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The Epidemiologic Significance of Leprosy within the Household [1]

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The evolution of endemicity of leprosy has been studied intensely but is little understood. Although abundant data pertaining to some of the epidemiologic features of the disease usually employed to assess its status as a public health problem have been compiled from time to time, their significance remains obscure. Likewise, there is little unanimity of opinion with respect to the factors causing these features of leprosy to differ with time, place and people.

What, for instance, is the significance of the lepromatous type rate? It has been said often that a high total prevalence of the disease is associated with a high lepromatous type rate. In a study relating to several areas located in eight provinces of India Dharmendra and Santra ([3]) did find it to be so, although not without exception. On on the other hand, Sharma and Prasad ([9]) reported the lepromatous type rate to be relatively low in groups of villages where the total prevalence of leprosy was relatively high. Skinsnes ([10]) also seemed to imply that the lepromatous rate in an area will be at its lowest at the time when total prevalence of the disease reaches its peak. Such disconcertingly conflicting contentions relating to the lepromatous rate, as well as to other indices of leprosy, are by no means few or far between.

The conflict in views pertaining to factors responsible for regional variations has centered around the involvement of genetic elements. Until the discovery of *Mycobacterium leprae* the existence of a hereditary tendency to leprosy, according to Virchow, had been admitted in all ages and in all countries. But workers like Leloir and Hansen adopted a quite opposite view and denied the existence of any such predisposition ([5]). Lately, Spickett ([11]) has advanced good reasons in favor of a role of heredity in determining the leprosy picture in the individual and in the community. Nevertheless, definite proof for it, and a true assessment of the role of environmental factors in the disease process, are yet to be furnished ([8]).

OBJECTIVES

The study here reported was undertaken in the context of this conflict in views,

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which still persists. The aim was to elucidate at least some of the numerous factors involved in the epidemiology of leprosy by investigating the disease with the household as the unit of study. The precise objectives were:

1. To assess the effect of intradomestic spread of the disease on various indices of leprosy in the area under investigation.

2. To determine if the disease, while spreading within the household, showed any predilection for blood relations of the index case.

3. To present some basic data relating to leprosy as a household problem in Uttar Pradesh.

4. To make suggestions with regard to leprosy control that may be indicated by any particular facts observed in the study.

MATERIALS AND METHODS

The area covered in the study here reported comprised the operational zones of six Leprosy Control Units, selected by picking of lots, from among the total number of twelve units functioning in the State of Uttar Pradesh at the commencement of this work in 1964. This area was composed largely of rural pockets in six districts of the State; besides a small part of one municipal town, it covered some 656 villages. In Deoria, Gorakhpur and Barabanki districts the surveyed villages fell respectively in Deoria, Khorabhar and Masauli Development Blocks.[3] In each of the remaining three districts, viz., Azamgarh, Bahraich and Moradabad the surveyed gram-sabhas (villages) formed a contiguous area, which extended into more than one Development Block.

Geographically Uttar Pradesh is divided in five distinct divisions. These comprise the areas of the northern Himalayan zone (8 districts), West Plain (19 districts), Central Plain (12 districts), East Plain (10 districts), and the hills and plateaus in the southern portion of the State (5 districts). This distribution of districts by geographic

divisions shows that, out of the total number of 54 districts, 41 are located in the plains. All six districts with which this report is concerned belonged to this group of 41 districts, as Moradabad lies in the area of Western plains and Barabanki in the Central plains, while the remaining four districts are situated in the area of Eastern plains (Fig. 1).

In the decennial census of 1961 ([2]) the rural population of these six districts was found to be 11,288,687. Out of this, 475,623, or 4.2 per cent, belonged to villages that had been surveyed for leprosy by the staff of the six Leprosy Control Units functioning there. It can be seen from Table 1 that 3,129 individuals, or 0.66 per cent of the population of the surveyed villages, were found to be suffering from leprosy.

The material for the study was constituted by the households found affected with the disease. As set out in Table 1, a total of 74,157 households were surveyed in the areas in question. Out of these, 2,829, or 3.8 per cent, had one or more leprosy patients. The number of surveyed households varied between the maximum of 19,-797 for Bahraich and the minimum of 8,095 for Deoria. With respect to the affected households, it may be remarked that although their maximum number was from Bahraich (784), the minimum was from Azamgarh (300), and not from Deoria.

The procedure adopted for the study included the following steps:

1. Obtaining initial information on households affected with leprosy, from the records of the Leprosy Control Units.

2. Collection of detailed information with respect to the affected households on specially drawn schedules through specially arranged visits to the villages to which these households belonged.

3. Analysis of the data thus compiled.

Definitions. For the present study the definition of a *house* was, more or less, the same as that of a census house during the last Census of India (1961) ([2]). The definition of a household was, however, different from that of a census family. A *household* was defined as the body of persons living in one house, including servants, and as the case might be, lodgers and boarders. In the

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[3]Development Block. For community extension and development service the State of Uttar Pradesh has been divided administratively into 875 Development Blocks. Each Block has about a hundred villages (organized into *gram-sabhas*) and a population varying between 25,000 and 98,000.
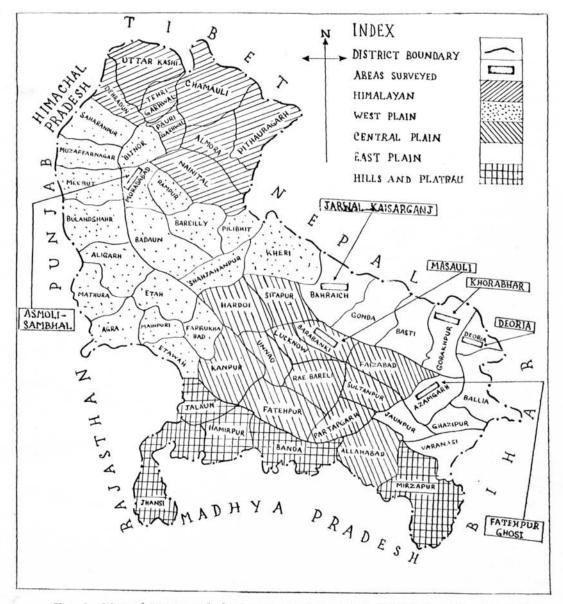
FIG. 1. Map of Uttar Pradesh showing its five natural divisions and the six areas surveyed for leprosy.

multiple case households, i.e., those households that had more than one living case of leprosy on the date of commencement of this investigation, the patient who gave the longest history of disease was taken as the *index case*.

The terms *lepromatous rate, sex rate, childhood rate,* and *multiple case rate* respectively denote the number of cases of lepromatous type, male leprosy cases, child (persons up to 15 years of age) leprosy patients, and leprosy cases from multiple case households, per 100 cases of leprosy. For the sake of convenience the group of cases from multiple case households has been designated as *multiple cases* to differentiate it from the group of *single cases*, i.e., patients from single case households.

TABLE 1. *Surveyed population and households according to districts.*

District	Develop. Block/s	Population			Patients		Households		
		District (rural)	Surveyed villages	District surveyed %	No.	Leprosy in surveyed villages (%)	No. surveyed	No. with leprosy	% with leprosy
Deoria	Deoria	2,317,498	60,322	2.6	538	0.89	8,095	469	5.8
Gorakhpur	Khorabhar	2,377,839	72,615	3.1	465	0.64	10,408	416	4.0
Azamgarh	Fatehpur: Ghosi	2,292,879	58,365	2.5	324	0.56	8,246	300	3.6
Bahraich	Kaisarganj: Jarwal	1,420,341	106,198	7.5	866	0.82	19,797	784	4.0
Barabanki	Masauli	1,344,297	71,071	5.3	548	0.77	11,276	499	4.4
Moradabad	Asmoli: Sambhal	1,535,833	107,052	7.0	388	0.36	16,335	361	2.2
Total		11,288,687	475,623	4.2	3,129	0.66	74,157	2,829	3.8

RESULTS

Those salient findings with respect to inmates of households found affected with leprosy, that bear on the questions under investigation, are recorded in Tables 2 to 11. Relevant observations pertaining to single and multiple case households, age and sex distribution of the inmates and patients, type distribution of patients, prevalence rate of secondary cases and their relative occurrence among the blood- and nonblood relations of index cases, are also set forth, as indicated in the following sections.

Multiple case households. From Table 2 it can be seen that 256, or 9.0 per cent, of the 2,829 households found affected with leprosy had more than one case per household. Among those that had multiple cases 223 (87.1%) were two-case households and 24 (9.4%) three-case households; of the remaining 9 (3.5%) every one had four or more cases. The number of inmates in the 256 multiple case households was 2,173, with an average of 8.5 inmates per household. The average household sizes of the surveyed households and of single-case households, were 6.4 and 6.7 respectively. Not only was the average size of multiple case households larger than these, but it was seen to increase, from 8.2 to 13.0, with increase in the number of cases per household.

A comparison of rates of occurrence of multiple case households, was attempted in those two of the six districts that showed maximum divergence in leprosy prevalence. One of the districts so compared was Deoria, where 0.89 per cent of the surveyed population and 5.8 per cent of the surveyed households were found affected. The other was Moradabad, where only 0.36 per cent of the surveyed population and 2.2 per cent of the surveyed households had leprosy (Table 3). It was noted that in Deoria 11.3 per cent, and in Moradabad only 6.9 per cent, of the affected households had multiple cases. This difference, which was statistically significant at the 5 per cent level ($\chi^2 = 4.5865$; $p < 0.05$), signifies that the prevalence of multiple case households was higher in the area with the higher prevalence of leprosy.

TABLE 2. *Affected households and their inmates according to number of cases per household.*

No. cases in household	Households			Inmates	
	No.	% affected	% multiple case.	No.	No. per household
1	2,573	91.0	—	17,280	6.7
2	223 ⎱	7.9 ⎱	87.1	1,832 ⎱	8.2 ⎱
3	24 ⎰ 256	0.8 ⎰ 9.0	9.4	224 ⎰ 2,173	9.3 ⎰ 8.5
4 or more	9	0.3	3.5	177	13.0
Total	2,829	100.0	100.0	19,453	6.9

TABLE 3. *Prevalence of leprosy and multiple case households in Deoria and Moradabad.*

District	Prevalence				
	Leprosy		Multiple case households		
	Surveyed population found affected %	Surveyed households found affected %	No. households found affected	No. multiple case households	Affected households having multiple cases %
Deoria	0.89	5.8	469	53	11.3
Moradabad	0.36	2.2	361	25	6.9

Age and sex of inmates of affected households in relation to leprosy. The distribution of the inmates of the single and multiple case households by age and sex is indicated in Table 4, from which it can be seen that these two groups were, in this respect, more or less alike. Evidently, therefore, the differences in prevalence of disease in these two groups of households, which are obvious from the figures given in Tables 5 and 6, were in all probability not due to any difference in age and sex composition of their inmates.

Tables 5 and 6 show that in single case households, 2,573 (14.9%) out of 17,280 inmates, and in multiple case households, 556 (25.6%) out of 2,173 inmates, were found affected. Study of prevalence rates by sex showed that among male inmates 20.4 per cent in single and 31.1 per cent in multiple case households, and among female inmates 7.7 per cent in single, and 18.4 per cent in multiple case households, suffered from leprosy.

Although the prevalence of the disease among the inmates of the multiple case households was distinctly higher than that observed in single case households, there was a marked similarity between the two insofar as the trend of prevalence according to age groups is concerned. Leprosy prevalence in various age groups ranged from 3.0 to 28.8 per cent in single case households, and 11.8 to 47.3 per cent in multiple case households. The lowest rate in both groups of households was seen in the children under 15 years of age, and the peak occurred in the 45-59 years age

TABLE 4. *Inmates of single and multiple case households by age and sex[a]*

Type of household	Age group (yrs)	Number of inmates			% dist. (age)
		Males	Females	Total	
Single case	0–15	3,504 (56.0)	2,755 (44.0)	6,259	36.2
	15 & over	6,259 (56.8)	4,762 (43.2)	11,021	63.8
	Total	9,763 (56.5)	7,517 (43.5)	17,280	100.0
Multiple case	0–15	465 (59.1)	322 (40.9)	787	36.2
	15 & over	763 (55.1)	623 (44.9)	1,386	63.8
	Total	1,228 (56.5)	945 (43.5)	2,173	100.0

[a] Figures in parentheses indicate percentage distribution of inmates according to sex.

group. In both groups the peak was followed by a decline in the rates, which were found to be lower in the next higher age group.

There was a marked difference in the leprosy prevalence noted in the groups of adult male and adult female inmates, prevalence rates in adult males being markedly higher in all age groups. In children, however, 3.6 per cent of males and 2.2 per cent of the females in single case households and 11.2 per cent of males and 12.7 per cent of females in multiple case households were found affected. Thus, in this young age group, in both types of households, little difference in prevalence of disease was found between male and female inmates.

Age and sex distribution of leprosy patients. Among the 3,129 cases detected in the surveyed area, 2,573 (82.2%) came from single case households and 556 (17.7%) from multiple case households. The number of secondary cases was 300; they formed 9.6 per cent of the total case pool. With respect to the distribution of patients according to the various age and sex groups it was noted that in both the single and the multiple case households the largest proportion of patients, in any one age group,

i.e., 35.3 per cent in the former and 28.7 per cent in the latter, was found in one and the same age group, viz., 30-44 years. This means that, although in both types of household prevalence rates of the disease were highest among inmates of the 45-59 years age group, the distributional peak of cases in both was found in a younger group (Tables 5 and 6).

Figures set out in Tables 5 and 6 show also that in comparison with the male patients the proportion of children was higher among females. This is clear from the observation that while 10.7 per cent and 23.6 per cent of the females in the single and multiple cases respectively were children, among the males only 6.4 per cent in the single and 13.6 per cent among multiple cases were of this age group.

Among the multiple and single cases the proportion of children was higher in the former group. From Table 7 it can be seen that 16.7 per cent among the former and 7.3 per cent among the latter belonged to this age group. This difference was found to be statistically significant even at the 1 per cent level ($\chi^2 = 49.0673$). Separate consideration of the index and secondary cases showed that in these two groups of cases the proportions of children were 3.5

TABLE 5. Inmates and leprosy patients in single case households by age and sex.

Age (yrs.)	Males				Females				Total (both sexes)			
	Inmates	No. cases	% inmates affected	% dist. cases	Inmates	No. cases	% inmates affected	% dist. cases	Inmates	No. cases	% inmates affected	% dist. cases
0–15	3,504	127	3.6	6.4	2,755	62	2.2	10.7	6,259	189	3.0	7.4
15–29	2,350	401	17.1	20.1	1,849	130	7.0	22.5	4,199	531	12.6	20.6
30–44	1,945	720	37.0	36.1	1,515	189	12.5	32.8	3,460	909	26.3	35.3
45–59	1,251	498	39.8	24.9	935	132	14.1	22.9	2,186	630	28.8	24.5
60 & over	713	250	35.1	12.5	463	64	13.8	11.1	1,176	314	26.7	12.2
Total	9,763	1,996	20.4	100.0	7,517	577	7.7	100.0	17,280	2,573	14.9	100.0

TABLE 6. Inmates and leprosy patients in multiple case households by age and sex.

Age (yrs.)	Males				Females				Total (both sexes)			
	Inmates	No. cases	% inmates affected	% dist. cases	Inmates	No. cases	% inmates affected	% dist. cases	Inmates	No. cases	% inmates affected	% dist. cases
0–15	465	52	11.2	13.6	322	41	12.7	23.6	787	93	11.8	16.7
15–29	306	87	28.4	22.8	257	32	12.4	18.4	563	119	21.1	21.4
30–44	216	107	49.5	28.0	190	52	27.4	29.8	406	159	39.2	28.7
45–59	155	88	56.8	23.0	107	36	33.6	20.7	262	124	47.3	22.3
60 & over	86	48	55.8	12.6	69	13	18.8	7.5	155	61	39.3	10.9
Total	1,228	382	31.1	100.0	945	174	18.4	100.0	2,173	556	25.6	100.0

and 28.0 per cent respectively (Table 7). A comparison of these two groups with the group of single cases showed that the difference in this respect between the single and index cases was significant at the 1 per cent level ($\chi^2 = 7.1015$), while that between the single and secondary cases was still more highly significant ($\chi^2 = 138.6195$).

With respect to the sex distribution of the cases, Table 7 shows that males formed 77.6, 68.7, 76.2 and 62.3 per cent, respectively, of the single, multiple, index, and secondary cases. In this connection it is to be noted that the difference with respect to male rates between the single and multiple cases and between the single and secondary cases was significant at the 1 per cent level ($\chi^2 = 19.7181$ and 34.1917 respectively). However, the difference between the single cases and index cases was not found to be statistically significant.

Type distribution of the leprosy cases. Among the 3,129 cases detected in the areas under study, 517, or 16.5 per cent, were found to be suffering from leprosy of the lepromatous (L) type, while 2,478, or 79.2 per cent, suffered from nonlepromatous (N) type. This disease in the remaining 134 cases (4.3%) was categorized as of intermediate (N?L) type (Table 8). The lepromatous rates were 15.9, 19.2, 28.5 and 11.3 respectively in the single, multiple, index and secondary cases. With respect to the lepromatous rate, the difference between the single and the index cases was found to be significant even at the 1 per cent level ($\chi^2 = 25.8106$). It was significant only at the 5 per cent level ($\chi^2 = 4.3537$) between the single and secondary cases, and not significant even at the 5 per cent level ($\chi^2 = 3.63149$) between single and multiple cases. Although not significant statistically, the lepromatous rate, as seen in the figures given above, was higher among the multiple cases than among the single cases.

Secondary cases and their relationship to the index cases. Prevalence rates for secondary cases among the inmates of the affected households are given in Table 9. In each one of the 2,829 affected households, a potential index case was present, but sec-

TABLE 7. *Distribution of cases of different categories by age and sex.*

	Single cases No.	Single cases %	Index cases No.	Index cases %	Secondary cases No.	Secondary cases %	Multiple cases No.	Multiple cases %	Total cases No.	Total cases %
Age (yrs.)										
0–15	189	7.3	9	3.5	84	28.0	93	16.7	282	9.0
15 & over	2,384	92.7	247	96.5	216	72.0	463	83.3	2,847	91.0
		(100.0)		(100.0)		(100.0)		(100.0)		(100.0)
Sex										
Male	1,996	77.6	195	76.2	187	62.3	382	68.7	2,378	76.0
Female	577	22.4	61	23.8	113	37.7	174	31.3	751	24.0
		(100.0)		(100.0)		(100.0)		(100.0)		(100.0)

TABLE 8. *Distribution of cases by type of disease.*

Type of leprosy	Single cases		Index cases		Secondary cases		Multiple cases		Total cases	
	No.	%	No.	%	No.	%	No.	%	No.	%
Lepromatous (L)	410	15.9	73	28.5	34	11.3	107	19.2	517	16.5
Nonlepromatous (N)	2,055	79.9	171	66.8	252	84.0	423	76.1	2,478	79.2
Intermediate (N?L)	108	4.2	12	4.7	14	4.7	26	4.7	134	4.3
Total	2,573	100.0	256	100.0	300	100.0	556	100.0	3,129	100.0

ondary cases were found to have occurred in only 256. The total number of inmates in the affected households who were exposed to the 2,829 first cases of leprosy, was 16,624, of whom 8,800 were males and 7,824 females. The number of secondary cases was 187 (2.1%) among males, 113 (1.4%) among females, i.e., 300 (1.8%) among the total number of inmates exposed to household contact. This is 2.7 times as high as the prevalence rate (0.66%) observed in the general population.

TABLE 9. *Inmates and secondary cases in affected households.*

Sex	Inmates other than first cases	Secondary cases	% affected
Male	8,800	187	2.1
Female	7,824	113	1.4
Total	16,624	300	1.8

TABLE 10. *Inmates and secondary cases in multiple case households.*

Relationship to index case	Inmates other than index cases	Secondary cases	% affected
Blood relations	1,293	224	17.3
Nonblood relations	624	76	12.2
Total	1,917	300	15.6

In the 256 multiple case households there were 256 index cases and 1,917 other inmates. Among these other inmates 1,293 were, and 624 were not, blood relations of the index cases. Among the blood relations 224 (17.3%), and among nonblood relations 76 (12.2%) secondary cases were found (Table 10). Since the blood relations and nonblood relations belonged to one and the same group of households, they cannot be considered as independent groups. A strict statistical test for the significance of the difference between the percentages of secondary cases observed in the two groups is,

therefore, not possible. However, if this association between the two groups is ignored, the above noted difference, which showed the prevalence of secondary cases to be higher among blood relations, was found to be statistically significant at the 1 per cent level ($\chi^2 = 8.2405$).

As there were marked differences in the age and sex composition of blood and nonblood relations, the prevalence rate of secondary cases in these two groups was studied further, after subdividing them into four subgroups. These subgroups were made up of male children, male adults, female children and female adults (Table 11). The prevalence rates of secondary cases in these subgroups among blood relations were respectively 10.3, 27.1, 12.2 and 16.0 per cent, whereas in the respective subgroups among nonblood relations, they were 3.2, 13.6, 11.5 and 12.5 per cent. These figures also show that, in comparison with its counterpart among nonblood relations, the prevalence of secondary cases was higher in every one of the four subgroups among the blood relations.

DISCUSSION

Epidemiologic implications of occurrence of multiple cases. The incidence of multiple cases in affected houses varies not only from disease to disease but also from one epidemiologic phase of the same disease to another. As far as diseases of infectious origin are concerned, the chances of their intradomestic dissemination increase or decline in an area with a rise or fall in the total number of affected houses. Obviously, therefore, in the instance of such diseases the multiple case rate is apt to be higher in areas with high levels of prevalence. Since leprosy also results from infection, this expectation should apply to this disease as well.

The finding in the present study of a significantly higher prevalence of multiple case households in that one of the two districts where the leprosy prevalence was also higher, supports this assumption (Table 3). A comparison of the relevant figures from these districts with those reported by Noordeen and Mohamed Ali ([6]) from Chingleput leads to a similar conclusion. The prevalence rates for leprosy in the surveyed populations in Moradabad, Deoria, and Chingleput were 0.36, 0.89, and 2.1 per cent respectively, while the respective multiple case household rates in these areas were 6.9, 11.3 and 15.8 per cent. Although these figures suggest that the higher the one rate in an area is, the higher the other will be, this cannot be taken as established conclusively. For validity of comparison it is essential that in relevant studies terms

TABLE 11. *Distribution of secondary cases and inmates other than index cases in the 256 multiple case households according to age, sex[a] and type of relationship with the index case.*

Sex	Age group	Blood relations			Nonblood relations		
		No. inmates	No. secondary cases	%	No. inmates	No. secondary cases	%
Males	0–15 15 & over	427⎫ 472⎭ (69.5)	44 128	10.3 27.1	31⎫ 103⎭ (21.5)	1 14	3.2 13.6
Females	0–15 15 & over	294⎫ 100⎭ (30.5)	36 16	12.2 16.0	26⎫ 464⎭ (78.5)	3 58	11.5 12.5
Total		1,293	224	17.3	624	76	12.2

[a] Figures in parenthesis indicate percentage distribution of inmates according to sex.

like "prevalence of disease," "household," "multiple case," etc. are defined identically.

Another relevant aspect of the spread of leprosy within the household is its restricted scope. A review of epidemiologic reports from several places where the prevalence of the disease ranged from 0.36 to 3.0 per cent, indicates that in these areas no more than one leprosy patient per household could be found in a large proportion of the affected houses. Thus, in Uttar Pradesh 91.0 per cent (Table 2), in the Vairag area in the Sholapur district of Maharashtra 85 per cent ([4]), in Chingleput 84.2 per cent ([6]), and in some endemic areas of the United States of America 85.5 per cent ([1]) of the affected households, showed only one patient each. In addition, these reports show that, even in those houses in which more than one case was found, no more than two were seen in 80 to 90 per cent. As a result of this, in these areas the disparity between the numbers of index and secondary cases was not very marked. For example, the number of secondary cases per index case came to 1.17 in the six surveyed areas in Uttar Pradesh, and to 1.23 in the Chingleput area.

In all likelihood the factors responsible for the sparing from contraction of manifest disease in the majority of household contacts lie as much in the parasite as in the environment or in the host. The same pathogenic organism that inflicts disease in one imparts immunity in another. The outcome, as far as the household is concerned, is shaped by the hurdles inherent in the mode of transmission of infection, the dearth of viable bacilli, to which Rees and Waters ([7]) have drawn attention, the socio-environmental factors that determine the degree of contact between the infector and the infected person, and, above all, individual variation in the capability of the latter to acquire immunity. It is with relation to this question of immunity or susceptibility in the host that genetic factors have to be considered.

Genetic factors in susceptibility to leprosy and occurrence of multiple cases. If inheritance is involved in determining susceptibility to leprosy, it would be logical to expect a higher incidence of secondary cases among those inmates of multiple case households who, because of ties of blood with the index cases, are genetically closer to them than nonblood relations. In the areas to which this report relates, this was indeed found to be the fact, for the prevalence of secondary cases was 17.3 per cent in the former and 12.2 per cent in the latter group (Table 10). But, apart from the basic impracticability of precise identification of the source of infection, several nongenetic factors may be responsible for such a finding. Foremost among these is the greater degree and duration of contact between the blood relations and the index cases, particularly during the childhood of the former. Moreover, among the blood relations the proportion of males was very much higher (69.5% among blood relations as compared with 21.5% among nonblood relations, Table 11), and, since males suffer more frequently from leprosy, it is probable that sex distribution was concerned in the prevalence of the disease in the two groups of relatives.

It must be admitted, therefore, that finding a higher prevalence of secondary cases among the blood relations is not enough, by itself, to prove that susceptibility to leprosy has some hereditary basis. Nevertheless, it furnishes another addition to the list of reasons advanced to show that such is the case. Besides, it distinctly marks a group among household contacts deserving priority in prophylaxis. Full exploitation of this finding, as well as of other such observations, will be possible, however, only when sound epidemiologic bases for determining the needs and assessing the results of antileprosy work are evolved.

Multiple case rates in relation to other leprosy indices. Until now, an epidemiologic assessment of leprosy that may be of real use for the public health worker has not been feasible. This is true mainly because the manner in which various epidemiologic features of the disease affect recognized leprosy indices is yet to be comprehended. The investigation here reported can justifiably claim to be a step in the direction of removal of this difficulty, for it aims at unravelling the relationship between the occurrence of multiple cases, which form

an important epidemiologic aspect of leprosy, and four leprosy indices, viz., the prevalence-index, and the child, sex, and lepromatous rates. In this context, the two subgroups, i.e., the index, and the secondary cases of which the group of multiple cases is composed, have also been considered separately.

Since these two subgroups are products of different epidemiologic conditions, differing with respect to age at first contact, as well as the degree and duration of contact, they are bound to differ also with respect to immunologic status and age and sex composition. Naturally, therefore, they are likely to affect the leprosy indices differently. Such a difference between the two was, in fact, found in the present study. If the rates observed in the single cases are taken as baselines, it would appear that index cases raised the lepromatous rate, while secondary cases lowered it (Table 8). Child rates, on the other hand, were lowered by the former and raised by the latter group of cases. Sex rates, in turn, were lowered by the secondary cases, but the index cases did not affect them significantly (Table 7).

As a result of these differences, and because there was no great disparity between the number of index and secondary cases, the impact of one group on the leprosy indices was largely neutralized by the other. Consequently, as far as the values of these rates in the total case pool are concerned, multiple cases could not have played a determinative role. As can be seen from Tables 7 and 8, the lepromatous, sex (i.e., male), and child rates, respectively, were 15.9, 77.6 and 7.3 per cent in single cases, and 16.5, 76.0 and 9.0 per cent among the total cases. From these figures it becomes clear that out of the three rates, the child rate alone was somewhat materially altered on account of the multiple cases.

For a comparative study in this respect, a scrutiny of the leprosy indices relating to the Chingleput area (⁶) may be of interest. In Chingleput the respective values for prevalence and multiple case, lepromatous, child, and male sex rates were 2.1, 29.5, 14.0, 17.0 and 62.5, while the same rates in Uttar Pradesh areas were 0.66, 17.7, 16.5, 9.0 and

76.0. Thus in Chingleput the lepromatous and male sex rates were lower, and the other three were higher. The distributional peaks of cases by age groups were found in the 30-44 years age group in Uttar Pradesh and the 20-30 years, i.e., a younger age group, in Chingleput.

In the study of multiple cases in relation to leprosy indices in Chingleput also it was observed that this group of patients comprised fewer males, and was younger than the group of single cases. From the observation that, in that area, the male sex rate was 63.7 in single cases and 62.5 in total cases, it is evident that multiple cases, in that instance also, did not alter this rate materially. The other two indices, i.e., the child and lepromatous rates, do not seem to have been studied separately for the various subgroups of patients in Chingleput. Elsewhere the question of correlation between lepromatous rates and the prevalence index has been discussed. For example, Sharma and Prasad (⁹) and Kapoor (⁴) have shown that a low lepromatous rate goes with a high total prevalence. Whether or not variations in the number of multiple cases associated with varying leprosy prevalence have anything to do with the association between these two indices can not be determined at present.

However, a reasonable explanation may be given for some of the other findings discussed above. For instance, a relative preponderance of cases of lepromatous type and of males among the index cases was to be expected, because it has generally been observed first that multiple cases are more likely to occur in households with a case of lepromatous type among their inmates, and, second, that leprosy of the lepromatous type is more common among males than females. The inclusion of index cases appears to be responsible for the higher lepromatous rate observed in the group of multiple cases. The reason for the higher proportion of females and children among the secondary cases appears to be a greater degree of contact to which inmates in this category are exposed within the household.

Leprosy indices in operational research and planning of control programs. This dis-

cussion, however, is not concerned so much with the explanation of present findings as with an epidemiologic study of the leprosy indices by which their effective utilization may become possible. So far as this is concerned, the study here reported of their relationship with the occurrence of multiple cases has not been of much help. For instance, the association of lepromatous and sex rates with multiple case rates was found to be so tenuous as to be of little use.

But, at the same time, the appearance of definite correlations between some of the other leprosy indices indicates that further investigation will prove valuable. Among these are correlations between prevalence of disease and occurrence of multiple cases, between lepromatous rates and prevalence of disease, between distributional peaks of patients by age group and leprosy prevalence, and, finally, between multiple case and child rates. Taken together these correlations point toward the possibility of identifiable levels of child, lepromatous, and multiple case rates, as well as of age groups with distributional peaks of cases that may be associated distinctly with different levels of prevalence of the disease.

It is obvious that if such values exist, their identification will be of service not only in the recognition of phases of rise and decline of the disease, but also in realistic assessment of the requirements and results of the application of different intensities of various control procedures. It is also clear that operational research in the field of leprosy will then remain a dismal proposition no more. In the study here reported, however, the problem has just been touched and the basic question remains unresolved. Its solution calls for a widely based study of leprosy indices in an adequate and representative number of endemic areas in different phases of the epidemic cycle.

SUMMARY

1. This communication, based on data from areas located in six different districts, presents a composite picture of leprosy as a household problem in the plains of Uttar Pradesh. In these areas 2,829, or 3.8 per cent of the 74,157 surveyed households, were found to be affected with the disease. The prevalence rate for affected households ranged between 2.2 and 5.8 per cent of those surveyed. Multiple and secondary cases constituted 17.7 and 9.6 per cent respectively of the total case-pool. The prevalence rate for secondary cases among the household contacts was found to be 1.8 per cent.

2. Although the prevalence of disease among inmates of multiple (25.6%) and single case households (14.9%) differed considerably, the trend of prevalence among them by age groups was similar. The highest rate of prevalence was seen in the 45-59 year age group, while the distributional peak of cases was in the 30-44 years age group. Leprosy prevalence was higher in male than in female inmates, but among children the prevalence in the two sexes did not show much difference. As a group female patients were younger than male patients.

3. Multiple case households constituted 9.0 per cent of the households affected. Not only was the average size of multiple case households (8.5) larger than the average for household size in the area (6.4), but it was found to increase from 8.2 to 13.0 as the number of cases per household increased.

4. The values for lepromatous, male sex, and childhood rates, respectively, were 15.9, 77.6 and 7.3 in single cases, 19.2, 68.7 and 16.7 in multiple cases, and 16.5, 76.0 and 9.0 in total cases. From this it has been concluded that, although the multiple cases differed considerably from the single cases, they did not materially alter the lepromatous and sex rates in the total case-pool. Child rates among the total cases, however, were raised by multiple cases.

5. Within the limits of the conditions obtaining in the areas studied, it was observed that a high prevalence of disease was associated with high child, and multiple case household rates, and low male sex and lepromatous rates. Apparently the values for multiple case rates, child rate, and total leprosy prevalence in an area are interlinked. It is probable that identifiable values of some of the epidemiologic indices of leprosy are associated with different levels of disease prevalence. Their identifi-

cation with a view to improvement in epidemetrics of leprosy is proposed.

6. In multiple case households the prevalence rate of secondary cases among blood relations of index cases (17.3%) was significantly higher than the rate in nonblood relations (12.2%). This held also for various age and sex subgroups within these two groups of relations. These findings provide indirect evidence in favor of the argument for a hereditary element in susceptibility to leprosy.

RESUMEN

1. Esta comunicación que se basa en la información que proviene de áreas ubicadas en seis distritos distintos, presenta un cuadro variado de la lepra como problema familiar en los llanos de Uttar Pradesh. En estas áreas, 2,829 familias, el equivalente al 3.8 por ciento de las 74,157 familias estudiadas, se encontraron estar afectadas por la enfermedad. La tasa de prevalencia en las familias afectadas varió entre 2.2 y 5.8 por ciento. Los enfermos en familias con casos múltiples y los casos secundarios constituyeron el 17.7 y 9.6 por ciento, respectivamente, del total de casos reunidos. La tasa de casos secundarios entre los contactos familiares fué de 1.8 por ciento.

2. Si bien la prevalencia de la enfermedad en los casos que permanecen en sus domicilios, en familias con múltiples enfermos (25.6 por ciento) y con un solo enfermo (14 9 por ciento) varió considerablemente, la tendencia de la prevalencia por grupos de edad, en cambio, fué semejante. La tasa más alta de prevalencia se observó en el grupo de 45-59 años de edad, en tanto que el acmé de la curva de distribución correspondió al grupo de 30-44 años de edad. La prevalencia de la lepra fué mayor en los hombres que permanecían en sus domicilios que en las mujeres en igual situación, en tanto que en los niños la prevalencia no tuvo tal diferencia entre los sexos, a pesar de que el grupo de enfermos de sexo femenino era más joven que los enfermos de sexo masculino.

3. Las familias con casos múltiples constituyeron el 9.0 por ciento de las familias afectadas. No solo fué el promedio de familias con casos múltiples (8.5) mayor que el promedio por familia en el área (6.4), sino que se encontró que aumentaba de 8.2 a 13.0 a medida que el número de casos por familia se elevaba.

4. Las cifras para lepromatosos, sexo masculino y tasas juveniles, respectivamente, fueron de 15.9, 77.6 y 7.3 en familias con casos únicos, y 19.2, 68.7 y 16.7 en familias con casos múltiples, en tanto que para el total de casos estos valores correspondieron a 16.0, 76.0 y 9.0. De lo anterior se concluye que si bien los enfermos en familias con casos múltiples difieren considerablemente de los enfermos en familias con un solo caso, ellos no alteran la tasa de formas lepromatosas ni la tasa por sexo en el conjunto de enfermos. La tasa de niños enfermos, en el total de casos, se alzó como resultado de los casos en familias que tenían múltiples enfermos.

5. Dentro de un contexto general, en las áreas estudiadas, se observó que la alta prevalencia de la enfermedad estaba asociada con tasas elevadas en la juventud y familias con casos múltiples y con tasas bajas en el sexo masculino y formas lepromatosas. Aparentemente, las tasas en familias con casos múltiples, la tasa de prevalencia en la juventud y la prevalencia total de la lepra en un área están relacionadas unas con otras. Es probable que cifras identificables de algunos índices epidemiológicos de la lepra están asociados con los diferentes niveles de prevalencia de la enfermedad. Se propone identificarlos con el propósito de mejorar la epidemjometría de la lepra.

6. La tasa de casos secundarios, a partir de casos índices, en parientes consanguíneos, en familias con múltiples enfermos (17.3 por ciento) fué significativamente más alta que la tasa en parientes no consanguíneos (12.2 por ciento). Esto es igualmente válido para los distintos sub-grupos de edad y sexo en los dos grupos de parentesco. Estos hallazgos constituyen una evidencia indirecta en favor del argumento de un elemento hereditario en la susceptibilidad a la lepra.

RÉSUMÉ

1. Cette communication est basée sur les données obtenues dans diverses régions de l'Inde, situées dans six districts différents. Elle traduit l'aspect complexe que présente la lèpre comme problème du foyer dans les plaines de l'Uttar Pradesh. Dans ces régions, on a observé que 2,829, c'est à dire 3.8 pour cent, des 74,157 foyers sur lesquels a porté l'enquête, étaient atteints de lèpre. Le taux de prévalence dans les foyers atteints variait de 2.2 à 5.8 pour cent, d'après les données obtenues dans les foyers étudiés. Les cas multiples et secondaires constituaient respectivement 17.7 et 9.6 pour cent du total des cas. On a observé un taux de prévalence de 1.8 pour cent chez las cas secondaires observés parmi les contacts domiciliaires.

2. Quoique la prévalence de la maladie chez les habitants des foyers à cas multiples (25.6 pour cent) ait différé considérablement de la prévalence notée dans les foyers ayant un seul cas (14.9 pour cent), l'allure de la courbe de prévalence en fonction des groupes d'âge était semblable dans les deux catégories. Le taux de prévalence le plus élevé a été observé dans le groupe d'âge de 45 à 59 ans, alors que le maximum de la distribution des cas se situait dans le groupe d'âge allant de 30 à 44 ans. Dans ces foyers, la prévalence de la lèpre était plus élevée chez les hommes que chez les femmes. Chez les enfants, toutefois, on n'a pas observé de différences notables de la prévalence entre les deux sexes. Dans l'ensemble, le groupe des malades de sexe féminin était plus jeune que celui des malades de sexe masculin.

3. Les foyers à cas multiples constituaient 9.0 pour cent des tous les foyers atteints. On a observé que la dimension moyenne des foyers à cas multiples (8.5) était plus grande que la dimension moyenne des foyers dans cette région (6.4); de plus, on a noté un accroissement de la dimension des foyers allant de 8.2 à 13.0 à mesure que le nombre de cas par foyer augmentait.

4. Les proportions respectives de malades lépromateux, de malades du sexe masculin, et d'enfants parmi les malades, étaient de 15.9, 77.6 et 7.3 chez les cas isolés, de 19.2, 68.7 et 16.7 dans les cas multiples, et de 16, 76.0 et 9.0 dans l'ensemble des cas. De ces données on a conclu que, malgré la différence considérable montrée par les cas multiples par rapport aux cas isolés, leur présence n'entraîne pas de modifications notables dans la proportion des cas lépromateux et dans la distribution selon l'âge dans l'ensemble des cas. Par contre, la proportion d'enfants dans l'ensemble des cas est accrue par la présence des cas multiples.

5. Dans la limite des conditions existant dans les régions étudiées, on a observé qu' une prévalence élevée de la maladie était associée avec une proportion élevé d'enfants parmi les cas, par un taux élevé de cas domiciliaires multiples, par une faible proportion de malades de sexe masculin, et par une proportion basse de malades lépromateux. Il semble que les valeurs obtenues pour les taux de cas multiples, pour la proportion d'enfants, et pour le taux de prévalence totale de la lèpre dans une région, constituent des paramètres liés entre eux. Il est probable que les valeurs identifiables de quelques uns des indices épidémiologiques utilisés dans la lèpre sont as-sociées avec différents niveaux dans la prévalence de la maladie. On propose l'identification de ces valeurs en vue d'améliorer l'épidémiométrie de la lèpre.

6. Dans les foyers à cas multiples, le taux de prévalence de cas secondaires parmi les parents de cas index liés par le sang, était significativement plus élevé (17.3 pour cent) que le taux observé chez des parents sans liens du sang (12.2 pour cent). Cette observation est également valable aux différents âges et dans les groupes répartis selon le sexe. Ces résultats fournissent un argument indirect en faveur de l'existence d'un élément héréditaire dans la susceptibilité à la lèpre.

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