

Estimation of Leprosy Prevalence in Bago and Kawa Townships Using Two-Stage Probability Proportionate to Size Sampling Technique

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Two surveys to estimate leprosy prevalence using two-stage probability proportionate to size sampling technique were conducted in Bago and Kawa townships. A total of 3519 and 3739 individuals were examined in each township. The two surveys were finished within 25 (Bago) and 30 (Kawa) working days at a cost of Kyats 10 000 (US\$1500) for each survey. The estimated leprosy prevalence obtained in Bago was 9.95 per 1000 population (95% confidence interval (CI): 7.11-12.78) and in Kawa it was 12.04 per 1000 population (95% CI: 8.85-15.22). A total of 30 (Bago) and 34 (Kawa) new leprosy cases were detected in the two surveys. Grade I disability was seen to be 20% in Bago and 18.78% in Kawa, whereas grade II disability was 17.14% in Bago and 15.56% in Kawa.

Leprosy prevalence was first estimated in Myanmar in 1890-1891 by the Leprosy Commission of India. At that time the prevalence was estimated at 0.84 per 1000 population for the whole country and 1.44 per 1000 population for central Myanmar. In 1951, another estimate was made with the help of a WHO consultant, and the prevalence of leprosy at that time was estimated to be 5 per 1000 population (Dharmendra).¹ In 1963 WHO Leprosy Advisory Team (LAT) conducted a survey in the Shwebo and Myingyan Districts in central Myanmar where leprosy was known to be highly endemic. The estimated leprosy prevalence in Shwebo District was 32.16 per 1000 population² and in Myingyan District it was 44.34 per 1000 population.² The last assessment of prevalence was done in 1973 by two independent bodies. One was the National Assessment undertaken by National Leprosy Control personnel, which covered most of the leprosy-endemic areas of the country. The estimated prevalence obtained from this study was 24 per 1000 population³ for the whole country (total 700 000 estimated leprosy cases). Simultaneously another survey was conducted with the assistance of the WHO Leprosy Advisory Team in lower and central Myanmar. In this survey the

prevalence obtained in Kawa Township was 12.5 per 1000 population.⁴ Bago Township was not included in the sample at that time.

Following the introduction of multidrug therapy (MDT) in 1988, leprosy cases could be discharged after a much shorter period of treatment. This has brought about a drastic decline in the total *registered* leprosy cases. The average duration of treatment with MDT at the time of the survey could not be determined because some of the cases had not completed the recommended regime. The majority of the cases are already on dapsone monotherapy and would only need a minimum additional six monthly doses of MDT for paucibacillary (PB) cases and 24 monthly doses for multibacillary (MB) cases. The registered leprosy prevalence for the whole country was reduced from 6.67 per 1000 population⁵ in 1984 to 3.99 per 1000 population in 1989.⁶ Since the number of newly detected cases in each year did not replace the total number of discharged cases, a net reduction in the registered cases was observed after the introduction of MDT. From the start of the leprosy control programme, the registered leprosy prevalence has been used as an indicator for the magnitude of the leprosy problem in Myanmar. Prior to the introduction of MDT and during the dapsone monotherapy era, the registered leprosy prevalence was a good indicator of the leprosy problem and the work load in each

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township because few cases were discharged from treatment quickly. The average duration of treatment for tuberculoid and indeterminate leprosy cases during the dapsone monotherapy era was 10.35 years,⁷ which shows that leprosy cases were only discharged after some years of treatment and so no drastic changes were seen in the registered prevalence within a short period of time.

The rapid discharge of cases after MDT has distorted the problem of leprosy especially in areas where MDT is being introduced. Hence the need to find out the estimated leprosy prevalence has become a priority for decision makers and programme managers in the leprosy control projects. Further, out of the total case load of 700 000 estimated by the National Assessment Survey in 1973, the coverage achieved at that time with dapsone monotherapy ranged between 40% and 50% in the different regions of the country.^{3,4} The assessment of the treatment coverage is also seen to be crucial if MDT is to have a meaningful impact on the control of leprosy in Myanmar. The treatment coverage with MDT must be boosted to a much higher level than that achieved during the dapsone monotherapy era if one of the objectives of the leprosy control programme—to interrupt transmission of the infection, thereby reducing the incidence of disease so that it no longer constitutes a public health problem—is to be fulfilled. It is also important that leprosy prevalence is estimated in order to help township-level health managers calculate treatment coverage as well as estimate the magnitude of the leprosy problem. Accurate assessment would help in the planning of leprosy control activities at the peripheral level as well as centrally.

METHODS

Two townships, Bago and Kawa in lower Myanmar were chosen as the two study areas. Kawa Township was chosen because in 1973, the WHO LAT survey was conducted there and so the estimated prevalence obtained from that survey could be used as baseline data for comparison. Bago Township was chosen because the investigators felt that an unsurveyed township should be included in order to get some baseline information which could be compared to Kawa Township. These two townships are situated in Bago Division which is highly endemic for leprosy. Bago Township has a population of 305 000 (272 per mile²) and Kawa Township has a population of 178 000 (370 per mile²). They are geographically adjacent and are similar to one another with respect to the ethnic composition, geography and socioeconomic status. The registered leprosy prevalence (as of December 1989)

for Bago Township was 5.4 per 1000 population and for Kawa it was 3.93 per 1000 population.⁸

Chosen for the study was the rapid survey method developed by Frerichs;⁹ a two-stage cluster sampling with probability proportionate to size of population at the first stage and a constant number of subjects per cluster at the second stage. This sampling method has been used by WHO to assess immunization coverage of EPI, but has never been used for the estimation of leprosy prevalence. This survey method was chosen because it is less time consuming and less costly compared to other sampling methods. The sample size estimation was done using the following parameters and performing a sensitivity analysis using a spreadsheet program developed by Frerichs¹⁰—estimated prevalence, 10 per 1000 population; 95% confidence interval of 0.005; 30 clusters (villages); average number of subjects to be examined per cluster, 100 and the interclass correlation coefficient 0.05.

In the first stage, a total of 30 clusters each in Bago and in Kawa Townships were selected based on probability proportionate to the size of the village population. At the time of the actual study, one village in Bago Township moved out and so that village was discarded without any replacement.

In the second stage individuals within the cluster to be examined were selected. From a central point in the village the specific part of the village to be surveyed was chosen by a spin dial, after which a map of all the households in that direction was drawn. On the map, these houses were numbered and from that list (sampling frame), the first household was randomly chosen. After the selection of the first household, all eligible individuals residing in that house were included into the study as the study subjects. The next household to be drawn into the study was that which was nearest to the first house and was identified based on a rough measure of distance from the front entrance of the house. If two houses were seen to be of equal distance the house on the right was chosen. An average of 121 individuals were examined per cluster in Bago Township and 125 individuals per cluster in Kawa Township. This exceeded the required sample size because to avoid having to restart the selection process should some of the household members refuse to participate by not turning up for examination at the examination centre, more households were selected than that actually required.

An eligible person was a permanent resident of that village. Individuals from the selected houses who were away and were not in the village at the time of the study were recorded in order to calculate the response rate. The diagnosis of leprosy was based on the

WHO's four cardinal signs; (a) hypo or hyperpigmented patch or patches, (b) anaesthesia, (c) enlarged, hard, thickened or tender nerves and (d) skin smear positive for acid-fast bacilli. The presence of two of the first three criteria or the presence of the fourth criteria alone is taken as a case of leprosy.

Cases discharged from the control programme were excluded from the study, either as an old case or a new case of leprosy even though they met the criteria for the diagnosis of leprosy, since these cases were assumed to have been cured. Cases though released from control but showing signs of relapse (either due to persisters, resistance or re-infection) were included into the study as a case of leprosy. Leprosy lesions were defined as active if one of the following signs were present. They were, (a) raised lesions with or without induration and/or tubercles, (b) erythematous or infiltrative skin lesions, (c) pain or tenderness along the peripheral nerves, (d) detection of new lesions at the time of examination or obtaining a history of appearance of new lesions within the past 6 months, (e) changes in sensation either in the intensity or area wise within the past 6 months, (f) reactions occurring within the past 6 months and (g) positive skin smears during the past 6 months. The disability was graded as O, I and II and cases were classified as PB and MB according to WHO's guidelines for disability grading and classification.¹¹

An old case of leprosy was one still on the treatment register regardless of whether this patient was taking regular treatment or not. Discharged cases (those who have completed the recommended treatment schedule either with dapson monotherapy or MDT) were not included as an old case. A new case was one who had never been registered and was put on treatment by the health staff.

All eligible people from the selected households present in the village at the time of the survey were examined by an experienced leprologist from the Bago Division Health Department. The same leprologist examined all the study subjects in both the surveys. All subjects were asked to come to a place which had been specially set up so that proper examination of the whole body could be made. Although inconvenient for the subjects, it enabled the leprologist to examine cases thoroughly. In the Bago leprosy prevalence survey, out of a total of 4342 eligible subjects (29 clusters), 3519 were examined. The rest were away from home at the time of survey and so could not be examined. In the Kawa survey out of 4331 eligible subjects 3739 were examined. The response rate for the Bago survey was 81.05% and in the Kawa survey it was 86.34%. Analysis of the nonresponders was not done. The majority of

the nonresponders were adults who were away in the fields or travelling to the nearest town or village. Since this population represents the age group where leprosy is most likely to develop, this would have resulted in under-estimating the prevalence.

Information on each subject was recorded on a survey form and the conduct of the survey was monitored by means of household and study disposition forms. The data was analysed using the Survey Mate software program and the point estimate and its 95% confidence intervals were calculated using the variance formula presented by Frerichs.¹⁰

The survey team, made up of the leprosy control programme's staff from the two study townships, were trained for 1 day by the investigators on the survey methods. In order not to interrupt the routine activities of the survey team members, the survey was incorporated into the monthly tour programme of the leprologist of the Bago Division. The actual field work to survey 29 clusters for the Bago Township survey took 25 working days (April and May 1990) and for that of Kawa Township it took 30 working days (June, July and August 1990). The two surveys cost Kyats 20 000 (US\$3000 at the exchange rate of US\$1 = Kyats 6.5) which was spent mainly on the *per diem* for the survey team members and for petrol.

RESULTS

The estimated leprosy prevalence in Bago Township was 9.95 per 1000 population (95% CI: 7.11–12.78) and in Kawa it was 12.04 per 1000 population (95% CI: 8.85–15.22).

The design effect observed in the Bago leprosy prevalence survey was 0.78 and in the Kawa survey it was 0.83. The interclass correlation coefficient was seen to be –0.002 in the Bago survey and –0.001 in the Kawa survey indicating that leprosy cases within clusters were unrelated to one another (Table 1).

TABLE 1 Estimate of leprosy prevalence and the design effect of the two surveys in Bago and Kawa Township

| | Bago Township | Kawa Township |
|--|---------------|---------------|
| Population examined | 3519 | 3739 |
| Clusters (No.) | 29 | 30 |
| Leprosy cases | 35 | 45 |
| Estimated leprosy prevalence (per 1000 population) | 9.95 | 12.04 |
| 95% confidence interval | 7.11–12.78 | 8.85–15.22 |
| Design effect | 0.78 | 0.83 |
| Interclass correlation coefficient | 0.002 | –0.001 |

TABLE 2 Age and sex distribution of leprosy cases

| Age (years) | Bago Township | | | | | | Kawa Township | | | | | |
|-------------|---------------------|--------|-------|---------------|--------|-------|---------------------|--------|-------|---------------|--------|-------|
| | Population examined | | | Leprosy cases | | | Population examined | | | Leprosy cases | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| 0-14 | 722 | 828 | 1550 | 2 | 2 | 4 | 901 | 862 | 1763 | 2 | - | 2 |
| 15-29 | 279 | 562 | 841 | 5 | 4 | 9 | 235 | 445 | 680 | 5 | 7 | 12 |
| 30-44 | 209 | 336 | 545 | 4 | 2 | 6 | 199 | 359 | 558 | 6 | 7 | 13 |
| 45-59 | 140 | 227 | 367 | 5 | 7 | 12 | 173 | 240 | 413 | 7 | 4 | 11 |
| 60-74 | 76 | 98 | 174 | 2 | 1 | 3 | 120 | 160 | 280 | 4 | 1 | 5 |
| ≥75 | 26 | 16 | 42 | 1 | - | 1 | 19 | 26 | 45 | 2 | - | 2 |
| Total | 1452 | 2067 | 3519 | 19 | 16 | 35 | 1647 | 2092 | 3739 | 26 | 19 | 45 |

Table 2 shows the age and sex distribution of leprosy cases. The male female ratio was 1.19:1 in Bago and 1.37:1 in Kawa Township. The proportion of cases under 14 years in Bago was 11.4% whereas in Kawa it was 4.4%. Excluding the 75 years and above age group, the highest leprosy prevalence was seen in the 45-59 year age group in both the townships (Bago 32.7 and Kawa 26.63 per 1000 population). The age-specific prevalence rates are also seen to increase in succeeding age groups.

The proportion of new cases that were inactive at the time of the survey was 46.67% in Bago and 38.23% in Kawa (Table 3). Among the old cases that are already on treatment, the proportion that were inactive was 20% in Bago and 72.7% in Kawa Township.

TABLE 3 Clinical status of leprosy cases

| Clinical status | Bago Township | | | Kawa Township | | |
|-----------------|---------------|-----|-------|---------------|-----|-------|
| | Old | New | Total | Old | New | Total |
| Active cases | 4 | 16 | 20 | 3 | 21 | 24 |
| Inactive cases | 1 | 14 | 15 | 8 | 13 | 21 |
| Total | 5 | 30 | 35 | 11 | 34 | 45 |

Table 4 shows the disability status of leprosy cases. In the Bago area the prevalence of disability grades I and II combined was seen to be 37.14% and that of grade II alone, 17.14%. In Kawa Township it was seen that disability grades I and II among the leprosy cases was 33.33% and grade II disability was 15.56%. Among the new cases that were detected, 16.67% in Bago and 5.88% in Kawa were disability grade II.

The MB proportion in Bago Township was 31.43% and in Kawa Township it was 35.56%.

DISCUSSION

The prevalence of leprosy in Bago Township was estimated as 9.95 per 1000 population (95% CI: 7.11-12.78) and in Kawa Township it was 12.04 per 1000 population (95% CI: 8.85-15.22). Since the two townships are comparable socioeconomically, the two prevalence estimates were found to be similar. Compared to the 1973 estimated prevalence of 12.5 per 1000 population (WHO LAT)⁴ in Kawa Township, the prevalence of leprosy did not appear to have changed. This could be attributed to the low treatment coverage (25%) observed in this township (Table 2).

The male to female ratio among the leprosy cases was 1.19:1 in Bago and 1.37:1 in Kawa Township. This is seen to be much less than the registered male to female ratio of 1.75:1 seen in 1989.⁶ The high sex ratio seen among registered cases could be due to fewer females coming in for treatment because of social pressures. The sex ratio among leprosy cases seen in 1973 LAT survey in Kawa and Kayan Township was 1.3:1⁴ for all leprosy cases (discharged cases included), which is seen to be similar to the present findings. The highest leprosy prevalence was seen in the 45-59 years age group in both Bago (32.7 per 1000) and Kawa (26.63 per 1000) Townships, except for the 75 year and above age group in Kawa Township.

The proportion of new cases to the total detected cases in Bago was 85.71% and in Kawa it was 75.56%. In 1973, it was observed that 42.8% (WHO LAT)⁴ of the total estimated cases were new. This shows that the present treatment coverage is still insufficient for chemotherapy to have an effect in cutting the chain of transmission.

TABLE 4 *Disability status of leprosy cases*

| Disability | Bago Township | | | | | | Kawa Township | | | | | |
|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Old | | New | | Total | | Old | | New | | Total | |
| | PB ^a | MB ^b | PB ^a | MB ^b | PB ^a | MB ^b | PB ^a | MB ^b | PB ^a | MB ^b | PB ^a | MB ^b |
| Grade 0 | 1 | 2 | 18 | 1 | 19 | 3 | 1 | 3 | 20 | 6 | 21 | 9 |
| Grade I | 1 | - | 2 | 4 | 3 | 4 | 1 | 1 | 3 | 3 | 4 | 4 |
| Grade II | - | 1 | 2 | 3 | 2 | 4 | 2 | 3 | 2 | - | 4 | 3 |
| Total | 2 | 3 | 22 | 8 | 24 | 11 | 4 | 7 | 25 | 9 | 29 | 16 |

^a Paucibacillary leprosy

^b Multibacillary leprosy

Among the newly detected cases 46.67% of them in Bago and 38.23% in Kawa were inactive at the time of the survey. The proportion of inactive cases observed in 1973 was 21.3% (WHO LAT)⁴ for all newly detected cases in Kawa and Kayan Townships combined. This difference could have been due to inter-observer differences or it could be due to increased self-healing occurring among leprosy cases at present. The role of BCG in these self-healing cases could not be excluded.

Of the cases 17.14% in Bago and 15.56% in Kawa Township are seen to be suffering from grade II disability which means that they are socially and economically at a disadvantage. In 1973, 30.91% (WHO LAT)⁴ of the cases were observed to be suffering from grade II and III disability. The 1973 findings may be high because they included a lot of 'backlog' cases as prevalent cases, some of which were old cases which could be discharged. The proportion of new leprosy cases with grade II disability was 16.67% in Bago and 5.88% in Kawa. Grade II and above disability in new cases was 8.99% in 1973 WHO LAT survey⁴ which shows that some of the new cases in Bago Township were quite far advanced in their disease process when compared to Kawa.

The proportion of MB leprosy for old and new cases combined was 31.43% in Bago and in Kawa it was 35.56%. Among the newly detected cases only it was 26.67% in Bago and 26.47% in Kawa. The proportion of lepromatous and borderline cases among new cases in 1973 was 7.9% (WHO LAT)⁴ which shows that the infectious case load in this community has increased. This increase in the MB proportion could be a result of

the accumulation of undetected MB cases resulting from poor case finding over the past years or it could be a reflection of an actual rise in MB cases in the population.

The design effect compares the variance of the two-stage cluster survey to the variance of a comparable sized simple random sample. In many studies of infectious diseases the design effect for cluster surveys is greater than one, indicating that two-stage cluster sampling is less precise than simple random sampling. However we observed that the design effect was less than one. This suggests that for surveys of leprosy two-stage cluster surveys are more efficient than simple random samples. Leprosy is not a highly infectious disease. Thus neighbours are no more likely to be infected than people in surrounding villages. That is, leprosy cases do not cluster to one area in villages. The design effect of 0.78 and 0.83 observed in the two surveys shows that this type of two-stage cluster sampling technique provides a quick and inexpensive method for estimating leprosy prevalence especially in endemic areas. The interclass correlation coefficient of -0.002 and -0.001 seen in the Bago and Kawa leprosy prevalence surveys could be interpreted as all people in the cluster are as similar to one another as they are to people in other clusters.

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