the 15mm cut-off point is used for BCG-positive children. When the 10mm cut-off is used for all children, the prevalence of PPD positivity is 21.2%.

The characteristics of the 1892 children are summarized in table 1.

The mean reaction size of all the children tested was 13 mm in diameter. The frequency distributions of diameter induration of BCG-positive & BCG-negative children are presented in figure 1 & 2 respectively.

In the bivariate analysis of factors under study, the following factors were found to be significantly different between cases and controls or PPD positive and negative children:

- age of the children.
- BCG scar positivity, and
- living with cattle.

These relationships were true whether a 10mm limit was chosen for all children, or whether the BCG-positive children were given a limit of 15mm.

The results of the comparison of age group by PPD positivity and negativity is presented in table 2.

The percentage distribution of PPD positivity among 1892 children by age group is presented in figure 3.

The result of the comparison of BCG scar positivity by PPD is summarized in table 3, showing that those with a BCG scar are less likely to be PPD positive. However, if the 10mm cut-off is used for all children

the relationship is reversed, with children with BCG scar being more likely to be PPD positive. See table 3b(new table).

Analysis of living in a room with cattle in relation to PPD is shown in table 4.

The following factors showed no significant difference between PPD positive and PPD negative children. Again, this was true whether or not the 15mm cut-off was used for BCG positive children, or whether 10mm was used for all children.

- sex ($p > .1$).

- raw cow's milk consumption ($p > .05$).

- household size ($p > .1$).

- contact history with a coughing person ($p > .05$).

The prevalence of PPD positivity by sex is summarized and presented in Table 5.

To determine the strength of the associations among statistically significant variables, odds ratios and 95% confidence intervals were calculated.

A strong association was found in the following factors

- age.

- living with cattle.

The relationship of the following independent variables was calculated to assess covariance:

- BCG scar positivity by age.

- BCG scar by living with cattle.

A summary of the relationship between age and BCG scar positivity is presented in table 6.

Percentage distributions of BCG scar positivity in each age group is also presented in figure 4.

It was thought that not having a BCG scar and living in a room with cattle might both represent the very poor. BCG scar by cattle was therefore cross tabulated. There was no significant difference observed. The result of the analysis is presented in Table 7.

Calculated annual risk of infection among non-vaccinated children is 2.73%. See Annex II.

Incidence of smear-positive pulmonary TB cases as calculated from the annual risk of infection is estimated to be 137 cases per 100,000 population, or 397 cases per total settled population. This estimation method assumes an equal risk of infection in all age groups.

TABLE 1
THE CHARACTERISTICS OF THE SURVEYED
(Mendeyo Awraja, Bale, 1989)

No	PARAMETER	FREQUENCY	%
1	NO OF CHILDREN	1892	100.0
2	MALES	1002	53.0
3	FEMALES	890	47.0
4	AGE GROUP IN YEARS		
	.5 - 3	460	24.3
	4 - 7	423	22.4
	8 - 11	778	41.1
	12 - 15	231	12.2

(TABLE 1 CONTINUED)

(TABLE 1 CONTINUED)

NO	PARAMETER	FREQUENCY	%
5	HOUSEHOLD SIZE		
	2 - 4	118	6.2
	5 - 7	821	43.4
	8 - 10	723	38.2
	11 +	230	12.2
6	BCG SCAR		
	PRESENT	1028	54.3
	ABSENT	864	45.7
7	CONTACT HISTORY		
	NO	388	20.5
	YES	1504	79.5
8	COW'S MILK CONSUMPTION		
	YES	1304	68.9
	NO	586	31.1
9	RAW MILK		
	YES	794	60.9
	NO	510	39.1
10	LIVE WITH CATTLE		
	YES	574	30.3
	NO	1318	69.7

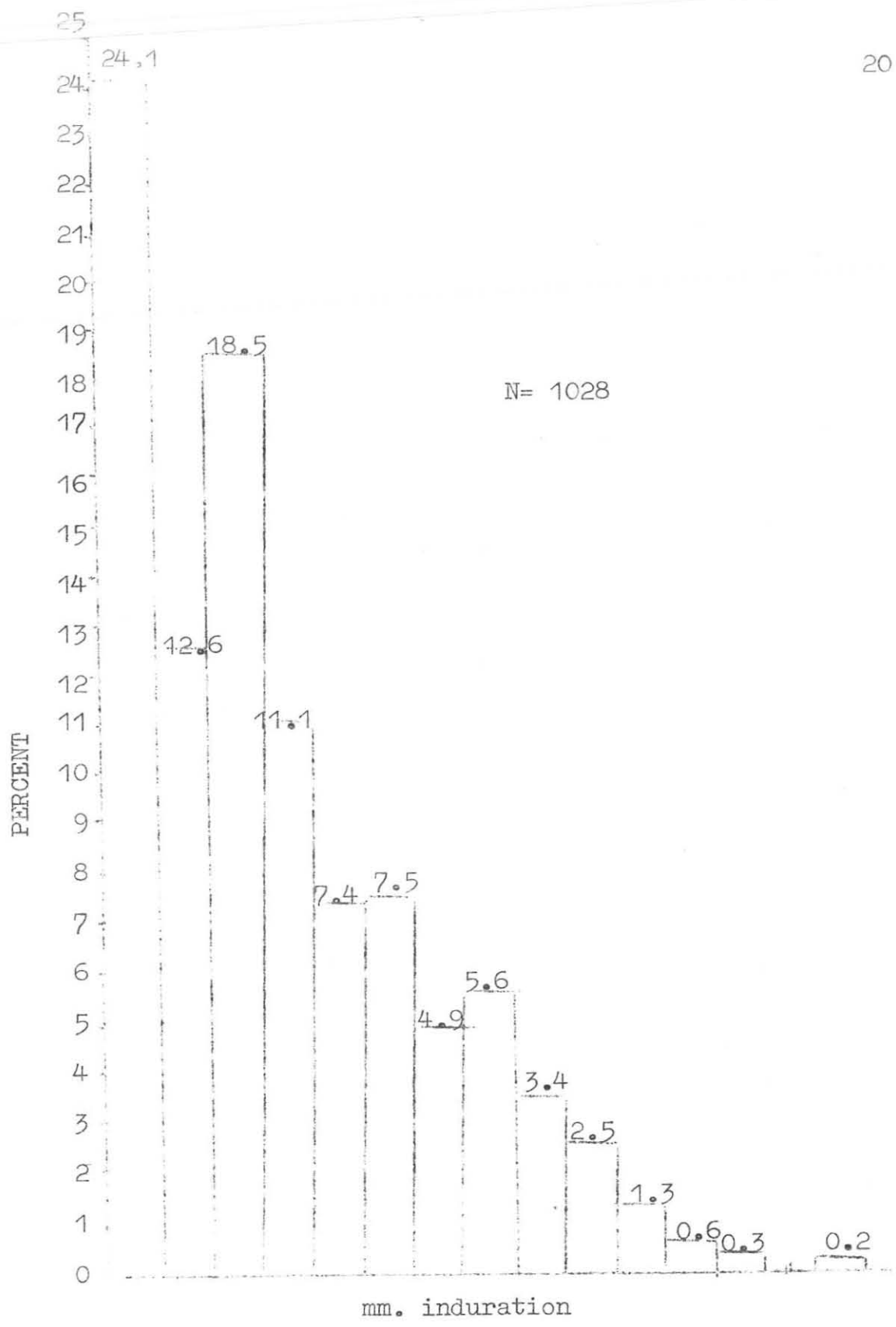


FIGURE 1. Frequency Distributions of diameters induration of BCG scar positive children, 1989.

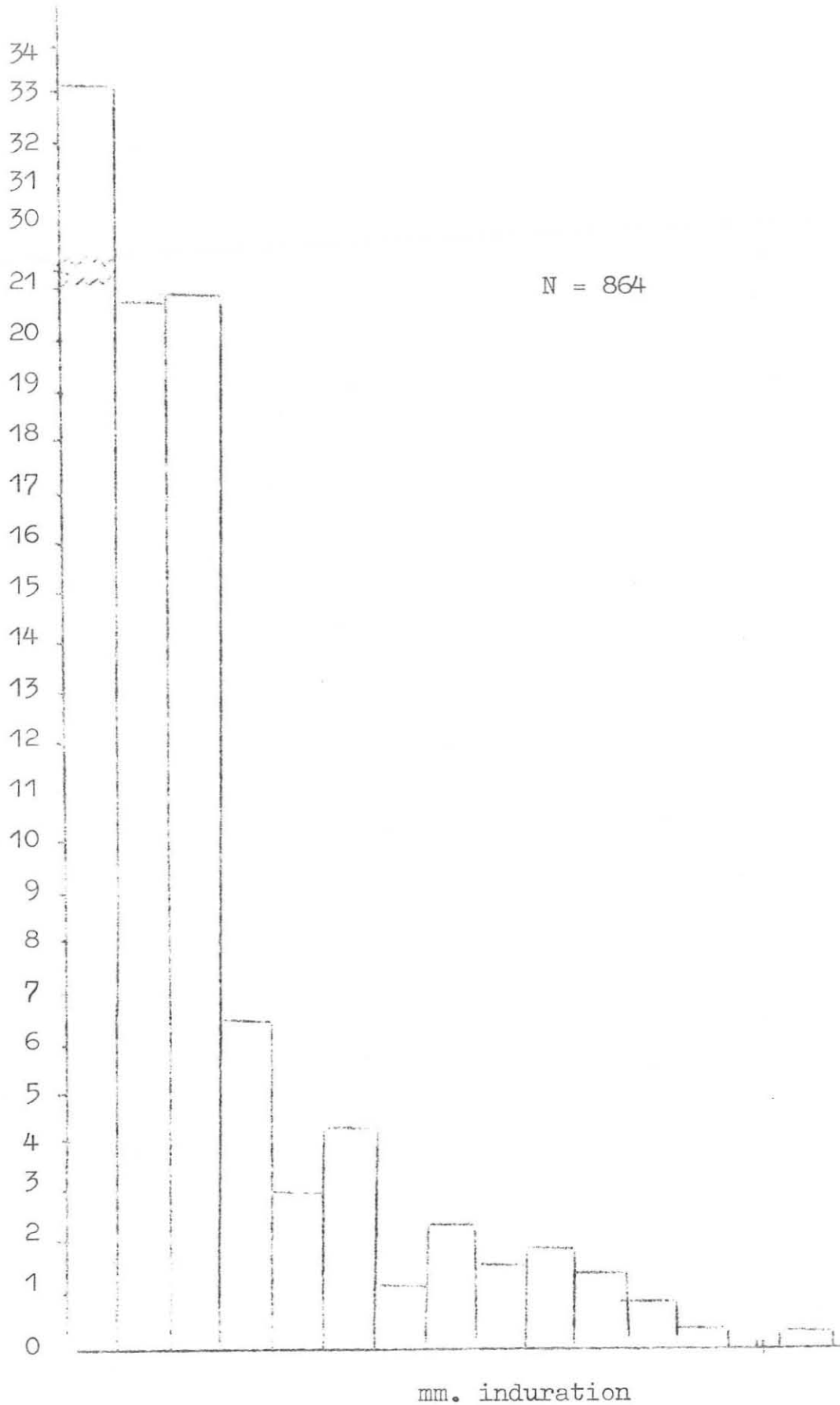


FIGURE 2. Frequency Distribution of diameters induration of BCG scar negative children, 1989.

TABLE 2
 PREVALENCE OF PPD POSITIVITY
 BY AGE GROUP
 (Mendeyo, Bale, 1989)

	+	-	OR
age .5-3	19(7.5%)	441(26.9%)	
group 4-7	38(15%)	385(23.5%)	2.29
in years 8-11	140(55.3%)	638(38.9%)	5.09
12-15	56(22.1%)	175(10.7%)	7.42

2

χ^2 df 3 = 78.9 (p < .001)

(The odds ratios are : the odds of being positive
 compared to the youngest age group.)

A cutt-off 15mm is chosen for children who are BCG positive.

N= 1892

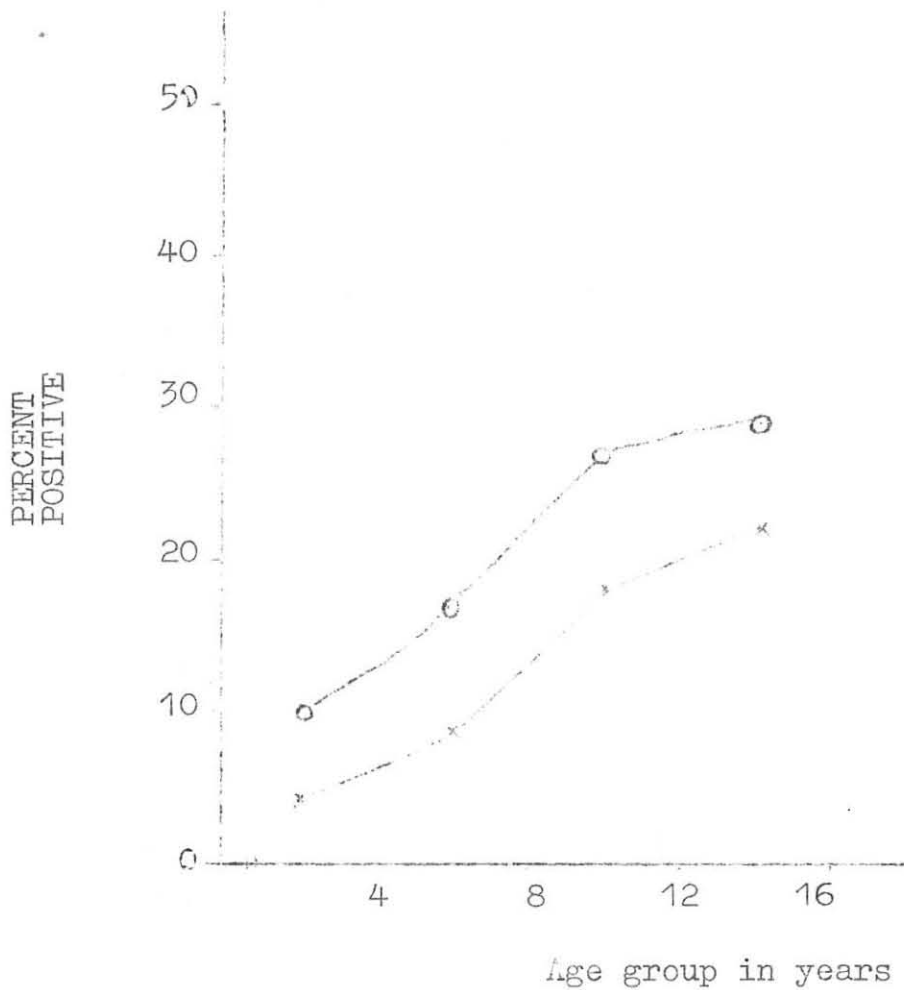
X= using 15 mm cut-off
for BCG positive
childrenO= Using 10 mm cut-off
point for all children

FIGURE 3. Percentage Distributions of PPD positivity among 1892 children. 1989.

TABLE 3a
 PREVALENCE OF POSITIVITY AMONG
 CHILDREN TESTED BY BCG SCAR
 (Mendeyo, 1989)

		INFECTION		
		YES	NO	TOTAL
BCG	YES	121(47.8%)	907(55.3%)	1028(54.3%)
	NO	132(52.2%)	732(44.7%)	864(45.7%)
SCAR		253(100%)	1639(100%)	1892(100%)

2

$$X = 4.71, p < .05, OR = 0.74(.56 - 1)$$

(when using 15 mm cut off for scar positives)

TABLE 3b
 PREVALENCE OF POSITIVITY WHEN USING
 10 MM CUT OFF POINT

		PPD		
		YES	NO	TOTAL
BCG	YES	270(67.2)	758(51)	1028
	NO	132(32.8)	732(49)	864
		402(100%)	1490(100%)	1892

X = 33.8
P < .001

TABLE 4
 PPD POSITIVITY IN RELATION
 TO EXPOSURE TO CATTLE
 (Mendeyo, 1989)

		INFECTION		
		YES	NO	TOTAL
CATTLE	YES	98 (38.7%)	476 (29%)	574 (30.3%)
	NO	155 (61.3%)	1163 (71%)	1318 (69.7%)
		253 (100%)	1639 (100%)	

2

X = 9.24 (P < .01)

OR = 1.54 (1.17 , 2.02) at 95% CI

Odds of being infected, live with cattle.

This uses 15mm as a cut-off for BCG positive children.

Table 5
Prevalence of Tuberculosis infection
in boys and girls

Gendre	No.	No. infected	% infected
Boys	1002	140	14.0%
Girls	890	113	12.7%
Total	1892	253	13.4%

2

$X = 0.66$ ($p > 0.1$)

TABLE 6
RELATIONSHIP OF BCG SCAR WITH AGE

	BCG SCAR		ODDS RATIO
	YES	NO	
AGE			
.5-3	267(26%)	193(22.3%)	
4-7	270(26.3%)	153(17.7%)	1.27
IN			
8-11	403(39.2%)	375(43.4%)	0.77
YEARS			
12-15	88(8.6%)	143(16.6%)	0.40

2

$\chi^2_{d.f3} = 44.4 (p < .001)$

Odds Ratios are the odds of being BCG scar positive as compared to the youngest age group.

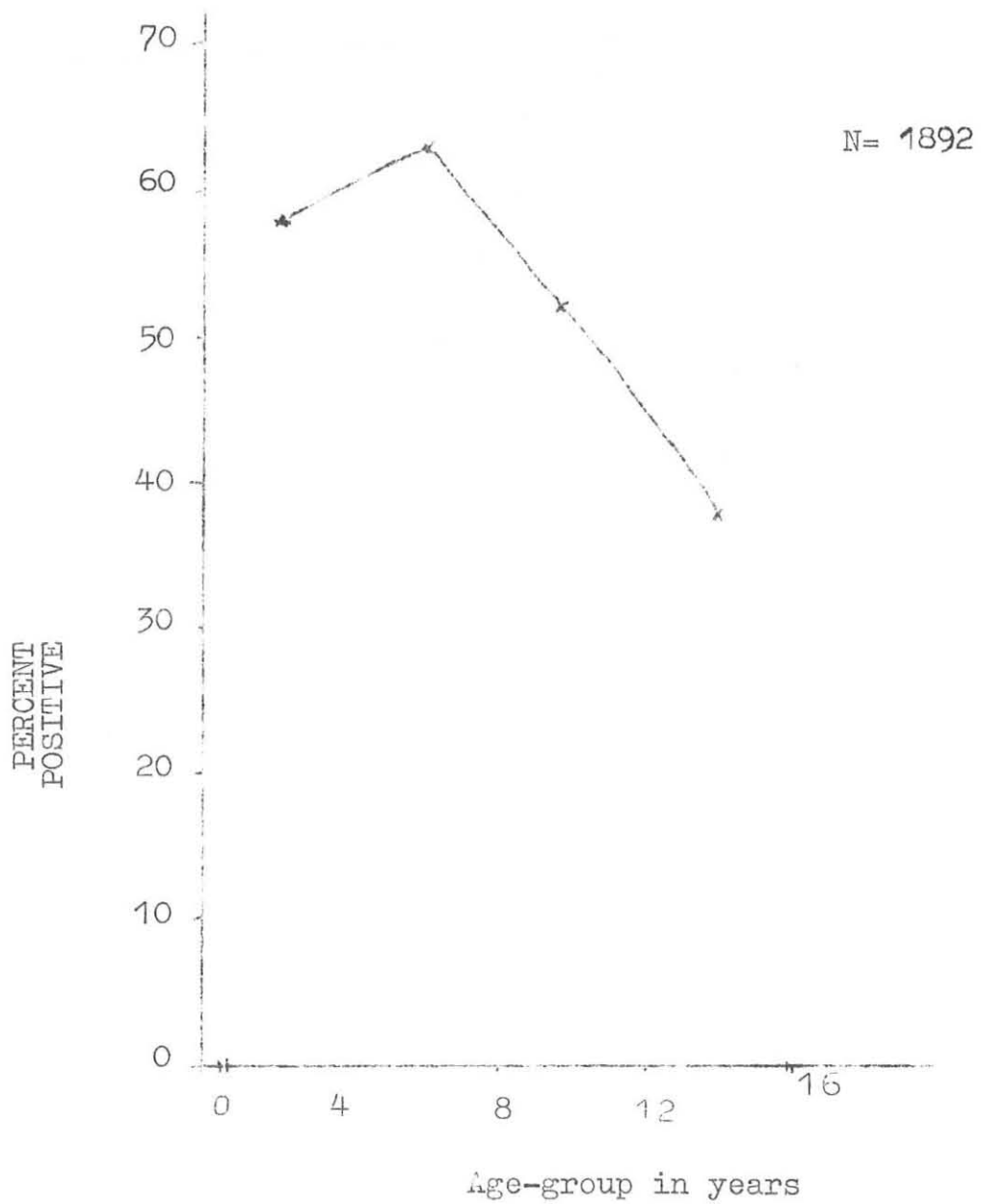


FIGURE 4. Percentage Distributions of BCG scar in each age group. 1989.

TABLE 7
RELATION OF BCG SCAR WITH
EXPOSURE TO CATTLE
(Mendeyo, 1989)

		BCG SCAR		
		YES	NO	TOTAL
CATTLE	YES	294(28.6%)	280(32.4%)	574(30.3%)
	NO	734(71.4%)	584(67.6%)	1318(69.7%)
		1028(100%)	864(100%)	1892(100%)

2

 $\chi^2 = 3.22 (P > .1)$

OR = 0.84 (0.69 , 1.02) at 95% CI

DISCUSSION

Surveys of the prevalence of tuberculin sensitivity in defined populations have been used in the determination of annual risks of infection, being based on a mathematical model²². However, this may pose a problem in populations where BCG vaccination is widely practiced. In such places selective analysis of those individuals without BCG scars may be used.

In the determination of the prevalence of tuberculin sensitivity, there exists an uncertainty associated with the interpretation of tuberculin tests in individuals with a past history of BCG vaccination. The determination of significant reactions from those non significant ones may create difficulty²².

The distinction between reactions representing tuberculous infection and cross-reactions is not precise. In general, the larger the reaction, the greater the probability that the reaction represents infection with *M. tuberculosis*²³. For individuals without BCG scar, the cut-off point of 10 mm induration is accepted. However, individuals with previous BCG vaccination need caution in interpretation of their results. Because of the difficulties of choosing a cut-off point for PPD positivity in BCG vaccinated children, analyses of the results was also done using 10mm as the cut off for children both with and without BCG vaccination. The difficulties in choosing a cut off point have been reviewed by Young et al in 1988²².

In this study, a prevalence rate of 13.4% in children 6 months to 15 years of age was found. This was achieved on the basis of selective

analysis for those with BCG scar and without BCG scar. Two different cut-off points were set for them. It could be argued that particularly in older children, 15 mm is too high a cut off. To the extent that this is true, this study underestimates the true prevalence of TB infection.

A prevalence rate of 13.4% positive reactors found in this study in children aged 6 months to 15 years is comparable with figures from other countries in Africa and some previous studies in Ethiopia. For example, the percentage of reactors to tuberculin in East Central Nigeria among all age groups was reported to be 27.4% in 1971¹⁰. The higher rate is attributable to the fact that the study population consisted of all age groups.

The result of studies carried out in Gambia and Ghana, which revealed prevalence rates of 11.2% and 15.4% respectively among children aged 0 to 9 years of age in 1964 is also compatible with the present study¹⁰.

The result of a study carried out in south western Ethiopia in 1979, among children between the ages of 6 to 10 years revealed a prevalence rate of tuberculosis to be 28%¹⁶. When we analyze the present study result by age groups, we have shown lower results.

The calculated annual risk of infection from the prevalence survey the present study is comparable with the annual risks of infection in other African countries. In Upper Volta, the annual risk of infection in 1967/68 among children aged 1.5 to 5 years was 2.9%, and in Libya it was 2.3% among children between the age of 0 to 4 years during 1959/60¹². Although, there are differences in the study population, one may compare these figures with the result of the present study.

The association between tuberculin sensitivity and age, that is low tuberculin sensitivity in younger age groups was also consistent and supported by other studies ^{10,22}

High coverage of BCG vaccination has been demonstrated among the total 1892 children surveyed, which shows a widely practiced immunization activity in controlling the disease. In the analysis of BCG scar positivity in each age group, a higher coverage of BCG vaccination was observed among children aged 4 to 7 years, which was a result of a single antigen vaccination campaign carried out by Norwegian Church Aid in the region five years back.

As in the present study, in most populations studied previously there was little differences between the sexes in the frequency of tuberculin reactors during childhood . ¹⁰

Although, traditionally overcrowding has been implicated as one of the factors that predispose to the development of infection, no statistically significant association was observed between infection and household size in the present study. An explanation for this finding may be cited as follows : It is not overcrowding by itself that predisposes to the development of a disease or infection. There has to be a source of infection, active case discharging tubercle bacilli. It has been clearly indicated that cases with Acid Fast Bacilli negative but culture positives are less likely to transmit the disease . ²⁴

In the present study, we failed to show a statistically significant

association between consumption of raw cow's milk and evidence of infection. However, it is well documented that *M. bovis* is transmitted by ingestion of especially raw cow's milk. It has been documented that in the Netherlands the annual risk of tuberculosis infection was noted to change drastically after 1940 as a result of compulsory milk pasteurization, which may explain in part the contribution of bovine infection in the population.

There was statistically significant association between the rate of infection and intimate exposure or living in a room with cattle as seen in this study . While bovine tuberculosis has been known as a problem in Ethiopia, its true prevalence is unknown and its contribution to tuberculin sensitivity in this study is also uncertain. However, studies carried out in Sweden have revealed that the annual risk of tuberculosis infection in man increases with an increase in the proportion of tuberculosis in cattle¹⁷.

Possible weaknesses in this study findings include limitations in interpretation of tuberculin sensitivity in individuals with previous BCG vaccination, especially in older age groups. By applying this method we hope to increase the sensitivity of the measurement in the present study. To the extent that the cut off point was too high, we increased our specificity at the expense of sensitivity.

CONCLUSION AND RECOMMENDATIONS

This study has demonstrated a high burden of tuberculous infection and exposure in children, starting in early childhood and increasing at least until school age. It has also demonstrated a fairly high coverage of BCG vaccination 54.3% in the surveyed population.

The prevalence rate of infection tends to be significantly associated with intimate exposure to cattle as defined by living in a room with them. This finding may be due to the role of bovine tuberculosis in man. Although the present study failed to show a statistically significant association between consumption of raw milk and infection, the contribution of bovine tuberculosis to the occurrence of human tuberculosis in the community should be further investigated.

On the basis of the above findings of the study, the following recommendations were made :

-BCG vaccination has to be continued as part of controlling the disease, in children at birth, and for those who are tuberculin negative at school entry.

-Early treatment of cases who are smear-positive has to be encouraged.

-Awareness of the community has to be raised by health education about the disease.

vaccination according to the present study was of little order (23%). Although there is a statistically significant association between infection and previous BCG vaccination, the association is of a weak strength and of limited clinical significance.

Possible weaknesses in this study findings include limitations in interpretation of tuberculin sensitivity in individuals with previous BCG vaccination, especially in older age groups. By applying this method we hope to increase the sensitivity of the measurement in the present study. To the extent that the cut off point was too high, we increased our specificity at the expense of sensitivity.

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ANNEXES**ANNEX I QUESTIONNAIRE**

1. Name of the respondent _____ No. _____
2. Sex _____
3. Age _____
4. Place of residence _____
 Wereda _____
 Kebele _____
5. History of contact with a coughing person at least for a month in the past

 year : YES _____
 NO _____
6. Household size of the respondent _____
 1. 2 to 4 persons
 2. 5 to 7 persons
 3. 8 to 10 persons
 4. 11 +
7. Did you drink cow's milk in the past? Yes ___ No ___
8. If yes to question 7,
 Is it : raw _____
 boiled _____
9. Did you live in a room with cattle ?
 Yes _____ No _____

10. BCG scar on the right shoulder

Present _____ Absent _____

11. PPD result in mm _____

ANNEX II

METHOD OF CALCULATION OF ANNUAL RISK OF INFECTION

1. the age range of children tested 6 months to 15 years
2. mean age 6 years
3. Let P be the proportion of T.B. infection in non-vaccinated group
4. i = the average annual risk, then :

probability (not infected in one year) = $1 - i$

probability (infected in 6 years) = $1 - (1 - i)^6$

From three above, proportion of T.b. positives = $1 - (1 - i)^6$

Therefore:

$$1 - p = (1 - i)^6$$

$$p = 0.1528$$

$$1 - .1528 = (1 - i)^6$$

$$.8472 = (1 - i)^6$$

$$(1 - i) = (.8472)^{1/6}$$

$$i = 1 - .9727$$

$$i = .0273.$$

$$i = 2.73\%.$$

በቦሌ ክ/ሀገር ወንድዩ አውራጃ የሰገብ በሽታ ጥናተና ምርምር

መጠን ቅጽ - 1981

ቅጽ የሚሞላው ከግማሽ ዓመት እስከ 15 ዓመት በቻ ለሆኑ ልጆች ነው።


1. የተጠያቂው ስም ከ ነስባት _____
2. ጾታ 1. ወንድ 2. ሴት
3. ዕድሜው በዓመት _____
4. የመኖሪያ ቦታው _____
ወረዳ _____
ቀበሌ _____
5. ቢያንስ ከወር በላይ ከሚያስለጩ ሰው ጋር አብረው ኖረዋል?
በአለፏት አንድ ዓመት ጊዜ ውስጥ
 1. አዎን
 2. አይ
6. በቤት ውስጥ ከሰንት ሰዎች ጋር ይኖራሉ?
/ የቤተሰብ ቦዛት/
 1. ከ2 እስከ 4 ሰዎች ጋር
 2. ከ5 እስከ 7 ሰዎች ጋር
 3. ከ8 እስከ 10 ሰዎች ጋር
 4. ከ11 በላይ
7. የሰዎ ወተት ይጠባሉ? 1. አዎ 2. አይ
8. የሰዎ ወተት ከጠጡ
ጥረ ነው
የረሳ
9. በአንድ ሴት ወይም ከፍለ ውስጥ ከከበ ተኛ ጋር አብረው ይኖራሉ?
 1. አዎን
 2. አይ
10. የቢሲኔስ ክትባት ጠባሳ በቀኝ ተከሻ ላይ
 1. የለም
 2. አለ
11. የፒፒዲ ወርፌ ውጤት በሚሊ ሜትር ከሁለት እስከ ሶስት ቀናት ከተወገ በኋላ _____ ሚሊ ሜትር.

DECLARATION

I, the undersigned, declare that this thesis is my work and that all sources of material used for this thesis have been duly acknowledged.

Name ADEM IBRAHIM, M.D.

Signature



Place Addis Ababa, Ethiopia

Date of Submission April 1989
