

# CHAPTER-IX

## CHAPTER IX CLINICAL FEATURES OF LEPROSY

Disease is by and large the clinical manifestation of various disfunction within the human body. The doctors or medical professionals are mostly concerned in viewing the disease as related to conditions within the body of the sufferer and pay very little attention towards the related environmental phenomena for the occurrence of the disease. Medical geographers on the other hand, are concerned with environmental and behavioural interaction as causes of disease and its spatial distribution depends on the variation in the interaction of agent, host and environment, where agent and host mutually interact, and both concurrently interact within the matrix of the total environment.

Although it does not fall within the purview of the subject matter of medical geography, some knowledge of the clinical features of the disease becomes very essential in order to explore the possible effects of the environment on disease incidence and behaviour.

### **9.1 Brief Description :**

This chapter is therefore an attempt to study in brief, some of the salient clinical features of leprosy that have

to be borne in the mind while undertaking any study connected with this disease.

Leprosy is classified into two types, multibacillary (MB) and Paucibacillary (PB). It is generally agreed that MB cases are the most important source of infection in the community. The common types of MB cases are Mid-borderline (BB), Borderline-Lepromatous (BL), and Lepromatous (LL) leprosy. In case of PB the Common types are as Indeterminate (I), Primary neuritic (PN), Tuberculoid (TT), and Borderline Tuberculoid (BT) leprosy (according to Thangaraj & Yawalker, 1989). The immunity of the body varies according to the type of MB and PB cases of leprosy found in an individual leprosy sufferer.

Since 1941 to cure leprosy, Diaminodiphexyl Sulphone (DDS) drug was used. In the recent times, under multidrug therapy programme introduced in 1982, Dapsone is given along with other drugs like Rifampicin and Clofazimine, in order to get better result in the chemotherapy of leprosy.

As we already know that leprosy is a chronic infectious disease caused by *Mycobacterium leprae*. It principally affects the peripheral nerve and skin. The common nerve either enlarged or thickened at the site of predilection

are Ulnar nerve - wrist and elbow, Median nerve- wrist and forearm, Radial nerve - upper arm, lateral popliteal nerve - just behind the neck of fibula, Posterior Tibial nerve - just behind and above the medial malleolus and facial nerve - over zygomatic bone in facial canal. Infection in the nerve cause anesthesia over the patch site or in the affected part of the body.

The deformities in leprosy are the main cause of socioeconomic debilitation. The word disability and deformity have been used interchangeably while referring to the physical problems in leprosy patients. The deformities in this group are due to the bacterial load of the patient and its local damaging effect on tissues for example, nodulation of the skin, leonine facies, sagging of ear lobules, loss of eye brows etc. Deformities which are produced due to indirect effects of the disease, for example, motor paralysis leading to muscle wasting and contracture, and secondary mutilation due to anesthesia and analgesia of extremities are grouped separately as paralytic and anaesthetic deformities respectively.

The grading of deformity is done according to 1988 WHO criteria in which all visible deformity is classified in

Grade -2 while anesthesia or non visible deformities are classified in Grade - 1.

When a leprosy sufferer in whom treatment is terminated after having completed an adequate course of multidrug treatment subsequently develops signs and symptoms of the disease, either during the surveillance period or there after he is considered to have "Relapsed". The period required for reviewing the sign of relapse in a patient ie, the occurrence of the leprosy patch again after he is made RFT, is called surveillance period. Surveillance period for MB cases is five years and for PB cases is two years after RFT.

#### 9.2 Type of Leprosy cases :

As already noted, there are two types of leprosy cases, viz, infectious - multibacillary (MB) and non-infectious, Paucibacillary (PB) Table 9.1 shows the classification of MB and PB type of leprosy cases among active child and adult cases. They are also related in terms of the hosts resistance power which is an indication of the demographic, social and economic selectiveness of the disease (Which is discussed later).

Table 9.1 : Range of clinical manifestation depending on the infected individual's resistance to leprosy bacilli.

Sr. Host's No. resistance of	Clinical Manifestation of Leprosy	Active Child		Active Adult		Total cases	
		PB	MB	PB	MB	NUMBER	%
1 Excellent	Clinical(no-infection)	-	-	-	-	-	-
2 Good	Non (Sub-clinical infection showing spontaneous regression.	-	-	-	-	-	-
	Paucibacillary(PB) leprosy	-	-	-	-	-	-
3 Fair	Indeterminate (I) primary	59	-	6	-	65	22.4
	Neuritic (PN)	-	-	5	-	5	1.7
	Tuberculoid (TT)	18	-	17	-	35	12.0
	Borderline tuberculoid	9	-	24	-	33	11.3
	Multibacillary (MB) Leprosy						
4 Poor	Mid-borderline (BB)	-	18	-	55	73	25.1
	Borderline-lepromatous(BL)	-	7	-	50	57	19.5
5 Very-Poor/none	Lepromatous(LL)	-	2	-	20	22	8.0
Total		86	27	52	125	290	100.0

Note : The structure of this table is taken from 'leprosy'

for medical practitioners and paramedical workers ed. by  
R.H Thangaraj and S.J Yawalkar (1989), P-26.

It is quite evident from table 9.1 that Indeterminate

(I) type of leprosy constitutes the highest (22.4) percentage and the chance of developing leprosy usually stems from the indeterminate type. Thus this group is at maximum risk of acquiring leprosy. Among these, 90% of cases are among children. Apart from these, 8% of cases are lepromatous type of which 10% are among children. Hence it appears that greater attention needs to be paid to such child cases for preventing the spread of leprosy.

### 9.3 Nature of Treatment :

Table-9.2: Indicates the nature of treatment undergone by leprosy patients. It is evident that 88% have undergone the multidrug therapy (MDT) while the remaining 12% had Diaminodiphenyl Sulphopne (DDS).

Table 9.2 : Type of treatment undergone by sufferers.

Sr. No.	Type of leprosy cases	Treatment undergone				Total cases
		DDS		MDT		
		MB	PB	MB	PB	
1	Active Child cases	1	-	26	86	113
2	Active Adult Cases	4	-	121	52	177
3	Relapse Cases	6	-	25	5	36
4	RFT Cases	38	46	195	165	444
	Total Cases	49	46	367	308	770
	Percentage	7	5	48	40	100

It is apparent that about 12% of the cases are those that have persisted from the period of DDS treatment, ie, from the period prior to 1984. That these cases have been in constant contact with infectious leprosy patients or are not regular in their treatment.

#### 9.4 Side Effect of Drug :

Several medicines are known to have varying degrees of side effects. Medicines used for the cure of leprosy have also shown some adverse effects. The side effects can be judged in two ways. One is subjective, ie., the patient himself complains about the after effects of the drug, while the other is objective, ie., the doctor examines and determines the side effects which are not known to the patient, viz shortness of breath, renal failure and shock, Pupura, acute haemolytic anaemia; Liver failure, high risk of hepatitis etc. While some side effects are bound to be there (such as, administration of 'rifampicin' will always result in red colour of urine), other effects vary from one individual to another.

Table 9.3 : Subjective response to effects of the drug used in the treatment of leprosy among sufferers.



Sr. Side Effect of Drug No.	Active child cases		Active Adult cases		Relapse cases		Total (2)
	MB	PB	MB	PB	MB	PB	
For DAPSONE							
1 Haemolytic Anaemia	-	2	7	1	1	1	12 (11)
2 Agranulocytosis	2	1	2	1	-	-	6 (5.4)
3 Dapsone sensitivity	-	-	-	-	-	-	-
4 Fixed drug eruption	-	-	-	-	-	-	-
For CLOFAZIMINE							
5 Skin change, Viz. discolouration	8	1	20	4	2	1	36 (22.5)
6 Diarrhoea, pain in abdomen	3	-	4	-	1	-	8 (7.2)
7 Change in the eye conjunctival pigmentation	-	-	12	-	2	-	14 (13)
FOR RIFAMPICIN							
8 Flushing or prurition the face and scalp.	-	-	9	2	1	-	12 (11)
9 Pain in the abdomen some time vomiting, diarrhoea.	-	-	-	3	-	-	3 (2.7)
10 Fever, chills, malaise, headache, bone or joint.	-	-	8	11	-	-	19 (17.2)
Total	13	4	62	22	7	2	110 (33.7)

From table 9.3 it is quite evident that from the total 326

active cases traced during survey, only 33.7% (110) had complained about the side effects of the drugs and the rest either did not respond or are not conscious about it. Among the 110 cases 32.5% complained about skin change due to administering of clofazimine, while 17.2% complained

about fever, chills, malaise, headache bones or joint pain when administered with rifampicin, Since information is gathered along with paramedical workers the objective type of side effect of the drug could not be highlighted.

#### 9.5 Differential Diagnosis :

Depending on the infected individual's resistance to the disease (Cell-mediated immunity) rather than on humeral immune status of the patient, leprosy presents an astonishingly broad spectrum of symptomless (eg, no itching) clinical lesion, ranging from a small solitary hazy macule to widespread multiple shiny nodules. As pointed out by Thangaraj and Yawalkar (1989), leprosy presents under various guises and mimics a variety of entirely unrelated diseases. The disease for which leprosy may be mistaken are thus many varied. In the study area in case of atleast 78 (24%) out of the 326 active cases surveyed, there was confusion among the paramedical staff in diagnosing the clinical features of MB and PB cases so due to wrong differential diagnosis some of the cases had been diagnosed as PB when they were actually other skin diseases.

## 9.6 Nerve Involvement :

M. leprae is the only bacilla which is known to infect peripheral nerve. The peripheral nerve consists of sensory, motor and automatic nerve fibres, damage to which results in anaesthesia (loss of sensation), muscle weakness or paralysis and lack sweat and sebum, causing dry skin. Table 9.4 shows the involvement of the nerve in the leprosy patient.

Table 9.4 : Number of cases with enlarged or thickened nerves.

Sr. No.	Type of nerve enlarged or thickened	Active child cases		Active Adult cases		Relapse cases		Total (Zage)
		MB	PB	MB	PB	MB	PB	
1	Ulnar	6	38	28	20	6	2	100 (31)
2	Median	2	16	14	13	-	1	46 (14.1)
3	Radial	3	5	13	6	-	-	27 (8.3)
4	Lateral Popliteal	1	8	18	6	2	1	36 (11)
5	Facial	1	-	5	2	-	-	8 (2.5)
6	Posterior tibial	1	11	11	5	-	1	29 (8.8)
7	Great Aricular	-	-	6	-	1	-	7 (2.2)
8	Cases Afflicted with							
	- 1 & 2 Nerves	5	4	4	-	2	-	15 (4.6)
	- 2 & 3 Nerves	3	2	3	-	1	-	9 (2.7)
	- 1 & 4 Nerves	4	2	2	-	3	-	11 (3.3)
	- 1, 2 & 3 nerv	-	-	2	-	1	-	3 (0.9)
	- 1, 2 & 4 nerves	-	-	5	-	3	-	8 (2.5)
	- 1, 4 & 6 nerves	-	-	4	-	2	-	6 (1.8)
	- 1, 3 & 6 nerves	-	-	3	-	2	-	5 (1.5)
	- 1, 2, 3 & 4 nerves	1	-	4	-	5	-	10 (3.0)
	- 1, 3, 4 & 6 nerves	-	-	3	-	3	-	6 (1.8)
Total		27	86	125	52	31	5	326 (100)

It shows that ulnar nerve is commonly either enlarged or thickened among 31% of leprosy patients followed by median -14% and lateral popliteal -11%. About 22% of the leprosy patients have more than one nerve either enlarged or thickened. Among these, nearly 45% of the leprosy patients had deformities as shown in table 9.5.

Table 9.5 : Classification of deformities /disabilities based on WHO grading.

Grading	Hands and feet	Eye	Total percentage	
Grade 0	-	-	-	-
Grade-I	287	6	293	90
Grade II	32	1	33	10
Total	319(98)	7(2)	326	100

According to table 9.5 there are no leprosy cases under the criteria of Grade 0. But from the total active leprosy cases surveyed, 90% had deformity of Grade-I type and the remaining 10% fall in Grade-II type. 98% of deformities are of the hands and feet, 90% fall in grade -I and the rest 10% fall in Grade-II. Similarly 86% of the deformity of the eyes lie in Grade -I and the remaining 14% in Grade-II. The detail classification of the grade -II

deformity is explained in Table 9.6.

Table 9.6 : Detailed classification of Grade-II deformity.

Grade-II type deformity	Child	Adult	Relapse	Total	%age
FACE					
- Lagophthalmas	-	1	-	1	3
- Mask Face	2	1	-	3	9
- Sagging Face	2	-	-	2	6
- Loss of eyebrow	-	1	-	1	3
- Loss of eyelashes	-	1	-	1	3
- Perforated Nose	1	-	-	1	3
HAND					
- Swallow Hand	1	-	-	1	3
- Contract fingers of Hand	1	1	-	2	6
- Contract Hand	-	1	-	1	3
- Absorption of Fingers	-	1	1	2	6
- Stiff joints of Hands	-	2	-	2	6
FEET					
- Swallow Hand	1	1	1	3	9
- Contract Leg	-	3	-	3	9
- Absorption of Fingers of toes	-	1	-	1	3
- Stiff joints of leg	-	2	1	3	9
- Claw Toes	-	2	-	2	6
- Tropic/Plant Ulcer	-	3	1	4	12
Total	8	21	4	33	100
Percentage-I	24.2	63.7	12.1	-	-
Percentage-II	7.0	12.0	11.0	10.0	-

Note : -Percentage-I is calculated from total deformed

(33) cases.

-Percentage-II is calculated from total Child

(113) cases, Adult (177) cases and Relapse (36)

From the table 9.6 it is quite evident that out of the total 326 total active cases surveyed nearly 10% had deformities. Among these 24.2% was found to be in child, 63.7% among adult cases and 12.1% among relapse cases. Breaking the total cases into groups, viz., child cases (113), Active cases (177) and Relapse cases (36), it is found that the percentage of deformed cases in all the groups is more or less similar being nearly 7% in child, 12% in adult and 11% in relapse caes.

#### 9.7 RELAPSE :

Medical literature indicates that the incidence of relapse decreases with the length of the resolved status, i.e., the longer the activity - free period after withdrawal of therapy, the lesser is the chance of relapse. A similar type of situation is found in this district. Out of total active cases (1515) only 3.5% (53) were found to have relapsed, thus making relapse rate of 0.64.

TABLE 9.7 : Number of relapse cases classified according to type of relapse.

Sr.No.	Types of Relapse found during survey	Number of cases	Percentage
1	PB <sup>-</sup> ----PB <sup>-</sup>	3	8.3
2	PB <sup>-</sup> ----MB <sup>-</sup>	14	39.0
3	PB <sup>-</sup> ----MB <sup>+</sup>	12	33.3
4	MB <sup>-</sup> ----PB <sup>-</sup>	-	-
5	MB <sup>+</sup> ----PB <sup>-</sup>	-	-
6	MB <sup>-</sup> ----MB <sup>-</sup>	2	5.5
7	MB <sup>-</sup> ----MB <sup>+</sup>	1	2.9
8	MB <sup>+</sup> ----MB <sup>-</sup>	2	5.5
9	MB <sup>+</sup> ----MB <sup>+</sup>	2	5.5
Total		36	100

Table 9.7 shows that the porportion of relapse cases was more in PB type (80%) than in MB type (20%). Thus it is quite evident that the PB cases usually relapse more compared to MB cases. The period after which these cases have relapsed is discussed in table 9.8

Table 9.8 : Time of occurance of relapse cases after made RFT.

Sr. No.	Types of Relapse found	Period after releases from treatment (in years)											
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-12	12-14 +15
1	PB <sup>-</sup> ----PB <sup>-</sup>	-	2	1	-	-	-	-	-	-	-	-	-
2	PB <sup>-</sup> ----MB <sup>-</sup>	2	5	3	2	1	1	-	-	-	-	-	-
3	PB <sup>-</sup> ----MB <sup>+</sup>	1	3	1	3	1	2	-	-	-	-	1	-
4	MB <sup>-</sup> ----PB <sup>-</sup>	-	-	-	-	-	-	-	-	-	-	-	-
5	MB <sup>+</sup> ----PB <sup>-</sup>	-	-	-	-	-	-	-	-	-	-	-	-

Cont...

Sr. No.	Types of Relapse found	Period after releases from treatment (in years)												
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-12	12-14	+15
6	MB <sup>-</sup> →MB <sup>-</sup>	-	-	-	-	-	-	-	-	-	1	1	-	-
7	MB <sup>-</sup> →MB <sup>+</sup>	-	-	-	-	-	-	-	-	-	-	1	-	-
8	MB <sup>+</sup> →MB <sup>-</sup>	-	-	-	-	-	-	-	-	-	1	-	1	-
9	MB <sup>+</sup> →MB <sup>+</sup>	-	-	-	-	-	-	-	-	-	-	-	1	1
Total		3	10	5	2	3	-	-	-	-	2	2	3	1
Percentage		8.3	28	14	14	5.5	-	-	-	-	5.5	5.5	8.3	2.6

The number of occurrence of relapse is highest between 1-2

years (28%) followed by 2-3 years and 3-4 years both contributing almost the similar number (14%) after these cases were released from treatment. According to WHO regime cases released after treatment (RFT) are kept under observation for five years in case of MB cases and two years in case of PB cases. If there are no further complaints about re-occurrence of the disease in them then they are classified as RFC, i.e, released from control. Here 70% (25) of cases relapsed during the limit specified by WHO. The remaining 30% (11) relapsed after they were considered RFC. Out of 11 cases 3 cases belong to MDT era of treatment while rest eight cases belong to DDS era of treatment. Thus out of total 36 relapse cases 22% (8)



cases belong to DDS time while rest 78% belong to MDT era. The reason for this is that, they might have once again come in contact with infectious cases of leprosy and due to their poor immunity, might have had a relapse. Overall, the relapse rate is very very low in the district.

### 9.8 Family Contact

Another important point noticed during survey was that out of the total 770 cases, 48% indicated that at least one of the family members had suffered or were suffering from leprosy (Table 9.9).

Table - 9.9 Family history of leprosy cases traced during survey.

Sr. No.	Type of Cases	Family members suffering				Total cases
		MB		MB		
		Yes	No	Yes	No	
1.	Active child	10	17	41	45	113
2.	Active Adult	40	85	16	36	177
3.	Relapse	18	13	2	3	36
4.	RFT	178	55	63	148	444
Total		246	170	122	232	770
Percentage		32	22	16	30	100

It is apparent that 368 out of 770 cases, i.e., 48% of

the total family contacts. Out of these cases 67% are of MB type while the remaining 33% are of PB type. Thus there can be a possibility that contact with MB cases increases the risk of acquiring the disease. Another point that emerges is that while 48% of the cases are acquired from within the family itself the remaining 52% are imported from other sources. So chance of contracting the disease from family source and from outside sources are almost equal.

#### **9.9 Effect of BCG Vaccination :**

The effect of BCG vaccination leprosy is still being debated in the world of medicine. In order to know the relationship between BCG vaccination and occurrence of the leprosy in the study area, the presence of BCG scar among sufferers was examined during the survey with the help of leprosy health workers, and the information collected is shown in Table 9.10.

It is apparent that out of total (770) leprosy cases surveyed nearly 53% had taken BCG vaccination while the remaining 47% were not vaccinated. Among those who had taken BCG Vaccine, 42% were of MB type while 58% were of PB type. The large percentage of PB cases could suggest

that the BCG Vaccination might have prevented these cases from becoming infectious or MB type cases. Among the cases who had not taken BCG Vaccination, the number in MB type is more (68%) as compared to PB type.

Table 9.10 Status of BCG scar among leprosy sufferers.

Sr. No.	Type of Cases	Status of BCG Scar				Total cases
		MB		PB		
		Yes	No	Yes	No	
1.	Active child	17	10	71	15	113
2.	Active Adult	35	90	19	33	177
3.	Relapse	10	21	3	2	36
4.	RFT	109	124	146	65	444
Total		171	245	239	115	770
Percentage		22	32	31	15	100

But one cannot come to a direct conclusion that living with infected person or by not taking BCG vaccination, one would contract leprosy. Hence to know the combined impact of these two factors among leprosy sufferers one has to cross examine both the factors (as shown in Table 9.11) in order to identify certain risk factors which may be directly or indirectly helping incidence of leprosy within the family.

Table 9.11 Cross examination of Family Contact with the status of BCG scar.

Group	Status of BCG Scar	Family Contact	Child		Replase		Adult		RFT		Total		Total cases
			MB	PB	MB	PB	MB	PB	MB	PB	MB	PB	
I	Yes	Yes	6	33	6	1	13	5	77	46	102	85	187
II	Yes	No	11	38	4	2	22	14	32	100	69	154	223
III	No	Yes	4	8	12	1	27	11	101	17	144	37	181
IV	No	No	6	7	9	1	63	22	23	48	101	78	179
Total			27	86	31	5	125	52	233	211	416	354	770

The fact that the number of cases who have no family contact and have been administered with BCG (Group-II) is higher than those having both family contacts and BCG scar (Group-I) shows that neither family contact nor BCG vaccines have affected the number of cases. Similarly among the cases who have not been vaccinated with BCG, the number with and without (Group-III & IV) family contact is more or less same. These two factors have not contributed to the type of cases either. This is evident from the fact that amongst children, PB cases are more than MB, irrespective of whether they have been vaccinated with BCG or not and whether they have family contacts or not.

Table 9.12 : Summerised information of Table 9.11.

Sr. No.	Status of BCG Scar	Family Contact				Total of BCG Scar
		MB		MB		
		Yes	No	Yes	No	
1. YES		102	69	85	154	410
2. NO		144	101	37	78	360
Total		246	170	122	232	770

Similarly, in case of adults, MB cases are more than PB cases, irrespective of family contact and BCG scar. So the only conclusion that can be drawn is that the severity of the disease is less amongst children as children are more likely to be affected with PB type. So if they are treated at early stages the disease can be effectively checked. Adults on the other hand, tend to be afflicted more severely because the number of MB cases are more amongst adults. This could be due to late reporting and detection of the disease.

As the number of cases where there is no family contact is higher in case of PB type family contact alone is not a risk factor. In case of MB type, on the other hand, the number of cases with family contacts is higher. BCG vaccination proved to be protective in the early age (as

discussed above) while in mature age it was not so. Whether BCG can be more effective, if given at the time of treatment of leprosy is a study that may be undertaken by medical personnel. However, at this stage it was necessary to make further statistical tests, to understand the significance of the present finding so the following hypotheses were tested.

#### 9.10 Hypothesis 2 :

There is no significance of family contact in the spread of disease for all type of cases.

Step : 1 In order to test the above hypothesis, Chi Square test method is used.

$$\chi^2 = \frac{\sum (Q_i - E_i)^2}{E_i} \sim \chi^2 \text{ df } (Y-1) (S-1)$$

Where  $E_i = \frac{(A)(a)}{N}$  (value of A, a & N should be taken from sample)

Y = Number of Horizontal coloumn of sample.

S = Number of Vertical colomuun of sample.

Step : 2 At level of significance  $\alpha = 5\%$

Step : 3 Sample Table

Family Contact	Child cases	Adult cases	Relapse cases	RFT cases	Total cases
Yes	51	56	20	241	368
No	62	121	16	203	402
Total	113	177	36	444	770

Let  $Q_1 = 51$ ,  $Q_2=56$ ,  $Q_3=20$ ,  $Q_4=241$ ,  $Q_5=62$ ,  $Q_6=121$ ,  $Q_7=16$   
 &  $Q_8=203$ ,  $a=113$ ,  $b=177$ ,  $c=36$  &  $d=444.$ ,  $A=368$  &  $B=402$ ,  
 $N=770$ ,  $Y=2$  &  $S=4$ .

Testing Hypothesis ( $H_0$ )= There is no significance of  
 family contact in the spread of the disease for all type  
 of cases.

Alternative Hypothesis ( $H_1$ )= There is significance of  
 family contact in the spread of the disease in some type  
 of cases.

Step : 4 Critical

If  $\chi^2_{cal} > \chi^2_{tab}$  Reject the Hypothesis ( $H_0$ )

If  $\chi^2_{cal} < \chi^2_{tab}$  Accept the Hypothesis ( $H_1$ )

If  $\chi^2_{\text{tab}} (2-1) (4-1) = 3$  degree of freedom.

Thus  $\chi^2_{\text{tab}} = 7.8147$  at  $\alpha = 5\%$

Step : 5 Calculation

Qi	Ei	$(Q_i - E_i)^2$	$(Q_i - E_i)^2 / E_i$
51	54.0	9.0	0.16
56	84.6	817.96	9.7
20	17.2	7.84	0.46
241	212.2	829.44	3.9
62	60.0	4.0	0.07
121	92.4	817.96	8.9
16	18.8	7.84	0.42
203	231.8	829.44	3.8
$\sum (Q_i - E_i)^2 / E_i = 27.41$			

Step : 6 Conclusion

At 5% significance level  $\chi^2_{\text{tab}} = 7.8147$  and  $\chi^2_{\text{cal}} = 27.41$

Since  $27.41 > 7.8147$

i.e.  $\chi^2_{\text{cal}} > \chi^2_{\text{tab}}$  Reject the hypothesis ( $H_0$ )



This implies that alternative hypothesis ( $H_1$ ) is true.

I.e. There is a significance of family contact in the spread of the disease in some type of cases.

Hence the risk of contact has to be studied in association with the infectivity of the disease, the susceptibility of the contact person and the closeness, frequency and duration of contact. All these clearly indicate the need to investigate the socio-cultural background of the patients in order to identify the risk of family contact.

#### 9.11 Hypothesis 3 :

BCG is not found protective in any types of leprosy cases.

Step : 1 In order to test the above hypothesis, Chi Square test method is used.

$$\chi^2 = \sum \frac{(q_i - E_i)^2}{E_i} \sim \chi^2 \text{ df } (Y-1) (S-1)$$

Where  $E_i = \frac{(A)(a)}{N}$  (value of A, a & N should be taken from sample)

Y = Number of horizontal column of sample.

S = Number of Vertical column of sample.

Step : 2 At level of significance  $\alpha = 5\%$

Step : 3 Sample Table

Status of BCG Scar	Child cases	Adult cases	Relapse cases	RFT cases	Total cases
Yes	88	54	13	255	410
No	25	123	23	189	360
Total	113	177	36	444	770

Let  $Q_1 = 88$ ,  $Q_2 = 54$ ,  $Q_3 = 13$ ,  $Q_4 = 255$ ,  $Q_5 = 25$ ,  $Q_6 = 123$ ,  $Q_7 = 23$   
&  $Q_8 = 189$ ,  $a = 113$ ,  $b = 177$ ,  $c = 36$  &  $d = 444$ ,  $A = 410$  &  $B = 360$ ,  
 $N = 770$ ,  $Y = 2$  &  $S = 4$ .

Testing Hypothesis ( $H_0$ ) = BCG is not found protective in  
any type of leprosy cases.

Alternative Hypothesis ( $H_1$ ) = BCG is found protective in  
some types of leprosy cases.

Step : 4 Critical

If  $\chi^2_{cal} > \chi^2_{tab}$  Reject the Hypothesis ( $H_0$ )

Or

If  $\chi^2_{cal} < \chi^2_{tab}$  Accept the Hypothesis ( $H_0$ )

$\chi^2_{tab} (2-1) (4-1) = 3$  degree of freedom.

Thus  $\chi^2_{tab} = 7.8147$  at  $\alpha = 5\%$

**Step : 5 Calculation**

Qi	Ei	$(Q_i - E_i)^2$	$(Q_i - E_i)^2 / E_i$
88	60.2	772.84	12.8
54	94.2	1616.04	17.2
13	19.2	38.44	2.0
255	236.4	345.96	1.46
25	52.8	772.84	14.6
123	82.8	1616.04	19.5
23	16.8	38.44	2.29
189	207.6	345.96	1.67
$\sum (Q_i - E_i)^2 / E_i = 71.52$			

**Step : 6 Conclusion**

At 5% significance level  $\chi^2_{tab} = 7.8147$  and  $\chi^2_{cal} = 71.52$

Since  $71.52 > 7.8147$

i.e.  $\chi^2_{cal} > \chi^2_{tab}$  Reject the hypothesis ( $H_0$ )

This implies that alternative hypothesis ( $H_1$ ) is true.

i.e., BCG is found protective in some types of leprosy cases.

To Investigate in which type of leprosy cases BCG could be effective the cases were divided into two groups, viz, adult and child. As seen before the number of PB cases are more than MB cases in children, implying that BCG is more effective in earlier age groups. While in case of adults the number of MB cases is more than PB cases, showing diminishing effect of BCG against leprosy. Statistical tests done to study the effectiveness of BCG, seem to further strengthen these findings.

#### 9.12 Hypothesis 4 : BCG is not ineffective in child cases.

**Step : 1** In order to test the above hypothesis, Chi Square test method is used.

$$\chi^2 = \frac{N (ad - bc)^2}{(a+b)(a+c)(c+d)(b+d)} \sim \chi^2_{df (Y-1) (S-1)}$$

Where  $Y$  = Number of horizontal column of sample.

S = Number of Vertical column of sample.

Note : Value of a, b, c & d are taken from sample.

This test is conducted separately on MB, PB and total cases of child.

Step : 2 At level of significance  $\alpha = 5\%$

Step : 3 Sample Table

Status of BCG Scar	Family contact				Total of BCG	
	MB		PB		Yes	No
	Yes	No	Yes	No		
Yes	6	11	33	38	39	49
No	4	6	8	7	12	13

For MB cases

For PB case

Total cases

Let a=6

Let a=33

Let a=39

b=11

b=38

b=49

c=4

c=8

c=12

d=6

d=7

d=13

N=27

N=86

N=113

Testing Hypothesis ( $H_0$ )= BCG is not found ineffective in child cases.

Alternative Hypothesis ( $H_1$ )= BCG is ineffective in child cases.

**Step : 4 Critical**

If  $X^2_{cal} > x^2_{tab}$  Reject the Hypothesis ( $H_0$ )

Or

If  $X^2_{cal} < x^2_{tab}$  Accept the Hypothesis ( $H_0$ )

$X^2_{tab} (2-1) (2-1) = 1$  degree of freedom.

Thus  $X^2_{tab} = 3.84$  at  $\alpha = 5\%$

**Step : 5 Calculation**

$$X^2_{cal} = \frac{N(ad-bc)^2}{(a+b)(a+c)(c+d)(b+d)}$$

$$\text{For MB cases} = \frac{27(36-44)^2}{(6+11)(6+4)(4+6)(11+6)} = 0.01540$$

$$\text{For PB cases} = \frac{86(231-304)^2}{(33+38)(33+8)(8+7)(38+7)} = 0.2332374$$

$$\text{For Total Cases} = \frac{113(507-588)^2}{(39+49)(39+12)(12+13)(49+13)} = 0.106577$$

Step : 6 Conclusion

At 5% significance level  $X^2_{\text{tab}} = 3.84$  and

$X^2_{\text{cal}}$  for MB cases = 0.01540, for PB cases = 0.2331374 and

for Total cases = 0.106577.

Since  $X^2_{\text{cal}} < X^2_{\text{tab}} \Rightarrow$  Accept the hypothesis ( $H_0$ )

i.e. 0.01540  $<$  3.84 for MB cases.

0.2331374  $<$  3.84 for PB cases.

0.106577  $<$  3.84 for total cases.

Thus BCG found effective in child cases.

This is evident from the fact that amongst children PB cases are more than MB cases, implying that to, a certain extent BCG might act as protective so as to reduce the severity of the disease among children.

Beside this, MB cases among children might have occurred due to constant exposure to the infection within or outside family or by late reporting due to ignorance about the disease among the family members.