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Trends in new leprosy case detection over 57 years (1952–2008) in Yuxi, Yunnan Province of Southwest China

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Summary
Background: Leprosy control and management in China was maintained *via* a vertical system. Despite substantial achievements in leprosy control in the past decades, leprosy has not been completely eliminated in several endemic areas of Yunnan Province, China.
Objectives: To report the epidemiological trends and management of leprosy in Yuxi, Yunnan Province from 1952 to 2008.
Design: Diagnosis, control, and treatment data for 2223 leprosy cases detected from 1952 to 2008 were analysed.
Results: Two large-scale house-to-house surveys were launched in 1957–1958 and 1964–1965, and a remarkable number of new cases were identified during these two surveys. The overall prevalence rate of leprosy in the Yuxi region presented a roughly unimodal distribution between 1952 and 2008, with a peak (9·27 per 10 000 population) in 1965. This reflects a combination of case detection and duration of treatment. Overall, the age distribution of the patients changed dramatically over the years, and there were only two childhood cases between 1995 and 2008 (both occurring in 1998). Nearly half of the total cases (49·1%) were classified as multibacillary leprosy type. With the introduction and ubiquitous coverage of the

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WHO multi-drug therapy (MDT) in this area, leprosy elimination was achieved in 1992. In recent years, the majority of cases (>80%) were detected by passive approaches, and there is an increasing tendency to find multibacillary leprosy patients.

Conclusions: Our results provide an overall profile of our 57-year effort regarding the leprosy control in the Yuxi region. The trend in detection of new cases in recent years suggested that the transmission of leprosy has stopped in the area or, at least, dramatically declined.

Introduction

Leprosy is a chronic, systemic disease caused by the pathogen *Mycobacterium leprae*.[1–3] It affects human skin and the peripheral nerve systems, as well as eyes and other systems, resulting in a variety of disabilities associated with leprosy.[1,3,4] As an ancient disease, leprosy existed and was transmitted amongst people for at least 4000 years[5] and still constitutes a public health problem today. Leprosy control in China and other countries has been successfully achieved during the past decades,[6–9] but it has not been eliminated in several regions according to the World Health Organization (WHO) leprosy elimination criterion (<1 case per 10 000 population).[10] The introduction of multi-drug therapy (MDT) against this disease since 1982 had effectively reduced the number of leprosy cases. In spite of the success achieved and the decreasing annual prevalence rate, 212,802 cases worldwide were still registered at the beginning of 2008.[10]

In China, leprosy was highly prevalent in many prefectures in the 1950s and earlier. Because of the success of the vertical approach, China achieved the goal of leprosy elimination in 1981 at country level.[6,11,12] The number of newly detected leprosy cases remained stable in recent years (around 1400–1660 cases per year).[10] There are currently around 6300 leprosy patients being treated, primarily in the Yunnan, Guizhou, Sichuan, Tibet, and Hunan provinces (http://www.lepinfo.org).

The Yuxi Prefecture of the Yunnan Province (north latitude 23° 19′ – 24° 53′, longitude 101° 16′ – 103° 9′) is historically an endemic region of leprosy. It contains eight counties (Jiangchuan, Chengjiang, Tonghai, Huaning, E'shan, Yimen, Xinping, and Yuanjiang) and one district (Hongta), altogether spanning an area of 15 285 km^2 and inhabited by a considerably large population size (2,122,522 individuals according to the population census data in 2007) (Figure 1).

The terrain of the Yuxi Prefecture is complex, with various geographic features including mountains, valleys, lakes, plateaus and basins. The whole area extends from high northwest to low southeast, and the difference of altitude between the highest and the lowest points is 2810 meters. Overall, more than 80% of the area is located in hilly and mountainous regions. The Yuxi Prefecture has a subtropical plateau monsoon climate, with an average annual temperature of 15 °C – 24 °C. Nearly 82% of residents in the Yuxi region work in agriculture; around 32% of the total population is composed of ethnic minorities including Yi, Hani, Dai etc. The leprosy control and management programme in the Yuxi Prefecture has been well maintained during the past years, firstly *via* a conventional vertical system and later as an integrated system, with a considerably comprehensive record for all registered patients. In this study, we report the leprosy diagnosis, control, and treatment results in Yuxi from 1952 to 2008, with an intention to learn more about the epidemiological trends and problems to improve disease prevention and treatment.

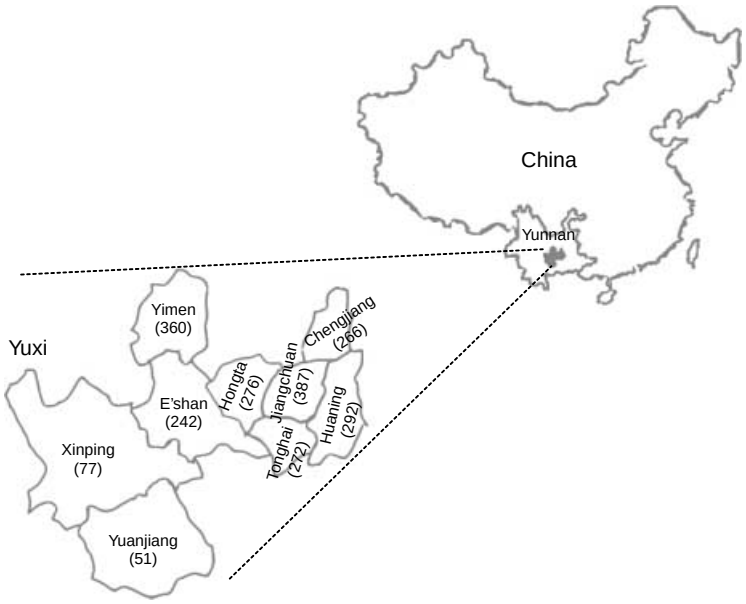

Figure 1. Map of the Yuxi Prefecture, Yunnan Province, China. The numbers in the parentheses refer to the exact number of patients in each region.

Patients and Methods

PATIENT DETECTION

Extensive records for all leprosy cases detected in the Yuxi Prefecture were maintained at the Yuxi Center for Disease Control and Prevention. By December 31, 2008, there were 2369 registered leprosy cases in the Yuxi Prefecture. Among them, 146 cases were detected during 1918–1951; these cases did not have sufficient clinical information and were excluded from the current analysis. Additionally there was no systematic field investigation on leprosy before 1956 in the Yuxi region. Between 1956 and 1986, an active case detection strategy was widely carried out. These active strategies include house-to-house surveys, physical examinations for cured patients, household contacts of confirmed leprosy patients, and the clue survey, by which professional health workers collected and confirmed leprosy patients in the area according to the information provided by rural paramedical workers. There were two massive campaigns of active case detection strategy in which house-to-house searches were performed in the Yuxi Prefecture: from the end of 1957 to 1958 and the end of 1964 to 1965. In recent years, case detection was mainly passive through voluntary reporting centers and self-reporting.

CASE DEFINITION

We diagnosed leprosy patients based on clinical and histopathological features, as well as the bacteriological index if available. Because of the classification systems, terms and

definitions of leprosy have evolved over the past decades, so we followed the strategy of Chen *et al.*[6] and grouped the cases into multibacillary (MB) leprosy and paucibacillary (PB) leprosy. In brief, lepromatous (L) and borderline (B) leprosy in the Madrid classification and lepromatous (LL), borderline-lepromatous (BL) and mid-borderline (BB) in the Ridley–Jopling classification were classified as multibacillary (MB) leprosy. Tuberculoid (T) leprosy in the Madrid classification, indeterminate (I) in both classifications, and tuberculoid (TT) and borderline-tuberculoid (BT) in the Ridley–Jopling classification were grouped as paucibacillary (PB) leprosy. The number of skin lesions, 1–5 for PB and >5 for MB according to the WHO operational classification[3] was also considered during the classification of patients. For patients that were recorded in the 1950s and 1960s, we re-evaluated the original related clinical, bacteriological, and histopathological profiles (if applied) and classified these patients according to the current classification system. Disability levels were graded according to the revised WHO grading system.[13] Similarly, for those patients who were registered before the agreement of the current grading system, we re-evaluated their originally recorded disability grades based on the newer WHO criteria. Relapse after treatment was defined according to the WHO guide to leprosy control, despite the fact that there may be confusion regarding re-infection and relapse.[14]

All the computerised data were analysed by using SPSS 13.0 (SPSS Inc., Chicago, Illinois). The institutional review boards of the Yuxi City Center for Disease Control and Prevention, the First Affiliated Hospital of Kunming Medical College, and the Kunming Institute of Zoology approved this study.

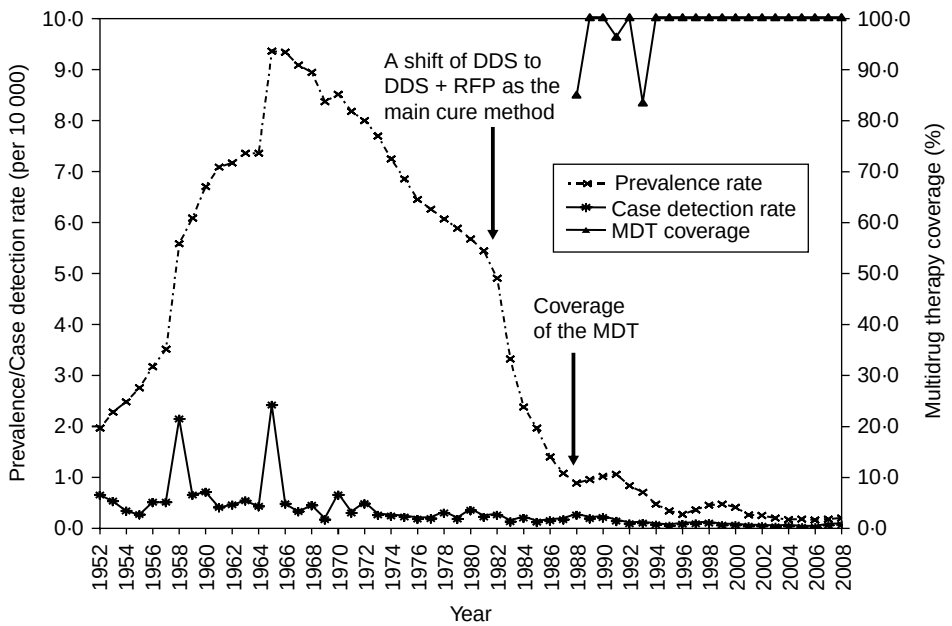

Figure 2. Prevalence and case detection rate of leprosy and MDT coverage in the Yuxi Prefecture during 1952–2008.

Table 1. Leprosy case detection, prevalence and related information in Yuxi, Yunnan, China, 1952–2008

		Case detection		Prevalence			Children (< 15 yr)		Nationality					Method of Detection			Classification		Disability				Treatment			
Year	Population Size	No.	Rate*	No.	Rate*	Male/ Female	No.	Proportion (%)	Han	Yi	Other†	Age at diagnosis (yr)	Delay detection (yr)	Active	Passive	Un-clear‡	PB	MB	Grade 0	Grade I	Grade II	Un-clear‡	DDS	DDS + RFP	MDT	Other§
1952	901,012	56	0·62	176	1·95	35/21	15	26·79	49	5	2	4 ~ 60	0 ~ 31	39	1	16	27	29	20	1	35	0	55	0	0	1
1953	977,041	49	0·50	221	2·26	34/15	10	20·41	39	6	4	10 ~ 48	0 ~ 13	36	6	7	23	26	21	1	27	0	48	0	0	1
1954	993,532	31	0·31	244	2·46	25/6	2	6·45	25	6	0	8 ~ 62	0 ~ 19	27	0	4	17	14	7	2	22	0	29	0	0	2
1955	994,009	24	0·24	271	2·73	17/7	4	16·67	19	5	0	8 ~ 62	0 ~ 11	21	1	2	12	12	9	1	14	0	21	0	0	3
1956	1,004,179	48	0·48	315	3·14	30/18	9	18·75	33	10	5	9 ~ 52	0 ~ 20	44	3	1	21	27	10	5	33	0	46	0	0	2
1957	1,032,231	50	0·48	359	3·48	35/15	7	14·00	33	14	3	5 ~ 63	0 ~ 27	44	6	0	27	23	14	3	33	0	47	0	0	3
1958	1,012,252	215	2·12	560	5·53	173/42	22	10·33	165	46	4	5 ~ 75	0 ~ 30	175	1	39	120	95	76	9	127	3	189	0	0	26
1959	995,010	60	0·60	600	6·03	44/16	10	16·13	39	17	4	7 ~ 58	0 ~ 21	54	1	5	37	23	21	11	28	0	49	0	0	11
1960	976,166	66	0·68	648	6·64	46/20	10	15·15	51	13	2	9 ~ 63	0 ~ 17	39	4	23	44	22	37	2	27	0	60	0	0	6
1961	968,215	37	0·38	680	7·02	26/11	4	10·81	27	8	2	11 ~ 47	0 ~ 8	27	3	7	23	14	9	5	23	0	31	0	0	6
1962	983,449	43	0·44	698	7·10	34/9	6	14·29	31	8	4	4 ~ 50	0 ~ 13	34	2	7	29	14	18	1	24	0	34	0	0	9
1963	1,023,292	52	0·51	746	7·29	44/8	4	7·69	40	7	5	12 ~ 80	0 ~ 42	50	0	2	32	20	34	1	17	0	49	0	0	3
1964	1,064,236	43	0·40	776	7·29	33/10	7	16·28	32	10	1	9 ~ 60	0 ~ 14	39	0	4	28	15	18	2	23	0	36	0	0	7
1965	1,098,512	261	2·38	1018	9·27	186/75	11	4·23	244	16	1	5 ~ 67	0 ~ 37	249	8	4	141	120	74	37	150	0	248	0	0	13
1966	1,134,744	50	0·44	1050	9·25	41/9	6	11·76	38	11	1	12 ~ 64	0 ~ 21	43	1	6	33	17	13	7	30	0	47	0	0	3
1967	1,158,507	34	0·29	1043	9·00	28/6	3	8·57	22	9	3	11 ~ 54	0 ~ 13	30	0	4	21	13	9	9	16	0	32	0	0	2
1968	1,202,463	51	0·42	1065	8·86	42/9	5	9·80	41	8	2	11 ~ 53	0 ~ 16	42	2	7	32	19	24	6	21	0	47	0	0	4
1969	1,256,984	21	0·17	1042	8·29	17/4	1	4·76	16	2	3	12 ~ 63	0 ~ 11	14	3	4	11	10	8	5	8	0	18	0	0	3
1970	1,276,279	83	0·65	1076	8·43	63/20	4	4·82	58	23	2	10 ~ 73	0 ~ 22	68	5	10	43	40	26	13	44	0	60	0	0	23
1971	1,334,446	40	0·30	1081	8·10	32/8	0	0·00	30	6	4	16 ~ 70	0 ~ 16	31	2	7	25	15	14	5	21	0	32	0	0	8
1972	1,376,768	67	0·49	1091	7·92	56/11	3	4·55	51	9	7	7 ~ 64	0 ~ 21	60	0	7	39	28	18	15	34	0	47	0	0	20
1973	1,409,070	36	0·26	1074	7·62	31/5	1	2·78	28	5	3	12 ~ 74	0 ~ 14	26	4	6	24	12	15	3	18	0	30	0	0	6
1974	1,443,864	34	0·24	1037	7·18	23/11	0	0·00	24	8	2	16 ~ 77	0 ~ 15	32	1	1	13	21	11	5	18	0	29	0	0	5
1975	1,477,971	33	0·22	1004	6·79	28/5	1	3·03	24	9	0	1 ~ 68	0 ~ 14	28	2	3	23	10	14	9	10	0	30	0	0	3
1976	1,508,149	27	0·18	964	6·39	22/5	1	3·70	19	6	2	14 ~ 64	0 ~ 18	22	1	4	16	11	9	7	11	0	24	0	0	3
1977	1,540,713	30	0·19	956	6·20	26/4	2	6·67	19	7	4	13 ~ 69	0 ~ 18	26	1	3	17	13	6	9	15	0	25	0	0	5
1978	1,566,088	47	0·30	942	6·01	38/9	0	0·00	38	5	4	19 ~ 63	0 ~ 30	40	1	6	28	19	16	10	21	0	42	5	0	0
1979	1,583,247	28	0·18	923	5·83	17/11	1	3·57	20	7	1	14 ~ 71	0 ~ 24	25	2	1	13	15	5	6	17	0	14	14	0	0
1980	1,596,460	56	0·35	897	5·62	39/17	5	8·93	36	17	3	8 ~ 72	0 ~ 50	50	5	1	31	25	27	6	23	0	26	28	0	2
1981	1,615,150	35	0·22	871	5·39	22/13	2	5·71	24	5	6	11 ~ 62	0 ~ 25	29	5	1	16	19	11	7	17	0	20	15	0	0
1982	1,633,216	43	0·26	794	4·86	34/9	2	4·65	30	11	2	12 ~ 70	0 ~ 24	29	14	0	20	23	14	13	16	0	18	25	0	0
1983	1,649,863	22	0·13	542	3·29	17/5	0	0·00	12	7	3	17 ~ 64	0 ~ 18	14	8	0	8	14	6	9	7	0	11	11	0	0
1984	1,670,021	33	0·20	394	2·36	22/11	3	9·09	21	7	5	10 ~ 83	0 ~ 16	19	14	0	10	23	13	9	10	1	9	24	0	0
1985	1,688,972	21	0·12	329	1·95	14/7	0	0·00	12	8	1	15 ~ 70	0 ~ 26	15	6	0	3	18	7	4	9	1	3	18	0	0
1986	1,710,639	26	0·15	238	1·39	20/6	0	0·00	24	1	1	17 ~ 61	0 ~ 28	12	14	0	9	17	15	1	9	1	2	24	0	0
1987	1,739,082	29	0·17	186	1·07	21/8	1	3·45	19	7	3	2 ~ 67	0 ~ 14	6	23	0	14	15	9	3	17	0	2	27	0	0
1988	1,766,938	46	0·26	156	0·88	37/9	1	2·17	34	8	4	14 ~ 81	0 ~ 18	9	37	0	17	29	21	9	16	0	0	4	39	3
1989	1,768,943	33	0·19	168	0·95	23/10	0	0·00	20	12	1	15 ~ 71	0 ~ 17	5	28	0	10	23	12	9	12	0	0	0	32	1
1990	1,794,562	38	0·21	181	1·01	29/9	4	10·81	25	10	3	9 ~ 68	0 ~ 11	8	30	0	15	23	21	8	9	0	0	0	38	0
1991	1,818,113	26	0·14	191	1·05	20/6	4	15·38	19	7	0	8 ~ 60	0 ~ 2	6	20	0	10	16	16	6	4	0	1	0	24	1
1992	1,838,075	16	0·09	153	0·83	13/3	0	0·00	11	5	0	17 ~ 85	0 ~ 15	3	13	0	8	8	9	4	3	0	0	0	16	0
1993	1,852,439	18	0·10	129	0·70	13/5	1	5·56	15	2	1	6 ~ 65	0 ~ 4	3	15	0	1	17	11	1	6	0	3	0	12	3
1994	1,871,945	14	0·07	88	0·47	9/5	2	14·29	8	5	1	12 ~ 69	0 ~ 21	2	12	0	3	11	8	1	5	0	0	0	13	1
1995	1,885,623	10	0·05	65	0·34	5/5	0	0·00	7	1	2	20 ~ 61	0 ~ 5	0	10	0	2	8	9	1	0	0	0	0	10	0
1996	1,904,778	15	0·08	52	0·27	11/4	0	0·00	14	1	0	21 ~ 62	0 ~ 14	2	13	0	4	11	9	4	2	0	0	0	15	0

Table 1. *continued*

		Case detection		Prevalence			Children (< 15 yr)		Nationality					Method of Detection			Classification		Disability				Treatment			
Year	Population Size	No.	Rate*	No.	Rate*	Male/ Female	No.	Proportion (%)	Han	Yi	Other†	Age at diagnosis (yr)	Delay detection (yr)	Active	Passive	Un-clear‡	PB	MB	Grade 0	Grade I	Grade II	Un-clear‡	DDS	DDS + RFP	MDT	Other§
1997	1,935,441	17	0·09	70	0·36	14/3	0	0·00	12	4	1	15 ~ 71	0 ~ 4	4	13	0	4	13	10	2	5	0	0	0	15	2
1998	1,946,349	20	0·10	87	0·45	16/4	2	10·00	15	3	2	12 ~ 79	0 ~ 3	9	11	0	5	15	9	6	5	0	0	0	19	1
1999	1,971,207	11	0·06	92	0·47	6/5	0	0·00	3	6	2	20 ~ 69	0 ~ 7	1	10	0	0	11	6	3	2	0	0	0	11	0
2000	1,991,346	10	0·05	82	0·41	6/4	0	0·00	7	2	1	16 ~ 65	0 ~ 9	1	9	0	3	7	2	3	5	0	0	0	10	0
2001	2,016,780	9	0·04	53	0·26	8/1	0	0·00	6	3	0	25 ~ 72	0 ~ 2	0	9	0	2	7	4	2	3	0	0	0	9	0
2002	2,034,065	8	0·04	50	0·25	5/3	0	0·00	5	0	3	31 ~ 66	0 ~ 2	4	4	0	3	5	3	4	1	0	0	0	8	0
2003	2,053,957	6	0·03	41	0·20	2/4	0	0·00	4	1	1	18 ~ 54	0 ~ 5	1	5	0	2	4	6	0	0	0	0	0	6	0
2004	2,068,473	9	0·04	36	0·17	8/1	0	0·00	7	1	1	30 ~ 69	0 ~ 4	1	8	0	1	8	4	3	2	0	0	0	9	0
2005	2,085,532	4	0·02	38	0·18	1/3	0	0·00	4	0	0	29 ~ 43	0 ~ 7	0	4	0	2	2	3	0	1	0	0	0	4	0
2006	2,091,649	5	0·02	34	0·16	3/2	0	0·00	2	2	1	19 ~ 54	0 ~ 17	1	4	0	0	5	3	1	1	0	0	0	5	0
2007	2,106,164	13	0·06	37	0·18	8/5	0	0·00	9	4	0	16 ~ 77	0 ~ 3	0	13	0	2	11	4	1	7	1	0	0	13	0
2008	2,122,522	14	0·07	42	0·20	10/4	0	0·00	8	4	2	21 ~ 64	0 ~ 46	4	10	0	6	8	5	4	5	0	0	0	14	0

Note: *The case detection rate and the prevalence rate are expressed per 10 000.
†Aggregation of these patients belong to Dai, Hui, Hani, Miao, Mongolian, Bai and Zhuang ethnic groups.
‡Patients with unclear information.
§Patients who received treatment with traditional Chinese medicine or other drugs.

Results

From 1952 to 2008, a total of 2223 leprosy cases were detected in the Yuxi Prefecture. The overall prevalence rate of leprosy in the Yuxi region presents a roughly unimodal distribution between 1952–2008, with a peak (9·27 per 10 000 population) in 1965 (Figure 2 and Table 1).

More than 95% of cases were of farmers living in impoverished, rural areas. This pattern reflects the population of the area, in which 80% of residents in the Yuxi region belong to the agricultural population. The majority of the cases are Han Chinese (1668/2223, 75·0%), followed by the Yi ethnic group (429/2223, 19·3%); the remaining cases (126/2223, 5·7%) are composed of individuals from the Hani, Hui, Dai, Miao, Mongolian, Bai, and Zhuang ethnic groups. There is a higher prevalence of disease in males (1663/2223; 74·8%) than in females (560/2223; 25·2%). Among all cases, 48·1% had a disability of Grade 2 and 14·1% of Grade 1; the remaining cases had no disabilities associated with leprosy. Due to the delayed detection and treatment of the disease, patients of older age had a higher chance of relapse and disability of Grade 2 than younger ones. This pattern was generally consistent with the result of a national survey conducted in China between 1984 and 1998.[15]

Nearly half of the 2223 cases were MB leprosy (49·1%) at the time of diagnosis. The proportion of MB patients among the annually detected cases was remarkably high ($>60\%$; with the exception of 1987, 1992, and 2005) since 1983 (Table 1). We observed a significant decrease of the prevalence rate to an average level of 0·47 per 100,000 population during 1988–2008 (Figure 1).

Concomitant with this decrease is the introduction of the WHO MDT treatment in 1988 which extended completely throughout the Yuxi Prefecture (excluding the years 1991 and 1993, in which 96·2% and 83·3% coverage was achieved, respectively). A total of 331 cases have received MDT treatment so far and none of them relapsed. Accompanying the full delivery of MDT service, a high proportion of new cases ($>80\%$, with a few years in exception) were detected by passive, instead of active approaches (Table 1).

The average age at diagnosis of the patients was $27{\cdot}7 \pm 13{\cdot}7$ years, whereas the delay between the estimated onset of leprosy symptoms and confirmed diagnosis was $3{\cdot}9 \pm 5{\cdot}6$ years. Note that the delayed detection time estimated here might not be reliable, as the information was based on each patient's recall. One hundred and seventy-six cases detected during 1952–2008 were of children (<15 years old). The overall age distribution of the patients has changed dramatically over the years, and there were no childhood cases among the newly diagnosed cases during 1995 to 2008 (except for two in 1998) (Table 1). The absence of childhood cases in recent years might mean that transmission has stopped in the area or, at least, dramatically declined.

Discussion

The final eradication of leprosy is a long process despite a successful fight against this disease in recent decades. The complete coverage of WHO MDT treatment and the integration of conventional vertical leprosy services into the general health care services in recent years have brought important changes for the leprosy control and management programme. To investigate the recent epidemiological trends of leprosy under these changes will provide useful information for the continual surveillance of leprosy. In this study, we summarise our 57-year efforts on leprosy control and management in the Yuxi Prefecture of

Yunnan Province. Our current study complements previous reports regarding leprosy in China,[6,7,11,12,15–24] especially on the recent trends of leprosy in the Yuxi region.

The leprosy elimination goal was achieved in 1992 in the Yuxi Prefecture. The long fight against leprosy in this region can be separated into three periods based on the different principal therapeutic approaches that were employed. During the first period (1952–1981), the prevalence rate was very high, with an average value of 6·32 per 10 000 population. The increase in prevalence of cases from 1952 until the mid 1960s reflects a combination of case detection and duration of treatment. During the two large-scale campaigns of active case detection (the end of 1957 to 1958 and the end of 1964 to 1965) in the Yuxi Prefecture, when house-to-house searches were performed, a large number of patients were detected, Dapsone (DDS) monotherapy was used as the main approach to cure leprosy, with a small portion of cases being treated with DDS + rifampin (RFP) and/or traditional Chinese medicine. Following DDS treatment, the overall relapse rates in the Yuxi region were relatively low for MB (5·51%) and PB (0·81%) cases. Our result was in general concordance with a previous nationwide survey of the leprosy relapse rates in patients treated by DDS[17]: MB patients (8·14% or 5·91 per 1000 patient-years (PY) over an average follow-up period of 13·8 ± 8·4 years); PB patients (1·25% or 0·86 per 1000 PY over an average period of 14·5 ± 8·9 years).[17] During the second period (1982–1988), DDS + RFP was widely used to cure patients. Especially in the last two years, this treatment was ubiquitous in the Yuxi region. Corresponding with the expansion of the DDS + RFP treatment, the prevalence rate of leprosy was dramatically decreased, averaging 2·26 per 10 000 population. We observed fewer cases with relapse (5·0%) compared to those who received the DDS treatment in the first period. The third period started with the introduction of the WHO MDT treatment in 1988. The quick widespread coverage of MDT caused a dramatic decline of the prevalence rate to 0·45 per 10 000 population. Remarkably, there have been no childhood cases since 1995 until now (excluding the two childhood cases detected in 1998), suggesting that leprosy transmission has been well controlled in the area in recent years. None of the cases treated with MDT treatment in the Yuxi Prefecture relapsed during the follow-up surveillance. The overall relapse rate in our patients treated with MDT was similar to that of a retrospective relapse survey by Shen *et al.*,[22] in which they also found a low relapse rate (0·21/1000 person-years).[22] The lower relapse rate in the Yuxi Prefecture may be due to better management of the patients during the MDT treatment and all patients completed treatment.

Although the WHO MDT treatment was the most effective method to control leprosy in the Yuxi region, there are several features to consider when implementing management policies for leprosy in the future. Firstly, the prevalence rate and case-detection rate had already declined before the introduction of MDT and seemingly reached a plateau in recent years. This pattern is consistent with previous reports,[8,12,25] suggesting that the previous leprosy control strategy and management was essentially useful for disease control. Secondly, corresponding with ubiquitous coverage in Yuxi, more MB cases were detected. The proportion of MB patients among the new cases (73·4%) detected between 1988 and 2008 was significantly higher than the proportion detected (46·8%) from 1952 to 1987. This change of leprosy epidemiology may deserve special attention in future disease control. Thirdly, we noticed several differences regarding the prevalence rate and the proportion of MB or PB leprosy in the nine counties of the Yuxi Prefecture (Figure 2).

The Hongta, Jiangchuan, and Tonghai counties had a higher proportion of younger patients (<20 years old), whereas Yimen and Xinping counties had a considerably high

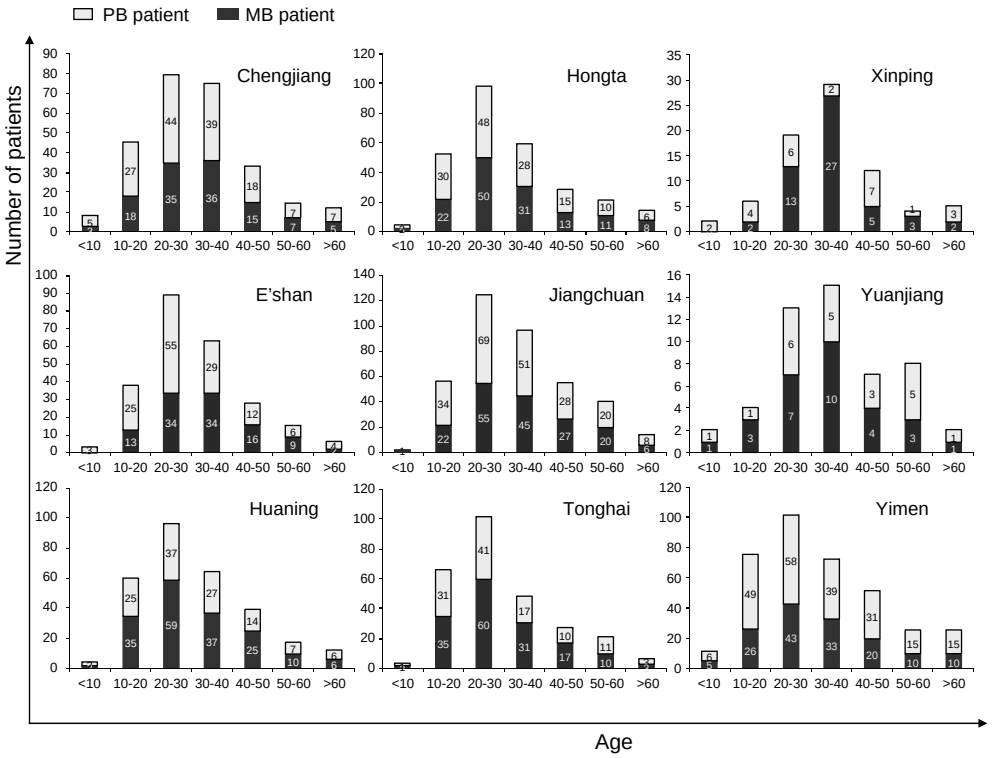

Figure 3. Distribution and classification of the leprosy cases in the Yuxi Prefecture. Patients were classified into multibacillary (MB) and paucibacillary (PB) leprosy groups according to the latest definition of the terms applied to the original medical records.

proportion (12·81%) of patients more than 50 years old. Additionally the Huaning and Tonghai counties had more MB than PB patients (Huaning, 59·59% vs 40·41%; Tonghai, 58·09% vs 41·91%) (Figure 3).

Delay in the detection of new cases was one of the major reasons for serious deformities and damage caused by leprosy.[26] There are many factors that may affect case detection and rehabilitation.[15,27] Early detection is an important way to avoid the higher grade of disability. The average delay in detection rate was 3·91 ± 5·6 years in all Yuxi cases, and it declined to 1·80 ± 3·77 years in the third period of leprosy control in this region. In 2005 and 2008, the overall delayed detection time was unexpectedly long. The associated disabilities of these late-diagnosed patients is not negligible as we observed a higher proportion of cases (>20%) with deformities at Grade 2 or even more severe (Table 1). Thoroughness in early detection and treatment will be essential to avoid high rates of deformity.

Most cases detected during the third period of leprosy control in the Yuxi region (from 1988 to 2008) were by passive approaches, which suggests that detection of cases through dermatological clinics and/or voluntary medical examination would be the main source for new case detection in the future. Leprosy education and disease diagnosis training for local clinicians and the public is undoubtedly essential for the ultimate goal of leprosy eradication.

In summary, we report here our 57-year efforts on leprosy control and management in the Yuxi Prefecture of Yunnan Province. The emerging features of the epidemiological trends of

leprosy in recent years in this region deserve special attention, especially for disease monitoring and management, and case-detection. Our fight against this ancient disease is promising and will not cease.

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References

[1] Britton WJ, Lockwood DN. Leprosy. *Lancet*, 2004; **363**: 1209–1219.
[2] Alter A, Alcaïs A, Abel L *et al.* Leprosy as a genetic model for susceptibility to common infectious diseases. *Hum Genet*, 2008; **123**: 227–235.
[3] Walker SL, Lockwood DN. Leprosy. *Clin Dermatol*, 2007; **25**: 165–172.
[4] Kumar B, Dogra S. Leprosy: a disease with diagnostic and management challenges! *Indian J Dermatol Venereol Leprol*, 2009; **75**: 111–115.
[5] Robbins G, Tripathy VM, Misra VN *et al.* Ancient skeletal evidence for leprosy in India (2000 B.C.). *PLoS ONE*, 2009; **4**: e5669.
[6] Chen XS, Li WZ, Jiang C *et al.* Leprosy in China: epidemiological trends between 1949 and 1998. *Bull World Health Organ*, 2001; **79**: 306–312.
[7] Shen J, Liu M, Zhou M. Current situation of leprosy colonies/leprosaria and their future in P.R. China. *Lepr Rev*, 2007; **78**: 281–289.
[8] Groenen G. Trends in prevalence and case finding in the ALERT leprosy control programme, 1979–1999. *Lepr Rev*, 2002; **73**: 29–40.
[9] Koba A, Ishii N, Mori S *et al.* The decline of leprosy in Japan: patterns and trends 1964–2008. *Lepr Rev*, 2009; **80**: 432–440.
[10] WHO. Global leprosy situation, beginning of 2008. *Wkly Epidemiol Rec*, 2008; **83**: 293–300.
[11] Ye G. Leprosy control in China. Achievements and prospect. *Chin Med J (Engl)*, 1995; **108**: 243–244.
[12] Shen JP, Gupte MD, Jiang C *et al.* Trends of case detection and other indicators of leprosy in China during 1985–2002. *Chin Med Sci J*, 2005; **20**: 77–82.
[13] WHO. WHO expert committee on leprosy. Sixth report. Geneva. (WHO technical report series, no. 768). 1998.
[14] Kaimal S, Thappa DM. Relapse in leprosy. *Indian J Dermatol Venereol Leprol*, 2009; **75**: 126–135.
[15] Chen XS, Li WZ, Jiang C *et al.* Leprosy in China: delay in the detection of cases. *Ann Trop Med Parasitol*, 2000; **94**: 181–188.
[16] Chen XS, Li WZ, Jiang C *et al.* Studies on risk of leprosy relapses in China: relapses after treatment with multidrug therapy. *Int J Lepr Other Mycobact Dis*, 1999; **67**: 379–387.
[17] Chen XS, Li WZ, Jiang C *et al.* Studies on risk of leprosy relapses in China: relapses after treatment with dapsone monotherapy. *Int J Lepr Other Mycobact Dis*, 1999; **67**: 371–378.
[18] Chen XS, Li WZ, Jiang C *et al.* Leprosy in children: a retrospective study in China, 1986–1997. *J Trop Pediatr*, 2000; **46**: 207–211.
[19] Chen XS, Li WZ, Jiang C *et al.* Studies on mode of detection of leprosy in China during the years 1981–1998. *Lepr Rev*, 2001; **72**: 302–310.
[20] Chen XS, Li WZ, Jiang C *et al.* Computerization of leprosy records: national leprosy recording and reporting system in China. *Lepr Rev*, 2000; **71**: 47–56.
[21] Ma HD, Ye GY, Shu HW *et al.* Studies on social medicine and leprosy in east China. *Proc Chin Acad Med Sci Peking Union Med Coll*, 1989; **4**: 61–64.
[22] Shen J, Liu M, Zhang J *et al.* Relapse in MB leprosy patients treated with 24 months of MDT in south west China: a short report. *Lepr Rev*, 2006; **77**: 219–224.

[23] Shen J, Liu M, Zhou M *et al.* Occurrence and management of leprosy reaction in China in 2005. *Lepr Rev*, 2009; **80**: 164–169.
[24] Liu D, Li G, Huang W *et al.* Analysis of newly detected leprosy cases and misdiagnosis in Wuhan (1990–2004). *Lepr Rev*, 2009; **80**: 410–415.
[25] WHO. Leprosy control in Thailand: trends in case detection, 1965–2005. *Wkly Epidemiol Rec*, 2007; **82**: 261–271.
[26] Kumar A, Girdhar A, Girdhar BK. Nerve thickening in leprosy patients and risk of paralytic deformities: a field based study in Agra, India. *Lepr Rev*, 2004; **75**: 135–142.
[27] Withington SG, Joha S, Baird D *et al.* Assessing socio-economic factors in relation to stigmatization, impairment status, and selection for socio-economic rehabilitation: a 1-year cohort of new leprosy cases in north Bangladesh. *Lepr Rev*, 2003; **74**: 120–132.