Prevalence of Leprosy in Gudiyatham Taluk, South India Part II. Geographical Variations^{1,2}

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The prevalence of leprosy varies between continents. Likewise, countries within a continent have differing rates of prevalence of leprosy (15). Even countries in which leprosy is endemic may demonstrate variations in leprosy prevalence from one state to another, and even from one district to another within the same state (13, 14,-¹⁵). The reasons for these variations have not been fully explained. The relationships existing between the type of leprosy and the total prevalence also have not been conclusive. Further studies, therefore, appear to be necessary to document the existence of the variations and to study the relationships between known demographic and geographic factors as related to leprosy. A previous paper described the specific rates of leprosy with reference to age, sex and type (⁸). In this paper the geographical variations observed within one taluk in a district are described and discussed with specific reference to the type of leprosy and certain demographic factors.

MATERIALS AND METHODS

Description of the area. The taluk of Gudiyatham is an inland area lying between $78^{\circ}35'$ to $79^{\circ}20'$ eastern longitude and $12^{\circ}40'$ to $13^{\circ}05'$ northern latitude and

⁴ An administrative subdivision of North Arcot District.

having an area of 510 square miles (Fig. 1). The climate of the taluk is warm throughout the year with low relative humidity. The mean maximum temperature varies between 30° C and 40° C and the mean minimum between 12° C and 23° C. The average rainfall is 800-900 mm per year.

Many small hillocks lie scattered in this region. The river Palar is the southern boundary and the rivers Goddar and Kaundanya flow from north to south and are tributaries to the river Palar. Except for a few days each year, these rivers are dry sandy wastes.

The forests in Gudiyatham Taluk are of fuel and scrub type. The northwest part is hilly and rises gradually along the neighboring district of Chittoor. The southern part is the Palar River bed, fertile enough to produce paddy and sugar cane. The soil is of black, red and alluvial types.

According to 1961 census reports $(^2)$, the population of the taluk was 385,228, the density was 755 persons per square mile, 40.3% of population were below ages 15 years, and 78% were living in rural areas. There were 982 females per 1,000 males, and the average size of household was 5.35. Of the total population, 42.6% were engaged in productive activities, cultivation being the main occupation.

About 65% of houses in the rural areas have mud walls, 23% have burnt brick walls, 67% have grass, leaf or similar roofs. Only 29% have tiles, slates, etc., 67% of the houses have only one room per house while the average number of persons per house is 3.19. A majority of the population belongs to poor socio-economic groups having poor sanitation. Of the total population, the Hindus form 93.3%, Muslims 4.3% and Christians 2.3%.

Prevalence surveys. Because of the known

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FIG. 1. Gudiyatham Taluk area map.

endemicity of leprosy in this taluk, a domiciliary treatment and leprosy control program was initiated by the Schieffelin Leprosy Research Sanatorium, Karigiri, in the latter part of 1962. The whole taluk was divided into 43 peripheral zones (centers), each having a clinic. Eight of the centers each had a population below 3,000; seven with a population of 3,000-4,999; ten with a population of 5,000-6,999; ten with a population of 7,000-9,999; and seven with a population of more than 10,000.

One or more of the centers were under the supervision of a trained paramedical worker, who was in charge of approximately 20,000 persons. A screening program for the taluk was successfully completed by 1967 in which the paramedical workers had visited every household (family) and surveyed all resident persons. After collecting data regarding demographic factors and environmental conditions, each person in the household was examined for leprosy. Where leprosy was suspect the subjects were referred to clinics where they were examined by clinicians. Skin smears were taken and the Bacterial Index (BI) determined according to Ridley's scale. Those found to have leprosy were registered and followed-up. For each of these cases, the basic demographic, social and medical data are available. A resurvey of the area was designed and carried out during 1968-1970 (⁸).

Gudiyatham town which had a population of 50,384 in 1961, is much influenced by a high migration rate. Data pertaining to this urban area is not included in this paper. The remaining 42 peripheral centers are considered here. In these, 305,096 persons were enumerated and 276,568 persons were examined as of April 1970. Of a total of 8,371 patients registered in these centers, 726 were not true residents of the taluk, and 503 had died, migrated or were lost and could not be followed-up. Of the remaining 7,142 patients; 17.6% had lepromatous, 55.5% tuberculoid, 10.5% borderline and 16.4% indeterminate type leprosy. There were 731 female patients per 1,000 male patients as compared with 984 females per 1,000 males in the population examined, thus indicating that leprosy is more prevalent among males. The child ratio (number of persons aged below 15 years per 100 persons of all ages) was 25



FIG. 2. Total prevalence rate in each peripheral center area of Gudiyatham Taluk.

among patients as compared with 43 for the population examined, indicating that leprosy was more prevalent among adults.

RESULTS

For the whole taluk the prevalence rate is 25.82/1,000. The rate varied from 11.98/1,000 to 126.37/1,000. The variation of prevalence rates according to the number of centers so involved is given in Table 1. The total prevalence rates at each of the centers are plotted in Figure 2.

TABLE 1. Number of centers grouped according to leprosy prevalence rates.

(per 1,000 population)	No. of centers
10-19	11
20-29	14
30-39	6
40-49	4
50-59	_
60-69	2
70-79	4
126.37	1
Total	42

Leprosy prevalence is higher in the western and northern parts and less in the eastern and southern parts. There were small hillocks in the area where the prevalence is high and the areas with low prevalence are plain lands or the Palar bed.

The 42 centers arranged according to groups based on the lepromatous rates, and the total prevalence rate as calculated in each group are presented in Table 2.

The prevalence rate increases with rise in lepromatous type prevalence rate (r =+0.889, P < .001). However, since the total prevalence rate is an addition of all the type-specific rates, a positive correlation also exists between the type-prevalence rates and total prevalence. Therefore, the centers were grouped by lepromatous index and the prevalence rates recalculated for each group in Table 3.

The relationship is not direct. The correlation coefficient between the lepromatous index and prevalence rate was: r = -0.024, which is not statistically significant.

The prevalence rate seems to be directly related to the child ratio among patients

Lepromatous prevalence rate	No. of centers	No. of patients	Population	Leprosy prevalence rate
Below 3.00	8	891	53,521	16.65
3.00 - 3.99	10	1956	99,071	19.74
4.00-4.99	7	1278	49,560	25.79
5.00 - 5.99	4	829	28,412	29.18
6.00 - 6.99	6	1070	28,322	37.78
8.00 & Over	7	1118	17,682	63.23
Total	42	7142	276,568	25.82

TABLE 2. Total versus lepromatous prevalence rates.

TABLE 3. Total leprosy prevalence as related to the lepromatous index.

Lepromatous index	No. of centers	No. of patients	Population	Prevalence rate
Below 10	3	361	9,009	40.07
10.00 - 14.99	9	1580	62,112	25.44
15.00 - 19.99	18	2908	106,490	27.31
20.00 & Over	12	2293	98,957	23.17
Total	42	7142	276,568	25.82

TABLE 4.	Leprosy	prevalence	rates	compared	with	child	ratio	among	patients.
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Child ratio for patients°	No. of centers	No. of patients	Population	Prevalence rate
Below 20	11	1814	90,329	20.08
20.00 - 24.99	12	2057	78,710	26.13
25.00 - 29.99	7	1410	57,212	24.65
30.00-34.99	6	1024	27,207	37.64
35.00 & Over	6	837	23,110	36.22
Total	42	7142	276,568	25.82

* Number of persons aged below 15 years per 100 persons of all ages.

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TABLE 5.	Total	prevalence	as	related	to	demographic	factors.

P-value		
0.7 <p<.8< th=""></p<.8<>		
0.02 < P < .05		
P<.001		
0.3 < P < .4		
P<.001		
0.05 < P < .1		
0.5 <p<.6< td=""></p<.6<>		
0.3 <p<.4< td=""></p<.4<>		

• Statistically significant.

and prevalence rate is r = +0.5493, which is statistically significant (P < .05).

Eight major demographic factors in the general population were examined in relation to the prevalence rate of leprosy. The factors considered were the percentages of males, of children (child ratio), of castes and tribes, of workers, and of literates, the number of persons per house, the number of persons per household and the number of persons per mile (population density). The correlation coefficients between total prevalence rate and each one of these factors are given in Table 5.

The percentage of children in the general population has a direct relationship with the prevalence rate (r = +0.3187, P < .05). Similarly the percentage of castes and tribes has a direct relationship with the prevalence rate (r = +0.5213, P < .05). The percentage of literates is inversely related to the prevalence rate (r = -0.4993, P < .05). All other factors have no significant relationship with the prevalence rate.

Since effective treatment would have arrested or completely cured or resulted in making the index cases noninfective, the duration of treatment may also be a factor in the variation of prevalence. In our data, the duration of the clinic and the control program in a center and prevalence rate were studied and found to be inversely related (r = -0.44, P < .05).

DISCUSSION

International or intranational comparisons on the prevalence of leprosy become difficult unless the studies have been carried out on a uniform basis. The methods of survey for detection of cases play an important role in determining the prevalence rate. Reports on prevalence should therefore be considered in relation to the methods employed before interpreting the variations noticed.

Most countries show wide leprosy prevalence variations between different regions. In Ecuador (⁴), the prevalence per 1,000 was 0.23 as compared with 0.51 in Cuba (⁶) and 20.9 in Argentina (¹). In Africa, the prevalence rate in the Upper Volta (⁹)

was 58.4 as compared to 25 per 1,000 in the Manga region (10). In Asia, reports indicate that Ceylon had a prevalence rate of 0.72, Indonesia 0.96, and Burma 30 per 1,000 (¹⁵). In India, the reported prevalence rates have shown wide variations, ranging from 8 per 1,000 in Maharashtra (⁵) to 35 per 1,000 near Wardha in Andhra Pradesh (14). In the present study, while one-third of the centers have a prevalence rate between 20 to 29 per 1,000 population, the remainder show either low rates or fairly high rates of prevalence. The reasons for these variations could not be entirely related to any geographic or demographic factor. While studying the history of leprosy in Netherlands, New Guinea, Leiker (7) suggested that the susceptibility of a community determines the pattern of prevalence more than the infectivity of the bacillus or demographic and social factors. In our earlier paper, emphasis was laid on the fact that the age structure determined the total prevalence of leprosy (⁸). Relationship between the type of leprosy and age was also established. The present analysis did not reveal any relationship between density of population and the total prevalence, but the level of literacy was inversely related. Since occupation and literacy are correlated, one may speculate as to whether occupational contacts, apart from intrafamilial contacts, are primarily responsible for the transmission of the disease.

In the present study while all typespecific rates seem to be associated with the total prevalence, the relationship between the lepromatous index and total prevalence showed an inverse relationship to a certain extent. With intensification of the control programs the lepromatous cases are rendered noninfective. However, those persons already infected continue to manifest the disease. Thus there results a continual increase in prevalence rate for some more time before a decline begins to register. In other words, the impact of a control program may be obvious only after it has been in operation for a certain period of time and when later identified cases are also put under control. Since the early cases were mostly children showing indeterminate type, the detection program contributes to

a higher prevalence rate. Dharmendra and Santra (³), in a study of several provinces of India, found a higher prevalence of leprosy associated with a high lepromatous type rate. On the other hand, Sharma and Prasad (¹¹) reported a low lepromatous rate in a group of villages in Utter Pradesh where the total prevalence was high. Spickett (¹²) indicated that lepromatous prevalence will be at its lowest at a time when total prevalence of the disease reaches its peak.

Barring a few exceptions, the prevalence was high in hilly areas. Further studies may be needed to identify specific environmental and climatic factors that may be contributing to this phenomenon. The present study indicates that while no single factor is responsible for the high prevalence of leprosy, the domiciliary program can be effective in reducing the magnitude of the problem. Further studies in this area should produce more evidence on the effectiveness of the control programs.

SUMMARY

Even within an endemic area, the prevalence of leprosy varies markedly between various geographic segments as shown in the rural areas of Gudiyatham Taluk, South India. The entire taluk was divided into 42 peripheral centers and for each area, the total prevalence as well as the distribution by type of leprosy was determined. The total prevalence per 1,000 population varied from 12 to 126, with a mean of 26. The prevalence was higher, in general, in the hilly areas. While the rates of each type of leprosy were correlated with the total prevalence rate, a somewhat inverse relationship was shown between the lepromatous index and the total prevalence. Eight major demographic factors were studied in relation to the total prevalence of which only three showed a significant correlation. The literacy rate correlated inversely with the total prevalence. No single factor could be shown to be responsible for these variations in prevalence. The implications of the findings are discussed in the light of effectiveness of leprosy control programs.

RESUMEN

Según lo observado en el área rural de Gudiyatham Taluk, India del Sur, aún dentro de un área endémica la prevalencia de lepra varía notablemente entre diferentes segmentos geográficos. Se dividió el Taluk completo en 42 centros periféricos y se determinó la prevalencia total y la distribución por tipos de lepra de cada área. La prevalencia total por 1000 habitantes varió entre 12 y 126, con una media de 26. Por lo general, la prevalencia fué más alta en las áreas montañosas. Aunque las tasas de cada tipo de lepra estaban relacionadas con la tasa total de prevalencia, se observó una relación algo inversa entre el índice de casos lepromatosos y la prevalencia total. Se estudiaron ocho factores demográficos principales en relación con la prevalencia total, de los cuales solamente tres mostraron una correlación significativa. La tasa de alfabetización fué inversamente proporcional a la prevalencia total. No se pudo demostrar que hubiera un solo factor aislado que pudiera ser responsable de estas variaciones de la prevalencia. Se discuten las implicaciones de estos hallazgos en relación con la efectividad de los programas de control de lepra.

RÉSUMÉ

Même á l'intérieur d'une région endémique, la prévalence de la lèpre varie de façon marquée dans les différentes zones géographiques, ainsi qu'en témoignent les observations faites dans les régions rurales du Gudiyatham Taluk, en Inde Méridionale. L'ensemble du Taluk a été divisé en 42 centres périphériques, et dans chacune des zones, on a déterminé la prévalence totale, de même que la distribution par type de lèpre. La prévalence totale pour 1.000 personnes a varié de 12 à 126, avec une moyenne de 26. La prévalence était plus élevée, en général dans les régions de collines. Lorsqu'on mettait en corrélation les taux de chaque type de lèpre, avec le taux de prévalence totale, on a observé une relation en quelque sorte inverse entre l'index lépromateux et la prévalence totale. Huit facteurs démographiques majeurs ont été étudiés, en relation avec la prévalence totale; trois seulement parmi ces facteurs ont montré une corrélation significative. Le taux d'alphabétisation témoignait d'une corrélation négative avec la prévalence totale. Aucun facteur unique n'a pu être mis en évidence, qui soit responsable pour les variations de prévalences observées dans cette étude. Las implications de ces résultats sont discutés en fonction de l'efficacité des programmes de lutte contre la lèpre.

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