

## Some Epidemiological Observations on Leprosy in India<sup>1</sup>

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Leprosy continues to be one of the major public health problems in many countries, including India (<sup>6</sup>). Although the introduction of multidrug therapy (MDT) has resulted in a sharp decline in the caseload, yet about 600,000 new cases are being reported each year in India alone. Thus, in spite of a declining trend in the prevalence of leprosy, the incidence or new case detection rate (NCDR) has not shown any significant decline during the last several years. In fact, a 1999 report of a modified leprosy elimination (MLEC) (Dharamasaktu, N. S. Report of modified leprosy elimination campaign. NLO Bull. 28, 1999, 97-103) has revealed that the prevalence rate, which during the pre-MLEC period was 4.75/10,000, had increased to 10.02/10,000 after the MLEC, showing a 92.2% increase which possibly is because of the detection of hidden cases. During the period, incidence or the NCDR has been shown to be higher (<sup>4</sup>) than prevalent cases. In JALMA, a specialized hospital for leprosy, about 200 new leprosy patients are being seen each year from the Agra District of India alone. The question one would like to answer is why this is happening? Is it that MDT is not effective or that it needs a changed strategy, particularly with reference to length of therapy among multibacillary (MB) patients (<sup>3</sup>), or have our efforts at case detection been inadequate? To find the answer to above, sample surveys have been conducted in rural and urban areas of Agra.

Here we report our 1-year experience in the community.

### METHODS

Geographically, Agra is a district on the extreme west of Uttar Pradesh about 150 kms south of Delhi with total population of about 3.3 million of which about 42% is urban and the rest live in rural areas. The district is composed of six Tahsil (subdistricts), namely, Agra, Bah, Fatehabad, Etmadpur, Kiraoli and Kheragad. Leprosy Control Units (LCU) which cover the whole district are supposed to extend SET (survey, education and treatment) services to the entire district. In reality, this coverage has been totally inadequate (Kumar, A., Qamra, S. and Girdhar, B. K. Frequency of leprosy campaign in U.P. NLO Bull. 29, 2000, 5-7). In addition, the district has a specialized treatment, training and research center.

As part of the countrywide case-detection activity, the state government in the district in 1999 and 2000 has reportedly conducted two Leprosy Elimination Campaigns (LEC). The actual coverage/population covered during these surveys has likewise been very poor. The present work undertaken during July 1999-June 2000 has been limited to 64 villages spread over all the subdistricts and 26 urban units, selected using systematic random sampling procedures. In each unit, 40 households were selected for survey. The survey team was composed of trained paramedical workers and highly experienced medical doctors. All of the cases detected and suspected by paramedical workers were confirmed by the medical officer who accompanied the team. Details about an individual's age, sex, education, occupation, BCG vaccination status, and household characteristics, such as type of house (kuccha, made of mud and straw; pucca, made of cement and bricks and semipucca, a mix of both types), cleanliness

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TABLE 1. *New leprosy cases detected and prevalent leprosy cases in Agra District, 1999–2000.*

Area	Persons examined	Leprosy cases		Total detected cases	Prevalence/1000 population examined
		New	Prevalent		
House survey	11,969	66	13	79	6.6
School survey	1,351	01	00	01	0.7
Rural	13,320	67	13	80	6.0
Urban house survey	3,841	12	03	15	3.9
Total	17,161	79	16	95	5.5

in and around, exposure to sunlight, toilet facility, and drainage, were recorded in addition to the outcome of a clinical examination. Patients detected in the field who had active disease and completely denied a history of treatment were taken as new cases, while those under treatment, active but had discontinued treatment, or declared released from treatment (RFT) but again active were taken as prevalent cases. The NCDR and prevalence rates quoted here are per 1000 population. When a case was found, the patient was given the appropriate treatment for 1 month or rifampin-ofloxacin-minocycline (ROM) as the case may be and then called to the JALMA hospital for investigations and further treatment.

A total of 13,320 people in rural areas and 3841 in urban areas (including semi-urban and slum areas) have been examined in an intensive door-to-door survey. The population examined also included 1351 school children in villages surveyed, and only one case was detected among school children. Since the information collected on children examined in schools did not have household information, the prevalence figures with reference to household characteristics did not include 1351 in the denominator and one case in the numerator.

The data have been analyzed using SPSS software, and prevalence has been compared for significance using the  $\chi^2$  test or Fisher's exact test using Epi-Info software (<sup>1</sup>) as the case may be. To assess the risk,

TABLE 2. *Leprosy caseload in rural and urban areas of Agra.*

No. cases	Rural areas		Urban areas	
	No. villages	%	Urban units	%
0	23	35.9	16	61.5
1	20	31.3	6	23.1
2	9	14.1	3	11.5
3	8	12.5	1	3.8
4	3	4.7	0	0
6	1	1.6	0	0
Total	64	100	26	100

odds ratios (OR) are computed using univariate and multivariate regression.

## RESULTS

### Geographical prevalence of leprosy

In rural areas, 13,320 persons were examined and of them 80 active cases of leprosy were detected, giving a prevalence of 6.0/1000 persons. This includes 67 new cases detected (NCDR 5.0/1000). Of the 13,320 persons examined in rural areas, 1351 were children examined in primary schools and one new case was detected in these schools. On the other hand, prevalence in urban areas was found to be 3.9/1000 (NCDR 3.1/1000). No school survey was undertaken in urban areas. The overall prevalence thus was 5.54/1000 or 55.4/10,000 population examined (Table 1).

Of the 64 villages surveyed, 41 (64.1%) were found to have at least one leprosy patient. Similarly, 10 (38.5%) of the 26 urban units had at least one leprosy patient (Table 2). In other words, in 23 (36%) villages and 16 (61.5%) urban units, no leprosy patient could be detected.

Details of the leprosy caseload in various Tahsils (subdistricts) is given in Table 3. At the Tahsil level, the highest prevalence of leprosy in the rural areas (8.8/1000) was observed in Bah Tahsil; the lowest (1.1/1000) in Agra. When both rural and urban settings were taken together, the prevalence of leprosy in Bah Tahsil was 7.9/1000 and 3.2/1000 in Agra. The data thus clearly reveal a significantly high prevalence of leprosy in Bah, Fatehabad and Kheragad Tahsils compared to the others (Table 3).

TABLE 3. *NCDR and prevalence of leprosy by Tahsil, Agra District, 1999–2000.*

Name of Tahsil	Persons examined	NCD/1000 (no. cases)	PR/1000 (no. cases)
Bah			
Rural	3,986	7.0 (28)	8.8 (35)
Urban	983	3.1 (03)	4.1 (04)
Total	4,969	6.2 (31)	7.9 (39)
Agra			
Rural	934	1.1 (01)	1.1 (01)
Urban	2,858	3.2 (09)	3.9 (11)
Total	3,792	2.6 (10)	3.2 (12)
Kheragad	1,633	5.5 (09)	6.1 (10)
Fatehabad	4,574	5.3 (24)	5.5 (25)
Kiraoli	1,469	2.7 (04)	5.4 (08)
Etmadpur	724	1.4 (01)	1.4 (01)
Total	17,161	4.6 (79)	5.5 (95)

### Prevalence among children and adults

Of the total of 8374 children (<15 years) examined (Table 4), the prevalence of leprosy was found to be 1.2/1000. Of the 10 child leprosy patients, three had multibacillary (MB) disease. As expected, adult males had a higher prevalence of leprosy (16.1/1000) than females (5.2/1000) of the same age group (Table 4).

### Clinical presentation of disease

As stated above, a total of 95 cases were detected in the sample study. Of these, 30.5% (29/95) were of the MB type (includes all BB/BL/LL patients and BT patients with either >5 patches or 1–5 patches and >2 thickened nerves, or neuritic patients with >2 thickened nerves). The remaining cases were of the paucibacillary (PB) type. Of the 66 PB cases, 51.5%

(34/66) were single skin lesion (SSL) cases. Of the 24 SSL patients, a third had one or more thickened nerves, more often the local cutaneous nerves. This includes 13.7% (13/95) cases with only one nerve thickened. Of the total cases, 37.6% (36/95) had BT type of disease with <5 lesions and ≤2 thickened nerves (PB); 3.2% (3/95) were TT, and indeterminate accounted for 8.4% (8/95), while 20% (19/95) had neuritic disease with ≤2 nerves affected. Of the 29 patients with MB disease, BT (MB type) or BB disease was seen in 16.8% (16/95) and BL/LL in 10.5% (10/95) and three patients were of the neuritic type with ≥2 nerves affected (Table 5). Three patients were found to be in reaction.

**Disability.** Of the 67 new cases in rural areas, disability of grade II or higher was found in 10 patients, giving a disability rate of 14.9% (4 patients had claw hand; 1 pa-

TABLE 4. *Prevalence of leprosy among children and adults by sex and classification of disease.*

Group	Population examined	Disease classification										Total cases of all types	Prevalence/ 1000 population examined
		Paucibacillary					Multibacillary						
		I	TT	BT	N <sup>a</sup>	BT	BB	BL	LL	N <sup>b</sup>			
Children age <15	8,374	4	1	2	0	1	1	1	0	0	10	1.2	
Male ≥15	3,607	4	1	24	10	5	4	4	4	2	58	16.1	
Female ≥15	5,180	0	1	10	9	2	3	1	0	1	27	5.2	
Total	17,161	8	3	36	19	8	8	6	4	3	95	5.5	

<sup>a</sup>Patients with ≤2 thickened nerves taken as PB.

<sup>b</sup>Patients with >2 thickened nerves taken as MB.



TABLE 5. *Leprosy cases by status of patches and thickened nerves in Agra District, 1999–2000.*

No. patients with patches	Patients with thickened nerves						Percent distribution
	0	1	2	3–5	>5	Total	
0 (no lesion)	0	13	6	3	0	22	23.2
1	22	11	1	0	0	34	35.8 (SSL) <sup>a</sup>
2	0	2	4	2	0	8	
3	0	2	2	1	0	5	
4	0	0	1	0	0	1	
5	1	1	1	0	0	3	
>5	5	1	6	5	5	22	
Total	28	30	21	11	5	95	

<sup>a</sup>SSL = single skin lesion.

tient in addition has a depressed nose; 3 cases of foot drop; 1 case of depressed nose; and 2 cases have absorption of fingers and toes). However, in the urban areas 25.0% (3/12) of the new cases were found with some disability: one patient each with claw hand, foot drop and one patient with foot drop and claw hand. Overall, the disability rate was found to be 13.7% (13/95).

#### Prevalence of leprosy by individual characteristics

**Age and sex.** Prevalence of leprosy was 1.25/1000 among persons under 15 years of age and increased monotonically to 28.5/1000 among persons aged >59 in the rural areas. In urban areas, the prevalence was 1.1/1000 among persons aged <15, increased to 12.0/1000 in the middle-age group (30–44), and then declined. Males in rural areas had significantly higher prevalence of disease ( $p < 0.001$ ) than females (8.9/1000 vs 3.4/1000). No such difference was observed between the two sexes in urban areas (Table 6).

**Education and work status.** In rural areas, persons with no formal education were found to have a higher prevalence (7.3/1000) of leprosy than those with formal education (4.5/1000). The difference was statistically significant (OR 1.6; 95% CI 1.01–2.68;  $p = 0.035$ ). The blue collar (manual) workers involved in agriculture, leather and other labor-oriented jobs were found to have a significantly ( $p < 0.0001$ )

higher prevalence of leprosy (19.7/1000) than others such as students, housewives and persons with no work (3.3/1000). Similarly, in urban areas manual workers had a significantly ( $p < 0.001$ ) higher prevalence (13.0/1000) of leprosy than others (2.3/1000).

**BCG status.** In rural areas, persons with no BCG scar had a slightly higher prevalence of leprosy (6.7/1000) than persons with a BCG scar (5.5/1000). A limited population survey in the urban areas showed that persons with a BCG scar had a significantly ( $p < 0.001$ ) higher prevalence of leprosy (7.8/1000) than those without a BCG scar (0.5/1000).

#### Prevalence of leprosy by household environment

**House type.** More persons living in kuccha (thatched) houses were observed to have leprosy (PR 7.8/1000) than those residing in semi-pucca or pucca houses (PR 5.4/1000) in rural areas. Similarly, in the urban area, prevalence was 7.8/1000 in families living in kuccha and 3.6/1000 in semi-pucca/pucca houses, respectively. In either case the difference was not statistically significant.

**Cleanliness of house.** In rural areas, houses that seemed to be dirty had a significantly ( $p < 0.01$ ) higher prevalence of leprosy (9.4/1000) than those houses that were found to have been kept clean (4.9/1000). A similar observation was noted in the urban areas (8.9/1000 vs 2.1/1000; Fisher's exact test;  $p = 0.003$ ).

**Cleanliness of surroundings.** In the rural areas, leprosy prevalence was found to be higher (PR 7.6/1000) in houses with dirty to very dirty surroundings than in those houses with clean surroundings (PR 4.9/1000). Similarly, in urban areas persons living in households with dirty to very dirty surroundings had a higher prevalence (4.8/1000) compared to 1.8/1000 in households with clean surroundings; however, this is not statistically significant. ( $p = 0.09$ ).

**Exposure to sunlight.** In rural areas, persons living in households with sufficient exposure to sunlight had a lower prevalence of leprosy (6.2/1000) than those with insufficient exposure to sunlight (PR 9.7/1000). The difference is, however, not statistically significant.

TABLE 6. *Prevalence of leprosy by personal and household characteristics, Agra District, 1999–2000.*

Variable	Rural Agra		Urban Agra	
	No. examined	Prevalence/1000 (no. cases)	No. examined	Prevalence/1000 (no. cases)
Age				
<15	6,494	1.3 (08)	1,880	1.1 (02)
15–29	2,915	3.8 (11)	942	3.2 (03)
30–44	1,939	8.3 (16)	584	12.0 (07)
45–59	1,131	18.6 (21)	263	7.6 (02)
>59	841	28.5 (24)	172	5.8 (01)
All	13,320	6.0 (80)	3,841	3.9 (15)
Sex				
Male	6,310	8.9 (56) <sup>a</sup>	1,790	4.5 (08)
Female	7,010	3.4 (24)	2,051	3.4 (07)
Education				
None	7,270	7.3 (53) <sup>a</sup>	1,776	5.1 (09)
Formal <sup>b</sup>	(6,050) <sup>b</sup>	4.5 (27) <sup>b</sup>	(2,065) <sup>b</sup>	2.9 (06) <sup>b</sup>
≤5 yr	3,348	3.0 (10)	801	2.5 (02)
5–10	2,251	6.7 (15)	1,062	3.8 (04)
>10	451	4.4 (02)	202	0.0
Work				
Agriculture/blue collar	2,230	19.7 (44) <sup>a</sup>	614	13.0 (08) <sup>a</sup>
Others	(11,090) <sup>b</sup>	3.3 (36) <sup>b</sup>	(3,227) <sup>b</sup>	2.3 (07) <sup>b</sup>
None	3,817	3.1 (12)	918	1.1 (01)
Students	3,678	1.6 (06)	1,257	0.8 (0.1)
H/W	3,595	5.0 (18)	1,052	4.8 (05)
Religion				
Hindu	11,565	6.7 (78)	3,460	3.5 (12)
Muslim	404	2.5 (01)	380	7.9 (03)
BCG				
Yes	7,960	5.5 (44)	1,901	7.8 (14) <sup>a</sup>
No	5,360	6.7 (36)	1,940	0.5 (01)
House type				
Kuccha	5,126	7.8 (40)	258	7.8 (02)
Semi-pucca/Pucca	7,289	5.4 (39)	3,578	3.6 (13)
House cleanliness				
Clean	7,505	4.9 (37)	2,833	2.1 (06)
Dirty/very dirty	4,464	9.4 (42) <sup>a</sup>	1,008	8.9 (09) <sup>a</sup>
Surroundings				
Clean	4,883	5.1 (25)	1,105	1.8 (02)
Dirty	7,086	7.6 (54)	2,736	4.8 (13)
Sun exposure				
Sufficient	10,521	6.2 (65)	3,820	3.9 (15)
Insufficient	1,448	9.7 (14)	21	0

<sup>a</sup>Indicates significance of difference.<sup>b</sup>Combined with detail given.

## DISCUSSION

Important observations come from these data. Leprosy prevalence, both in the rural and urban areas of Agra District, seems to be high, especially with reference to the leprosy elimination target of <1/10,000. In the present ongoing study, the data show

that the prevalence rate in the Agra region is 60.1/10,000 in rural areas, 39.1/10,000 in urban areas and 55.4/10,000 in the whole population surveyed. Geographically, the disease seems to exist in almost two thirds of the areas surveyed, indicating its widespread nature. It is noteworthy that the lowest prevalence (1.4/1000) found in Etmad-



TABLE 7. *Unadjusted and adjusted odds ratios of factors for leprosy transmission in Agra District.*

Variable	Odds ratios <sup>a</sup> (95% CI)		Odds ratios (95% CI) <sup>b</sup>		Odds ratios (95% CI) <sup>c</sup>	
Cleanliness of house (COH)						
Yes	0.48	(0.32–0.73)	0.49	(0.33–0.74)	0.49	(0.33–0.75)
No	1.0		1.0		1.0	
Formal education						
Yes	0.95	(0.61–1.49)	0.97	(0.62–1.52)	0.56	(0.35–0.90)
No	1.0		1.0		1.0	
Work status						
HW/Students, etc.	0.45	(0.29–0.71)	0.45	(0.29–0.72)	0.53	(0.28–1.02)
Blue-collar	1.0		1.0		1.0	

<sup>a</sup>Unadjusted.<sup>b</sup>Adjusted for rural/urban status.<sup>c</sup>Adjusted for rural/urban status and for age, sex.

pur Tahsil is still more than 10 times the national targeted prevalence of <1/10,000. Detection of disease in children indicates continuing infection in the community because of a hidden pool of infection.

In Agra, persons with formal schooling were observed to have a significantly lower risk of leprosy, as observed after adjustment (OR 0.56; 95% CI 0.35–0.90) for rural/urban status, age and sex (Table 7). The findings are similar to those from Malawi where extended schooling and good housing have been reported to be associated with a reduced risk of leprosy (<sup>7</sup>). Agricultural/blue collar workers had a significantly higher risk of disease than did housewives, students or the unemployed, who had nearly half the risk of disease (OR 0.53; 95% CI 0.28–1.02). This could be because of the higher chances of coming into contact with germs while engaged in work with the soil, leather or other labor-oriented jobs and, therefore, with infection. Persons living in clean housing had one half the level of risk (OR 0.49; 95% CI 0.33–0.75) of acquiring disease than did those who lived in dirty to very dirty houses (Table 7). Similarly, persons living in dirty surroundings also have a higher risk of leprosy (OR 1.49; 95% CI 0.91–2.47) and, also, persons living in houses with insufficient exposure to sunlight were observed to be more afflicted by the disease (OR = 1.57; 95% CI: 0.84–2.88). In urban areas, persons using outdoor toilet facilities had a significantly higher prevalence (5.6 vs 1.3/1000) of disease (Fisher's exact test,  $p$ , <0.05). These observations clearly reveal the role of poor sani-

tary conditions in increasing the chances of leprosy transmission. Observations from the Punjab have indicated a similar role of environmental factors in transmitting leprosy (<sup>5</sup>).

During our survey all available contacts had been examined. The examination of contacts of 29 MB patients revealed four cases of leprosy, giving a prevalence rate of 28.4/1000 (4/141) among MB contacts. This is more than five times the overall prevalence in the community. It is suggested that although residential contacts with MB cases is the strongest risk known risk of leprosy transmission, the vast majority of such contacts never manifest the disease indicating a crucial role for genetic and/or environmental factors (<sup>2</sup>). It can thus be hypothesized that a dirty living environment probably creates conditions suitable for transmission of *Mycobacterium leprae* which causes the disease.

Taking the figures of both urban and rural together, it was also found that BCG did not offer any protection against leprosy. As is well known, the BCG scar often fades out as age advances and, therefore, it is possible that among adults this factor may not reveal the true significance of a difference.

The study thus indicates that Agra District, which had been considered a low endemic area, has a significant caseload, the prevalence of leprosy ranging from 44.1 to 66.7 per 10,000 (95% CI) (<sup>8</sup>). If the number of new cases detected plus the number of cases under treatment are any indicators than guesstimates would suggest that there may be a large number of cases in the com-



munity. Therefore, there is a need for intensive efforts to cover the entire population so as to detect all hidden cases and bring them under treatment to achieve the national target of leprosy eradication.

### SUMMARY

This population sample survey conducted in rural and urban areas of the Agra District in India showed an active leprosy caseload of 60.1/10,000 in the rural and 39.1/10,000 in the urban areas against a targeted prevalence of <1/10,000. The disease appeared to be widespread since almost 65% of the villages or urban pockets surveyed had at least one prevalent case of leprosy. Significantly larger numbers of leprosy patients were found among males, agricultural/manual workers, persons with no formal schooling, individuals living in unkept households with dirty surroundings, and among those living in dark and poorly ventilated houses. The epidemiological significance of this study reveals the endemic nature of leprosy in Agra and suggests the need to intensify and widen case-detection activities to achieve leprosy control.

### RESUMEN

Esta investigación, realizada en las áreas rural y urbana del Distrito de Agra en India, indicó una incidencia de lepra de 60.1/10,000 en el área rural y de 39.1/10,000 en el área urbana, contra una prevalencia deseada de <1/10,000. La enfermedad pareció estar muy diseminada ya que casi el 65% de las regiones rurales o urbanas tuvieron cuando menos un caso prevalente de lepra. Se encontraron más casos de lepra entre los hombres, trabajadores agrícolas o manuales, personas sin escolaridad formal, individuos habitantes de lugares hacinados y alrededores sucios, y moradores de casas oscuras y mal ventiladas. El significado epidemiológico de este estudio revela la naturaleza endémica de la lepra en Agra y sugiere la necesidad de intensificar la búsqueda de casos para lograr el control efectivo de la lepra.

### RÉSUMÉ

Cette enquête, portant sur un échantillon de population localisée à des sites ruraux et urbains du district d'Agra en Inde, a révélé 60,1/10 000 et 39,1/10 000 cas de lèpre active, respectivement, comparée à une prévalence cible inférieure à 1/10 000. La maladie est

apparue être disséminée puisque presque 65% des villages et quartiers urbains présentaient un cas prévalent de lèpre. Un nombre significativement supérieur de patients hanséniens fut observée parmi les hommes, les ouvriers agricoles/travailleurs manuels, des personnes sans éducation scolaire formelle, des individus vivant dans des foyers mal entretenus avec voisinage sale, et parmi ceux vivant dans de maisons sombres et mal ventilées. L'implication épidémiologique de cette étude est que la lèpre est endémique dans la région d'Agra et surtout qu'il est nécessaire d'intensifier et d'élargir les activités de détection de nouveaux cas afin d'obtenir un meilleur contrôle de la lèpre.

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