Spatial patterns of leprosy in an urban area of central Brazil

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Reported is the spatial variation of leprosy in an urban area of Brazil and its correlation with socioeconomic indicators. From November 1991 to October 1992 a total of 752 newly diagnosed leprosy patients who were attending all outpatient clinics in Goiânia city, central Brazil, were identified. A database of leprosy cases was set up linking patients' addresses to 64 urban districts. Leprosy cases were detected in 86% of the districts and three risk strata were identified. The highest-risk area for leprosy was in the outskirts of the city and detection rates increased on moving from more developed to poorer areas. The risk of detecting leprosy cases was 5.3-fold greater (95% CI: 3.8–7.4) in the outskirts of the town than in the central zone.

Discussed are the methodological issues related to leprosy case ascertainment, completeness and reliability of information, and the interpretation of the spatial distribution of leprosy per unit area. Highlighted also are the lack of leprosy control activities in primary health care units and the usefulness of geographical analysis in planning health services.

Introduction

The occurrence and distribution of many infectious and parasitic diseases has changed because of the rapid growth of cities, internal migration, and socioeconomic changes in the least developed countries. Several studies have demonstrated the importance of rural–urban migration in disease patterns and the need to improve control strategies in urban settings (1–3).

In more than 90 countries, whose total populations amount to 2.4×10^9, leprosy is endemic, with a prevalence of at least 1 per 10 000.[a] Although the introduction of multidrug therapy (MDT) in the 1980s made a major contribution to treating leprosy in most of the endemic countries, the disease is still an important cause of morbidity and physical deformities in Asia, Africa, and Latin America (4, 5).

Examination of the records of patients attending the routine services of specialized leprosy pro-grammes has permitted time-trend analysis and comparisons between countries to be made (6–8). However, few studies have addressed the dynamics of leprosy transmission in urban environments in South America, particularly Brazil. To the best of our knowledge, the only study that did address this issue showed a rather variable distribution of leprosy cases among different socioeconomic census tracts in a highly urbanized area of south-east Brazil.[b] The need to improve understanding about the patterns of transmission of leprosy to facilitate the planning of health care services has encouraged the development of analytical tools based on studies of the geographical patterns of the disease (9–11).

This article reports the results of an ecological study designed to investigate the spatial variation of leprosy in an urban area and its relation to socioeconomic indicators, as a possible methodology to assist in the planning of health services.

Methods

Study area

The study was carried out in Goiânia, central Brazil, a city of population 900 000 (population density, 520 inhabitants/km²), 99% of whom live in the urban

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[b] **Andrade, VLG.** [*Epidemiological characteristics of Hansen's disease in a municipality of São Gonçalo, Rio de Janeiro*]. MSc thesis. Escola Nacional de Saúde Pública, Rio de Janeiro, 1990 (in Portuguese).

area. A large proportion of the population migrated from rural areas during an intense migration influx in the mid-1960s. Over the last two decades the annual population growth rate has decreased from 6.5 to 2.3 per 100 due to an important decline in fertility rates and in internal migration waves (12).

Goiânia is divided administratively into 64 districts, which are aggregations of census tracts and cover areas with broadly similar socioeconomic characteristics. These spatial units were conceived by the city council to define a framework for socio-economic policy and research purposes.

The study area has the second highest leprosy endemicity in Brazil, with a prevalence and annual detection rate of 3.7/1000 and 56.7/100 000 inhabitants, respectively. The detection rate has increased by 8% per annum over the last 20 years (7, 13).

The leprosy control programme in the city is based on passive case detection and treatment, and BCG vaccination of household contacts. Multidrug therapy (MDT), delivered as an outpatient regimen, is the first therapeutic choice for leprosy (13, 14). The local notification system is considered to be a reliable source of information, and is believed to include the majority of cases in this urban setting.

For the purposes of the study, a new case was defined as a person who showed clinical signs of leprosy and who had never been treated for the disease in the past. Case detection was carried out by trained doctors, and patients were classified on the basis of clinical signs and skin-smear results for allocation to MDT regimens, according to the Brazilian Leprosy Control Programme protocol.

The date of birth, address, date of first diagnosis, date of attendance, clinical type of leprosy, and the number of contacts were recorded for all newly diagnosed leprosy patients attending all seven outpatient clinics that provided treatment for leprosy patients in the city over the period November 1991 to October 1992.

Statistical analysis of data

A database of leprosy cases was set up linking patients' addresses to districts. Detection rates and 95% confidence intervals (95% CI) were calculated using the total number of leprosy cases notified by the sanitary authorities as numerator and the district population as denominator, at different geographical levels. Cases whose addresses could not be assigned to a specific geographical area were excluded from the analysis (5.5% of cases). The administrative districts' boundaries were drawn up from existing maps using computer-aided design (CAD) software. Five socioeconomically homogeneous areas were defined by grouping contiguous districts, taking into account

income level and the proportion of a district that was paved, according to the following categories: area I (minimum wage = 1; <15% of district paved); area II (minimum wage = 2; ≥15% to ≤90% of district paved); area III (minimum wage = 3; ≥15% to ≤90% of district paved); area IV (minimum wage = 4; >90% of district paved); area V (minimum wage >4; >90% of district paved). Water supply and sewage were not suitable for discriminating socioeconomic status since there were small variations in these variables between the districts. The estimated risk ratio and 95% CI were calculated for the high-risk stratum by age group, using the low-risk stratum as the reference group.

Results

During the study period, 752 new cases of leprosy were diagnosed. Complete information was available for 711 (94.5%) of them and they were included in the analysis. All patients had residential addresses in the urban area. Almost 80% of all cases were diagnosed in only one health centre located in the central zone, irrespective of the geographical distribution of cases and whether there were nearby health units for leprosy treatment. The mean age (±SD) of leprosy patients was 36.1 ± 16.4 years, with males accounting for 51.3% of the cases. A total of 71% were multibacillary cases (lepromatous and borderline clinical forms), while tuberculoid and indeterminate forms accounted for 14.1% and 14.8% of the cases, respectively. Approximately 85% of the patients reported that their illness had lasted for less than 1 year and the low rate of all disabilities (8.0%) suggests that most cases were of recent onset. Leprosy was detected in 86% of the districts, with the detection rates by district in the range 7.4/100 000 to 381.3/100 000.

Based on the detection rates and confidence intervals, area I and area V correspond to the low- and high-risk stratum, respectively. The intermediate stratum was built by pooling areas II, III and IV, since there is overlap of the confidence intervals, indicating similar detection rates (Fig. 1).

Table 1 shows the newly detected cases of leprosy, stratified by age groups in the three socioeconomic strata. For the high- and intermediate-risk areas the detection rates increased up to the 45–54-year age group, while the peak incidence in the low-risk areas was for the 55–64-year age group. The overall risk of detecting leprosy cases was 5.3-fold higher (95% CI: 3.8–7.4) in the outskirts of the town than in the central zone. Also, estimated risk ratios were greater than unity when they were stratified by age and were statistically significant for all age

Fig. 1. Detection rates of leprosy cases and 95% confidence intervals according to risk strata.
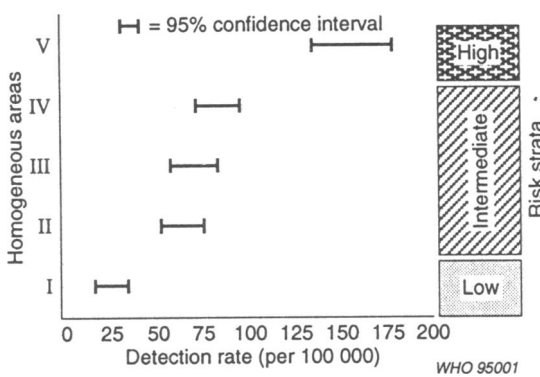
groups except for the youngest and oldest. Approximately 83% of the population lives in areas considered to be of high or intermediate risk for leprosy (Fig. 2).

Discussion

Our findings identified the spread of leprosy cases in an urban area of Brazil. However, there was a clearly defined high-risk area in the outskirts of the city, with the belt of higher detection rates corresponding roughly to the areas of low socioeconomic status that were lacking in health facilities.

The geographical distribution of leprosy was far from uniform, with some groups being at a much higher risk of infection than others (15). About 15% of the population of Goiânia lives in areas where detection rates were high and socioeconomic status was low. The relationship between leprosy and low

socioeconomic status has long been recognized. Higher prevalences of leprosy in areas of low socioeconomic status have been reported by Zuniga (16). More recently, Ulrich et al. found that low standards of living were closely related to infection with leprosy (17). While the relationship between poor health and lack of socioeconomic development is generally recognized, causal links have proved difficult to identify.

Regionally, periurban populations are composed of rural migrants who are largely unskilled. The high concentration of leprosy cases in peripheral settings indicates an inverse association between the incidence of the disease and the quality of the environment the individuals live in. In addition, an intense rural–urban migration in the 1960s and early 1970s may have contributed to this geographical distribution of cases. It is interesting to note that in more developed settings the peak age group for leprosy is 10 years older than that elsewhere, perhaps because the age at infection is greater in the former settings.

In our study, self-reported current residence was used to calculate detection rates by districts. This could be considered a relatively insensitive approach for the following reasons: leprosy has a long latent period; health facilities in the cities may attract patients from periurban and rural areas, leading to an overestimate of the leprosy distribution in urban areas; and leprosy patients could provide incorrect addresses because of the social stigma of the disease. The geographical mobility of cases also reduces the sensitivity to detect environmental hazards associated with leprosy (18). Lifetime residential histories are therefore suitable for analysing rural–urban migration and different intervals of exposures for risk assessment purposes.

Cases of leprosy detected by health services may have underestimated the real incidence, since they

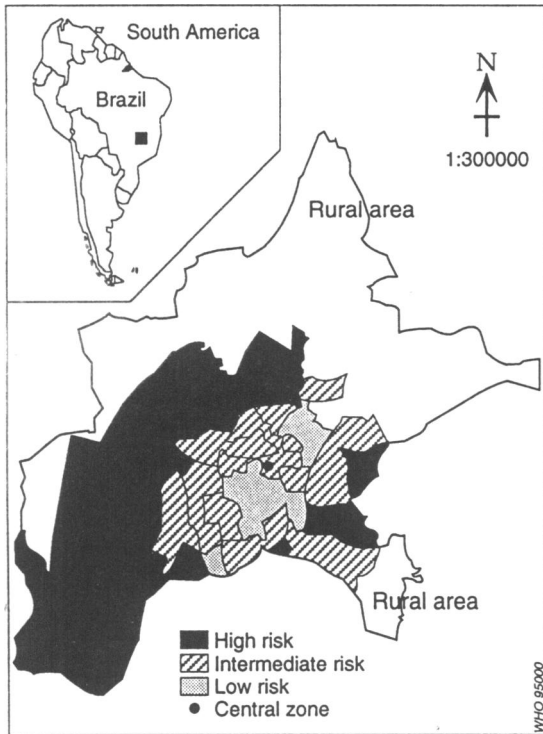**Table 1: Comparison of newly detected cases of leprosy in urban areas of Goiânia city, central Brazil**

Age group[a] (years)	Low-risk stratum:			Intermediate-risk stratum:			High-risk stratum:			Estimated risk ratio[c]
	No. of cases	Population size	Rate[b]	No. of cases	Population size	Rate[b]	No. of cases	Population size	Rate[b]	
1–14	2	51 687	3.8	33	208 940	15.7	7	44 024	15.9	4.2
15–24	14	32 653	42.8	90	131 995	68.1	56	27 811	201.3	4.7
25–34	9	25 998	34.6	100	105 095	95.1	46	22 143	207.7	6.0
35–44	5	18 260	27.3	94	73 817	127.3	39	15 553	250.7	9.2
45–54	5	11 916	41.9	73	48 168	151.5	32	10 149	315.3	7.5
55–64	5	7 428	67.3	36	30 037	119.8	15	6 326	237.1	3.5
≥65	4	6 809	58.7	36	27 525	130.7	5	5 799	86.2	1.5
Total	44	154 751	28.4	462	625 567	73.8	200	131 805	151.7	5.3

[a] Age data were missing for 5 cases.
[b] Per 100 000 inhabitants.
[c] With low-risk strata as the reference group.

Fig. 2. **Map showing spatial leprosy distribution patterns in Goiânia city, central Brazil.**

Public health services supplying primary health care were distributed throughout all the districts. However, few health units deliver leprosy treatment, and almost all cases were diagnosed and treated in only one unit located in the centre of the city. The health care coverage was clearly insufficient for leprosy surveillance purposes. Although the principle of using primary health care in leprosy control has been widely accepted in theory (21),[c] less developed areas still tend to concentrate their control activities in traditional leprosy treatment centres. An effort should therefore be made to change this situation if leprosy is to be eliminated from underdeveloped regions.

The spatial distribution of leprosy and the ecological approach of the study permitted the identification of different risk strata. Application of the method to epidemiological studies may provide useful data for health planning activities. Many of the issues regarding leprosy—demand versus need-based health service attendance as well as treatment compliance—still need to be tackled. The priority should focus on building stratified models using risk analysis to improve health care delivery in urban settings. Case–control studies are currently being carried out to determine the differences in case detection resulting from migration and socioeconomic status. Also, the study population's awareness and knowledge about leprosy should be evaluated in order to optimize the provision of health care.

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Résumé

Répartition spatiale de la lèpre dans une zone urbaine du centre du Brésil

Cet article décrit la répartition spatiale des cas de lèpre dans une zone urbaine du Brésil et sa corrélation avec les indicateurs socio-économiques. Entre novembre 1991 et octobre 1992, 752 cas de lèpre nouvellement diagnostiqués, vus dans l'ensemble des dispensaires de Goiânia, dans le centre du Brésil, ont été identifiés. Une base de données concernant les cas de lèpre a été éta-

represent only a proxy measure of all newly diagnosed cases (19). Nevertheless, the use of such cases for correlation studies is preferable to the use of prevalence data, since the nature of the association between socioeconomic conditions and leprosy may be influenced by the duration of the disease. The underlying assumption of ecological studies is that the variables describing groups of individuals correspond to the individuals themselves, which may be fallacious (20). Our interpretation of the spatial distribution of leprosy based on the 845 census tracts (340 neighbourhoods) in Goiânia may have some pitfalls because of the relatively small populations in each area. In such situations detection rates with large confidence intervals might be expected, implying less precision in assessing leprosy indicators. We therefore consider the 64 study districts to be a reasonable scale for population samples; also, socioeconomic data were available for them. In contrast, if districts are merged to form larger regions, although interpretation of the data would have been easier, the ability to discriminate more precisely between risk areas and clusters of leprosy would have been more difficult (9).

blie, et l'on a relié l'adresse des malades à 64 districts urbains correspondant à des secteurs de recensement et couvrant des zones de caractéristiques socio-économiques très voisines. Les taux de détection des cas de lèpre, avec leurs intervalles de confiance à 95% (95% CI), ont été calculés par district et par zone socio-économique. Des cas de lèpre ont été détectés dans 86% des districts, et trois niveaux de risque ont été identifiés. La zone à risque le plus élevé se situait dans les faubourgs de la ville, et les taux de détection augmentaient des zones les plus développées vers les zones les plus pauvres. Le risque de détecter un cas de lèpre était 5,3 fois plus élevé (95% CI = 3,8 − 7,4) dans les faubourgs de la ville que dans le centre.

L'article examine les questions méthodologiques liées à la confirmation des cas de lèpre, à la fiabilité et à l'exhaustivité des informations, et à l'interprétation de la répartition spatiale de la lèpre par zone. L'absence d'activités de lutte antilépreuse au sein des services de soins de santé primaires et les caractéristiques d'utilisation des services antilépreux dans les régions en développement ont été soulignées, de même que l'utilité de l'analyse géographique dans la planification des services de santé.

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