

Long-Term Effect of Leprosy Control in Two Prefectures of China, 1955–1993¹

Huan-Ying Li, Xiao-Man Weng, Tong Li, Da-You Zheng,
Zhi-Min Mao, Shun-Peng Ran, and Feng-Wu Liu²

It is well known that leprosy has an uneven distribution and its prevalence is associated with the socioeconomic development of the area concerned. China is a country of 9.6 million sq. km. with a wide range of geographical conditions. Its 1.12 billion population consists of 56 ethnic groups of which 96% are Han. Besides Mongolians in the north, Uyur in the northwest and Tibetans on the high Himalayan Plateau, the other divergent ethnic minorities live mostly in the mountainous areas of the southwestern provinces. Taking these into consideration, China set a two-tier objective at the 1981 Second National Leprosy Conference in Guangzhou: to eliminate leprosy (prevalence < 0.1/10,000/county) from at least 95% of its 2510 counties by the end of this century.

This paper compares the prevalence and detection rates since 1955 plus the features of new patients detected after 35 years of control (1980–1993) in two prefectures of widely divergent geographical conditions and socioeconomic development. The prevalence and detection rates until the year 2000 are extrapolated with the purpose that appropriate measures be taken to meet the national goal by year 2000.

MATERIALS AND METHODS

Weifang Prefecture, situated on the alluvial plain of the Yellow River in the Shan-

dong Peninsula, consists of 10 counties. The effects of 25 years of intensive control have been reviewed previously⁽³⁾. Wenshan Prefecture of Yunnan Province, one of the 30 autonomous prefectures established within the country, borders on Vietnam and has eight counties. Besides Han, Zhuang and Miao there are a total of 17 different ethnic groups living in this subtropical, landlocked, mountainous area. Although leprosy control as part of the national program was initiated in the late 1950s, organized control only began 10 years later when the Prefectural Institute of Dermatology was established (Fig. 1; Table 1).

Measures of control were mainly clue survey plus contact tracing followed by institutionalized dapsone monotherapy until clinical cure (clinical, histopathology and smear negative) plus 2–5 years of maintenance therapy with dapsone. In clue surveys, the 10 major symptoms of leprosy plus methods of case finding were taught in 2–3 days to the primary health workers of the township health center and the village clinics under its administration. In addition to health education on leprosy, the major leprosy symptoms also were made widely known to the public in the villages concerned. All suspects were examined clinically and smears taken for acid-fast bacilli (AFB) by experienced leprosy workers and technicians and were further confirmed by histopathology^(3, 5).

China followed the Madrid classification until 1970, but the Ridley-Jopling classification has since been adopted of which borderline (B) and LL-BL-BB are classified as multibacillary (MB) for the present study.

Rifampin plus dapsone was introduced in 1979 and substituted by multidrug therapy (MDT) in 1986. Weifang treated all patients with MDT until smear negative; Wenshan adopted the fixed duration regimen [MB 24/36, paucibacillary (PB) 6/9 months]⁽¹¹⁾.

¹ Received for publication on 15 October 1994; accepted for publication in revised form on 16 February 1995.

² H.-Y. Li, M.D., M.P.H., Senior Researcher; X.-M. Weng, M.D., Assistant Researcher; T. Li, Technician, Beijing Tropical Medicine Research Institute, 95 Yun An Lu, Beijing, China. D.-Y. Zheng, Director; Z.-M. Mao, Statistician, Weifang Prefectural Institute of Dermatology, Shandong Province, China. S.-P. Ran, Director, Wenshan Prefectural Institute of Dermatology. F.-W. Liu, Deputy Director, Yunnan Provincial Institute of Dermatology.

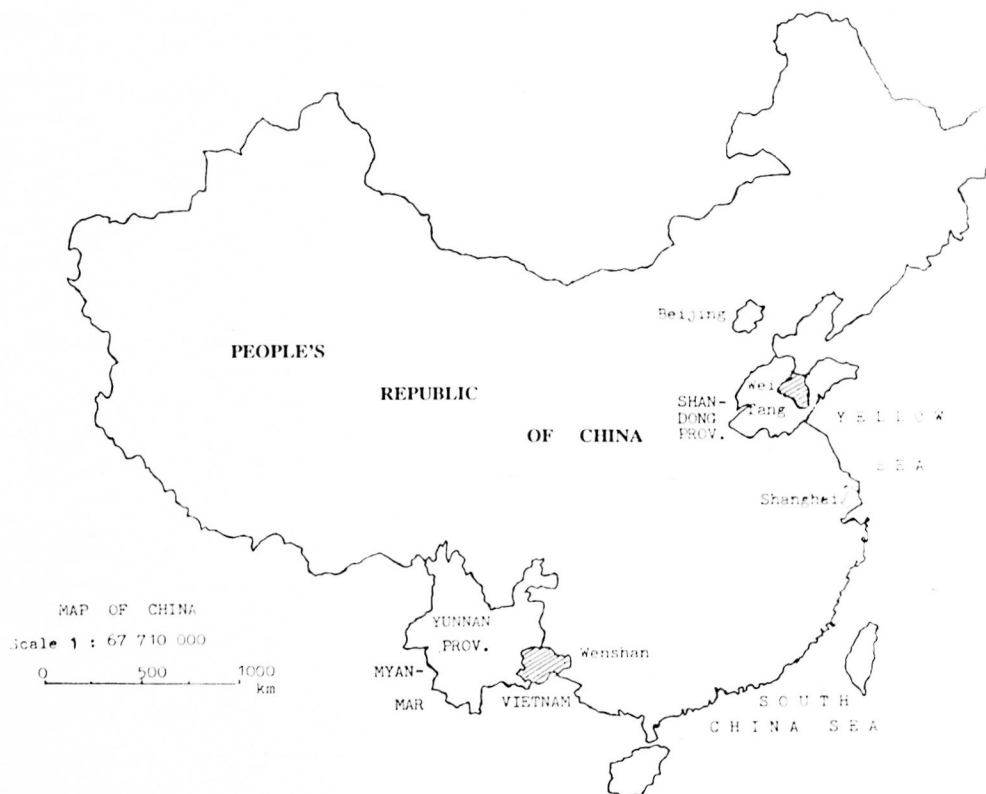


FIG. 1. Map of the People's Republic of China.

RESULTS

Prevalence

Prevalence was highest in 1960 for Weifang (10.1/10,000) and in 1973 for Wenshan (19.7/10,000). In Weifang prevalence declined gradually through reduction of reservoir of infection by repeated systematic clue surveys (1965, 1971, 1975 and 1983) and the treatment of all confirmed cases with dapsone until smear negative as well as decreases due to death, lost to follow up, etc. There was a sharp decline from 1985 (0.05/10,000; 395 patients) to 1986 (0.02/10,000; 15 patients) due to screening of old patients for MDT and deleting from the registry those who were declared clinically cured.

In Wenshan, on the other hand, prevalence remained at about 18.0/10,000 through 1979, when rifampin plus dapsone therapy was introduced, and declined further after the implementation of fixed duration MDT, from 0.49/10,000 in 1985 (1335 patients) to 0.27/10,000 in 1986 (763 patients). Although patients completing 6–

24 months of MDT were not counted any more as patients, prevalence again remained at about 1.0/10,000 between 1988–1993 while annual input of about 150 new patients, presumably from individuals infected before MDT, remains steady (Fig. 2).

Case Detection

Before the implementation of MDT, Weifang already had kept leprosy under control, reducing the detection rate from 35.23/100,000 in 1956 to 0.66/100,000 in 1985; decreasing further with MDT (0.05/100,000 in 1993), reflecting the reduction of transmission since the 1960s.

In the late 1950s Wenshan placed more effort on case finding which caused the sharp decline between 1957–1961, but in the following 10 years the detection rate remained at 10 to 15/100,000. With the establishment of a network of eight county skin disease control stations in 1973 and the introduction of rifampin plus dapsone therapy in 1979, improved case finding activities plus

TABLE 1. General profile of Weifang Prefecture, Shandong Province, and Wenshan Prefecture, Yunnan Province, China.

	Weifang	Wenshan
Longitude	118°10'–120°01'E	103°33'–106°11'E
Latitude	35°35'–37°26'N	22°34'–23°28'N
Area	17,024 sq. km.	33,659 sq. km.
Population		
1958	8,520,000	1,430,000
1992	8,690,000	2,970,000
Persons/sq. km.		
1992	510/sq. km.	88/sq. km.
Climate	temperate	subtropical
Annual rainfall	550–950 mm	800–1,300 mm
Terrain	alluvial plain	mountains (> 70%)
Nationality	Han	Han, Miao, Zhuang, Hui, etc. (totaling 17 ethnic groups)
GNP/capita (RMB ^a)		
1985	970.5	322.0
1991	3,094.0	564.1
Annual income/capita (RMB)		
1980	103.1	41.6
1982	957.0	233.0
Infant mortality		
1990	23.68/1,000	66.73/1,000
Life expectancy		
1991 Male	70.7 yrs.	63.8 yrs.
Female	74.1 yrs.	66.3 yrs.
Cumulative no. patients detected	12,251 (1955–1993)	8,579 (1957–1993)

^a RMB = Renminbi (monetary unit in China).

cure and deleting from the registries due to patients lost to follow up and deaths caused the drop in the two following years (1974–1975 and 1979–1980); thereafter, however, it remained at about 5/100,000 (Fig. 3).

The prevalence and case detection rates in Weifang already coincide with each other between 1975 and 1981. With the more vigorous case finding in the 1980s, the rate of decline was also similar. In Wenshan these two rates declined very slowly until 1986. After the implementation of fixed duration MDT (¹⁰), the annual relative decline of prevalence increased from 4.7% (1960–1985) to 18.2% (1986–1992) (Table 2); whereas the detection rate remained unchanged.

Features of new patients detected

Type-, age- and sex-specific rates. In Wenshan the detection rate was lower in females in both MB and PB types of leprosy.

The peak of detection was in the 30–39 age group for males. For females, it was in the 20–29 age group for MB and between 20–49 years for PB patients. In females proportionally more cases were detected between the age of 20–49 years, which speaks the proneness to leprosy during child-

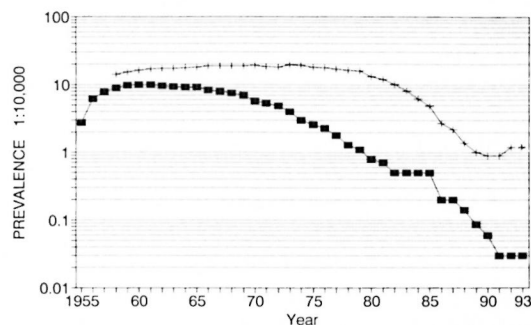


FIG. 2. Registered leprosy prevalence in Weifang and Wenshan Prefectures of China, 1955–1993. ■ = Weifang; + = Wenshan.

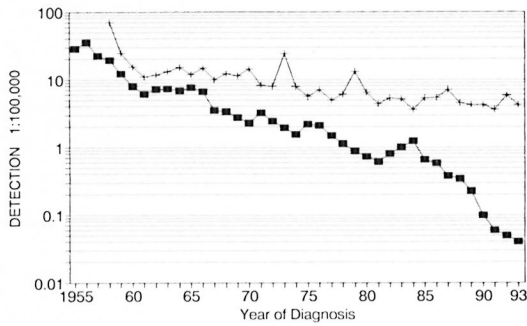


FIG. 3. Leprosy detection rates in Weifang and Wenshan Prefectures of China, 1955–1993. ■ = Weifang; + = Wenshan.

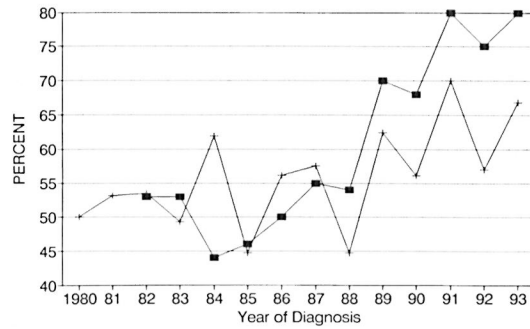


FIG. 5. Multibacillary rates at diagnosis. ■ = Weifang; + = Wenshan.

bearing age, and more for MB leprosy. The type-, age- and sex-specific detection rates in Wenshan, compared with the findings reported by Lechat (2), shifted toward the older age groups, reflecting the delay in case detection. But the decline in the general trend of leprosy in China may also play a role (Fig. 4, a and b).

MB rate. In Weifang, the MB rate was 53% in 1982, decreasing to 44% in 1984, and then increasing steadily to 80% in 1991 and 1993, representing only 4–5 patients detected each year. Although Wenshan generally also has shown a rising MB rate, this increase was less marked and appeared with less regularity (Fig. 5).

Deformity rate. Visible deformity (10) was consistently high for the patients detected each year in Wenshan; in Weifang it varied between 0% and 32% in the last 5 years, representing the few patients detected each year (6/10, 1/9, 0/5, 1/4 and 1/5 in the successive years between 1989 and 1993). They

were most likely the last few patients who had escaped detection in the past (Fig. 6).

Child rate. In Weifang no children < 15 years old were detected in the last 8 years due to interruption of transmission several decades ago, as mentioned above, and in Wenshan this figure varied between 4%–9% (Fig. 7). In 1985, a survey of 228,057 (a survey of 47.5% of the total population of children) 4 to 15-year-old children detected only 3 patients (one each of indeterminate, TT and BT; 1.3/100,000) (unpublished data). This low figure is likely due to local leprosy workers missing early cases.

Detection at the year of onset. The increased early detection since MDT implementation in Wenshan is highly significant (Table 3); it fluctuated widely in Weifang, again due to the small number of patients detected each year.

Voluntary reporting. There was an increasing discrepancy in the proportion of voluntary reporting by patients between these two prefectures. In Weifang voluntary

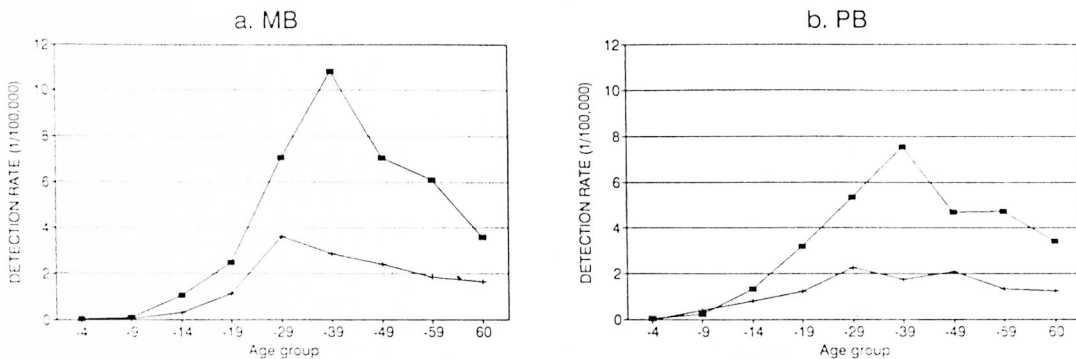


FIG. 4. Detection rates of leprosy by sex, age and type in Wenshan Prefecture, China, 1980–1993. ■ = Males; + = females.

TABLE 2. Annual relative decline of prevalence before (1960–1985) and after (1986–1993) MDT in Weifang, Shandong, and Wenshan, Yunnan Provinces, China.

Prefecture	Period	Therapy ^a	Cumulative no. patients	Prevalence at beginning of period (1/10,000)	Prevalence at end of period (1/10,000)	Annual decrease (R%) ^b
Weifang	1960–1985	DDS/R+D	5380	10.1	0.5	11.3
	1986–1993	MDT	148	0.5	0.04	26.2
Wenshan	1960–1985	DDS/R+D	5118	16.5	4.9	4.7
	1986–1993	MDT	1013	4.9	1.2	18.2

^a DDS/R+D MDT = Dapsone/rifampin + dapsone; MDT = multidrug therapy.

^b $R\% = 1 - \sqrt[n]{P_n/P_0} \times 100\%$ where P_0 = prevalence at year of start, P_n = prevalence at year of end, and n = number years of observation.

reporting increased to 100% in 1991 and 1993; in Wenshan it increased from 22% in 1982 to 60% in 1986 and, after a decrease to 49% in 1987 and an increase to 55% in 1990, has been falling rather rapidly in the last 3 years (Fig. 8).

Socioeconomic development

With the reform and open-door policy in China since 1978, Weifang has experienced a rapid growth of average annual income (AIC) and gross prefectural product per capita (GNP) since 1985 (increase of 9.3-fold and 3.2-fold, respectively). In Wenshan, however, the economic development has been rather slow (increase of GNP 5.6-fold and AIC 1.75-fold) (Fig. 9, a and b). The negative correlations between the growth of GNP with the detection and prevalence rates of leprosy are highly significant for both prefectures. However, there is a negative correlation of these rates with AIC in Weifang and a positive correlation in Wenshan. This is likely due to the increased control activ-

ities in Wenshan since the implementation of MDT in 1986 (Table 4).

Prediction of leprosy trend

Comparing with the grey dynamic (improved exponential) (⁹) and linear regression models, it was found that the geometric progression method can reflect the epidemiological trend more satisfactorily. Using the data of detection and prevalence rates of these two prefectures for the period between 1986 and 1993, the number of patients in the coming years was extrapolated. It was found that by year 2000, Weifang may detect only one patient and will have six patients undergoing MDT. Based upon the estimated population by the year 2000, the detection rate will be 0.13/100,000; the prevalence rate, 0.008/10,000. Wenshan may detect 100 new patients and 106 patients may still be undergoing therapy, giving a detection rate of 2.98/100,000 and a prevalence rate of 0.32/10,000 by year 2000 (Fig. 10, a and b).

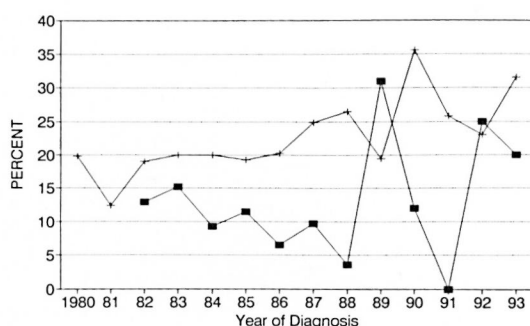


FIG. 6. Percentages of deformities in cases detected in Weifang and Wenshan Prefectures, China. ■ = Weifang; + = Wenshan.

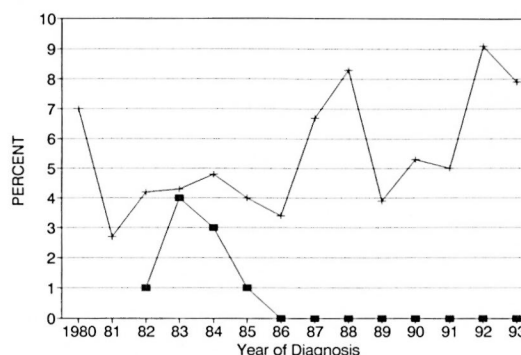


FIG. 7. Percentages of children with detected leprosy. ■ = Weifang; + = Wenshan.

TABLE 3. Delay of detection in 1967 patients diagnosed before (1980–1985) and after (1986–1993) implementation of MDT, Wenshan Prefecture, Yunnan Province, China.^a

Period	No. patients detected between onset and diagnosis				Total
	< 1	1–2	2–5	> 5 years	
1980–1985	263 (32.0) ^b	189 (23.0)	231 (28.1)	138 (16.8)	821 (100)
1986–1993	468 (40.8)	309 (27.0)	275 (24.0)	94 (8.2)	1146 (100)
Total	731 (37.2)	498 (25.3)	506 (25.7)	232 (11.8)	1967 (100)

^a $\chi^2 = 46.14$; degree of freedom = $(4 - 1)(2 - 1) = 3$; $p < 0.001$.

^b Figures in parentheses are percentages.

DISCUSSION

Leprosy control was launched in China in the mid-1950s with dapsone monotherapy until clinical cure plus prolonged maintenance therapy. Leprosy was prevalent and more effectively controlled in the provinces along the coast, but the economically less-developed provinces in the southwest were lagging behind. Since the introduction of MDT in 1986, Wenshan Prefecture (based upon the experiences gained at Menla County, Yunnan Province since 1983^{4,5}) adopted the fixed-duration regimen and Weifang Prefecture treated all patients until smear negative according to the standards set at the 1982 National Leprosy Technical Conference in Nanjing⁵). Therefore, the study of the effects of control in these two prefectures has nationwide implications. After 10 years of control there has been a markedly downward prevalence trend in Weifang since 1965 through effective case finding and treating all patients with dapsone until clinical cure. In Wenshan, on the other hand, the downward trend began only in 1979, when rifampin plus dapsone was introduced, and took momentum since 1985, when 572 old cases were screened for MDT and removed from the registry.

In Weifang, the detection and prevalence rates were already close to the elimination level when MDT was introduced. With the continued control efforts, these two rates were almost identical (a difference of 1:10) from 1975 until 1981. Case finding again was intensified following the declaration of the basic elimination in November 1981; hence, the rising detection rate between 1981–1984 and, correspondingly, no decrease of prevalence during this period. Since 1985 with the declining detection numbers and increasing number of patients cured, these two rates again were clearly together.

In Wenshan, due to the underdetection and the treatment of patients until clinical cure, there were proportionally more patients on the registry, the number of whom declined sharply with the shortened period of therapy and having been deleted from registries as cured since 1986¹⁰). The detection rate remained constant; thus causing the increasing difference between detection and prevalence rates.

It is well known that leprosy prevalence is associated with socioeconomic development^{1,7,8,12}), and the effectiveness of control depends upon communication facilities and input from the health services. The difference in the socioeconomic growth and prevalence rates in Weifang increased more than in Wenshan with the open-door policy and market reform since 1985.

From the features of new patients detected since 1980, Weifang's MB rate rose faster than Wenshan's and no more children < 15 years old were detected since 1986. It may be noted that Weifang already has kept the infection and spread of leprosy under control. In Wenshan the detection rate is still high and, in conjunction with the high child and deformity rates plus the decreas-

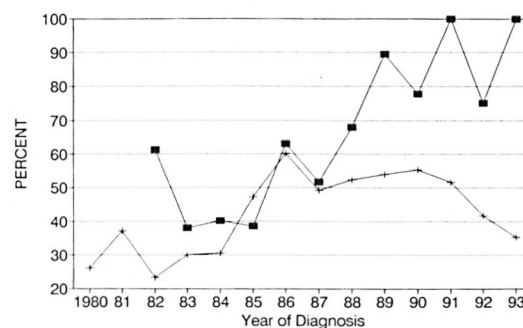


FIG. 8. Percentages of those reporting voluntarily in newly diagnosed leprosy. ■ = Weifang; + = Wenshan.

TABLE 4. Simple correlation between detection/prevalence rates and gross prefectural product (GNP)/average annual income per capita in Weifang and Wenshan, China, 1985–1991.

	Prefecture	Detection		Prevalence	
		r	p	r	p
GNP	Weifang	-0.9727	<0.001	-0.8373	<0.001
	Wenshan	-0.7828	<0.001	-0.8842	<0.001
Income	Weifang	-0.9499	<0.001	-0.7801	<0.002
	Wenshan	0.9786	<0.001	0.8062	<0.001

ing rate of voluntary reporting, more effort in case finding and health education activities is urgently required. Perhaps the existing rural health system should be upgraded and more fully utilized.

A previous study of age at onset by year of birth in Shandong indicated continued declining age-specific incidence rates for males and females for the cohorts from 1920–1929 to 1950–1959 (3). A continued analysis of the succeeding cohorts for 1960–1969 showed a similar trend (Fig. 11, a and b) (unpublished data). As Weifang constitutes about 1/10 of Shandong's total population (8,640,000/84,393,000 = 9.77%; 1991) and about 1/4 of Shandong's cumulative number of leprosy patients (12,251/53,328 = 22.97%; 1955–1993), it may be said that the decline in the age-specific incidence in the succeeding cohorts of Shandong Province is also applicable for Weifang Prefecture.

The protective effect of BCG vaccination against leprosy was reported to vary between 23% (Chengalpattu, India) to 80% (Uganda). A case-control study in Tamil Nadu, India, suggested that BCG increased

the risk for indeterminate leprosy but was protective against the more severe forms (6). Shandong Province initiated BCG vaccination in the 1970s, reaching 90% coverage in newborns and schoolchildren in 1990. Since the detection was generally low in children and high in adults, with the known low detection in indeterminate leprosy, BCG apparently also has played some role in the reduction of morbidity of leprosy. On the other hand, BCG coverage in Yunnan Province is low in children (52.3%, 1992). BCG vaccination, like other health programs, is hampered by the difficult terrain and low socioeconomic development.

Although regularity of MDT was high (> 98%) once the patients were detected, other control activities such as surveillance and disability prevention require continued attention in the management of the program.

It is estimated that Weifang may detect 1 patient and have 6 patients under therapy by the year 2000 and in Wenshan these figures will be 100 and 106, respectively. As indicated by WHO, with a high coverage of MDT the detection/incidence and prevalence rates will approximate each other by

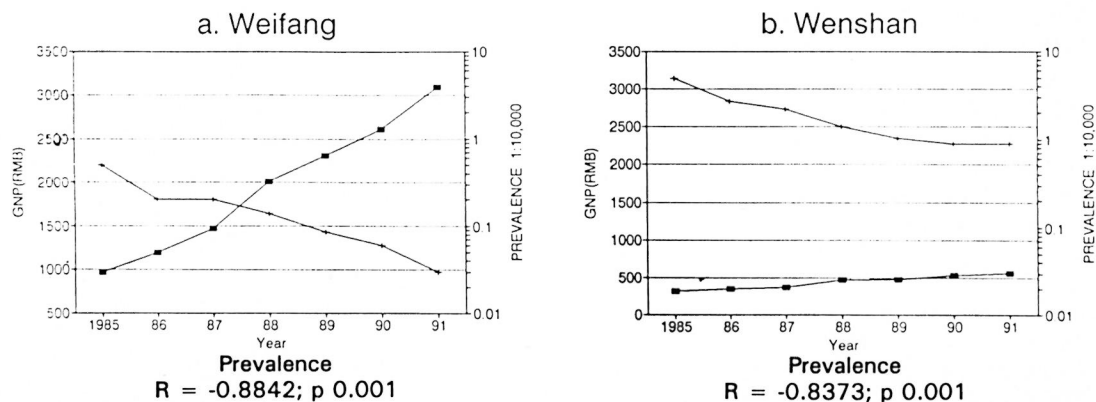


FIG. 9. Correlation between gross prefectural product (GNP) and leprosy prevalence, 1985–1991. ■ = GNP [RMB (renminbi = monetary unit in China)]; + = prevalence.

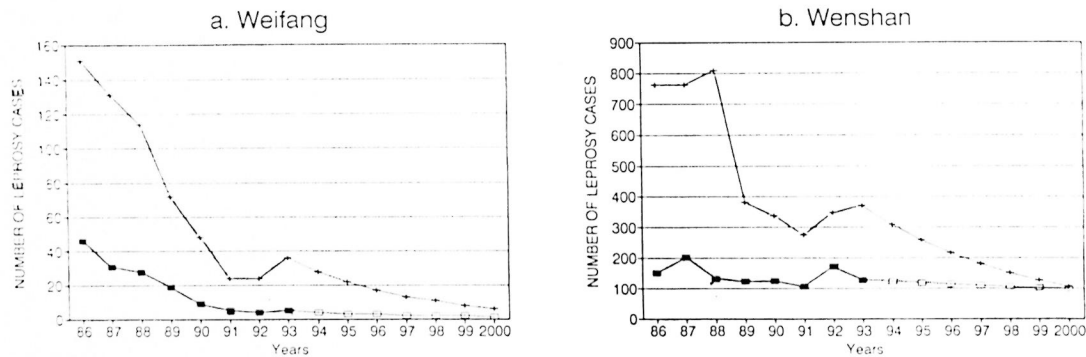


FIG. 10. Numbers of cases detected and prevalence in Weifang and Wenshan Prefectures, China, 1986–2000. ■ = Detection; + = prevalence.

the end of this century⁽¹³⁾. Shandong already had reached the elimination goal in all of its 104 counties (inclusive of the 10 counties of Weifang) in May 1994. It is expected that the two most prevalent counties of Wenshan (prevalence 1.3–1.6/10,000) also may meet the national goal of elimination in the early part of the next century, if the present trend of detection continues.

There are more counties, such as those in Wenshan, in the outlying mountainous areas of the country. Only 5–6 years are left for us to reach the elimination target. At the International Conference on Elimination of Leprosy (Hanoi, 4–7 July 1994), the participating countries recommended the implementation of the Global Plan of Action for the Elimination of Leprosy as a Public

Health Problem by the Year 2000. It is high time for us to identify such areas and bring the benefit of cure to all persons afflicted with leprosy and to prevent them from becoming disabled.

SUMMARY

In Weifang Prefecture, Shandong Province, and Wenshan Prefecture, Yunnan Province of China, leprosy was highly prevalent in the 1950s. Due to differences in geographical conditions and socioeconomic development, the decline in leprosy prevalence between 1955 and 1993 was 99.5% (10.1 to 0.05/10,000) in Weifang and 93.9% (19.7 to 1.2/10,000) in Wenshan. The decrease in the detection rate was 99.9% (35.2 to 0.05/10,000) in Weifang and 91.7% (69.9

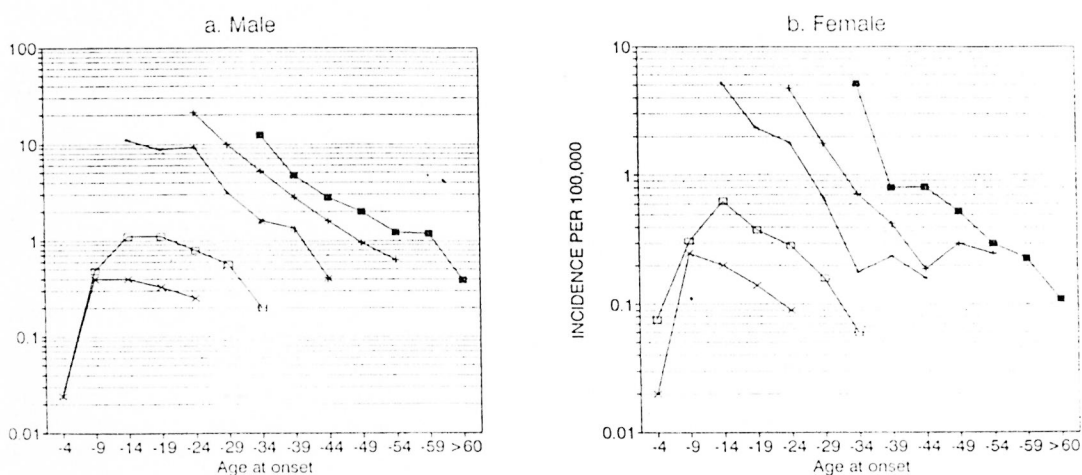


FIG. 11. Age-specific incidence of leprosy by year of birth and sex, Shandong Province, China, 1920–1969. Cohorts and number of patients in each cohort by sex: ■ = 1920–1929 (M = 2009, F = 649); + = 1930–1939 (M = 3610, F = 706); * = 1940–1949 (M = 3153, F = 114); □ = 1950–1959 (M = 905, F = 400); x = 1960–1969 (M = 346, F = 177).

to 5.8/10,000) in Wenshan. The decrease was more apparent in these two prefectures since the implementation of multidrug therapy (MDT) in 1986. Findings such as specific detection rates by age, sex and type, as well as the multibacillary, child, and deformity rates of patients detected since 1980 were studied. Using the detection and prevalence rates between 1980 and 1993, the number of patients until the year 2000 is extrapolated for these two prefectures.

RESUMEN

La lepra fue altamente prevalente en los años 1950s en las Prefecturas de Weifang, Shandong y Wenshan, de la provincia de Yunnan, China. Debido a los cambios en las condiciones geográficas de la zona y al desarrollo socioeconómico de la población, entre 1955 y 1993 la lepra disminuyó en un 99.5% (10.1 a 0.05/10,000) en Weifang y en un 93.9% (19.7 a 1.2/10,000) en Wenshan. La disminución en la frecuencia de detección de casos fue del 99.9% (35.2 a 0.05/10,000) en Weifang y del 91.7% (69.9 a 5.8/10,000) en Wenshan. Lo anterior resultó más aparente desde que en las dos prefecturas se implementó la poliquimioterapia (PQT), en 1986. En el presente estudio se analizaron las frecuencias de detección por edad, sexo y tipo de lepra, la multibacilaridad, el tamaño de la progenie, y la frecuencia y grado de deformidad de los pacientes detectados desde 1980. Usando las frecuencias de detección y prevalencia entre 1980 y 1993, en el estudio se hace una extrapolación del número de pacientes que habrá en el año 2000 en estas dos prefecturas.

RÉSUMÉ

La lèpre était hautement prévalente dans la Préfecture de Weifang, Province de Shandong, et la Préfecture de Wenshan, Province de Yunnan, en Chine, dans les années 1950. Par le fait de différences de conditions géographiques et de développement socio-économique, la diminution de la prévalence de la lèpre entre 1955 et 1993 fut de 99.5% (10.1 à 0.05/10,000) à Weifang et de 93.9% (19.7 à 1.2/10,000) à Wenshan. La diminution de la prévalence était plus évidente dans ces deux préfectures depuis l'introduction de la polychimiothérapie (PCT) en 1986. On a étudié des facteurs tels que les taux de détection spécifiques pour l'âge, le sexe et le type de lèpre, ainsi que les proportions de multibacillaires, d'enfants et d'incapacités parmi les patients détectés depuis 1980. On a, à partir des taux de détection et de prévalence, extrapolé pour ces deux préfectures le nombre de patients jusqu'à l'an 2000.

Acknowledgment. The leprosy control program with multidrug therapy in Shandong Province is supported

by the Sasakawa Memorial Health Foundation; in Wenshan, by the World Health Organization. We are thankful for the assistance in the statistical analysis of data by Dr. Yang Zhong-Min, Associate Professor, Cancer Research Institute, Chinese Academy of Medical Sciences, Beijing, and extend our sincere gratitude to Prof. M. Lechat for his valuable comments.

REFERENCES

- IRGENS, L. M. Leprosy in Norway. *Lepr. Rev.* **51** Suppl. (1980) 1-130.
- LECHAT, M. F. and VANDERVEKEN, M. Basic epidemiological indicators for monitoring leprosy control. In: *Proceedings 4th International Workshop on Leprosy Control in Asia*. Tokyo: Sasakawa Memorial Health Foundation, 1983, pp. 42-65.
- LI, H.-Y., PAN, Y.-L. and WANG, Y. Leprosy control in Shandong Province, China 1955-1983, some epidemiological features. *Int. J. Lepr.* **53** (1985) 79-85.
- LI, H.-Y., YU, X.-L. and HUANG, W.-B. Eight years follow up of multibacillary leprosy after 24-27 months of multidrug therapy. *Int. J. Lepr.* **61** Suppl. (1993) 5A.
- LI, H.-Y., YU, L., ZHANG, M.-S., DUAN, C.-X., HUANG, W.-B., ZHANG, S.-B., ZHU, K. and MA, J.-F. Short-term multidrug therapy in multibacillary leprosy—review of 80 cases in two provinces of China (1983-1988). *Int. J. Lepr.* **57** (1989) 622-627.
- MULIYIL, J., NELSON, E. K. and DIAMOND, E. L. Effect of BCG on the risk of leprosy in an endemic area: a case control study. *Int. J. Lepr.* **59** (1991) 229-236.
- SAIKAWA, K. The effect of rapid socio-economic development on the frequency of leprosy in a population. *Lepr. Rev.* **52** Suppl. 1 (1981) 167-175.
- SOMMERFELT, H., IRGENS, L. M. and CHRISTIAN, M. Geographical variations in the occurrence of leprosy: possible roles played by nutrition and some other environmental factors. *Int. J. Lepr.* **53** (1985) 524-532.
- WANG, A.-Q. and YU, M. Use of grey dynamic model in the prediction of mortality of diseases. *Chin. J. Epid.* **9** (1988) 47-52.
- WHO EXPERT COMMITTEE ON LEPROSY. Sixth report. Geneva: World Health Organization, 1988. Tech. Rep. Ser. 768.
- WHO STUDY GROUP. Chemotherapy of leprosy for control programs. Geneva: World Health Organization, 1982. Tech. Rep. Ser. 675.
- WORLD HEALTH ORGANIZATION. Global strategy for the elimination of leprosy as a public health problem. Geneva: World Health Organization, 1994. WHO/CTD/LEP/94.2.
- ZHAO, D., WONG, Y. W. and ZHONG, J. Z. The relationship between leprosy incidence and economic development. *China Lepr. J.* **9** (1993) 145-147.