

# Case detection and management of mobile leprosy in Baoan District, Shenzhen : A retrospective analysis

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## Research Article

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# Abstract

The mobile leprosy control programme in Baoan district was launched in the late 1990s with the goal of elimination of leprosy in mobile population. Here, we aim to describe the characteristics of mobile people suffering from leprosy and the achievements, over the past 30 years in Baoan District, Shenzhen, China, and identify the challenges for better mobile leprosy control. Data from the Leprosy Management Information System in China (LEPMIS) and the annual Leprosy Records were obtained, including patient's basic demographic information and clinical characteristics. A total of ninety five patients were newly detected from 1991 to 2020, with the new case detection rate per 100,000 ranging from 0.14 to 0.07, while the prevalence rate per 100,000 ranging from 0.48 to 0.37. There were no childhood cases and relapse cases. 83.2% of mobile patients coming from southwestern and mid-southern provinces were detected. The median length of time between symptom onset and diagnosis was 31 months (range, 3-296 months). 61.1% of patients had nerve damage at the time of diagnosis. Ulnar nerve was the most commonly involved nerve in nearly 50.0% of total patients in the study. Nearly one third of patients had a reaction and neuritis at some point. 16.8% had a disability of Grade 2 and 25.3% of Grade 1. Among these deformities, leprosy deformities involving hand were 22(23.2%), feet were 30(31.6%), eye were 4(4.2%), respectively. A total of 76 patients have completed MDT treatment and none of them relapsed. 4 patients were loss to follow-up and 15 patients moved back to their household registered location. The case finding and management of mobile leprosy has made remarkable progress in this area. The challenges for mobile leprosy elimination in the next stage are multi-sectoral coordination, involvement of the whole society, sustainable support and investment from the government, stable professional workforce, regular follow-up and tracking survey, establishing an effective surveillance network and referral system.

## Introduction

Leprosy is a chronic infectious disease caused by *Mycobacterium Leprae* that mainly affects skin and peripheral nerves in vulnerable individuals. Especially in the 1980s, leprosy is curable with a combination of rifampicin, dapson, clofazimine recommended by the World Health Organization (WHO) and the number of leprosy patients in China has decreased by 95% over the next 20 years [1]. National Leprosy Elimination Programme (2011-2020) (NLEP) was initiated in China to "control the leprosy epidemic effectively, eliminate the harm of leprosy". China has been very successful in the control and elimination of leprosy [2]. In the past 70 years, more than 500 000 cases of leprosy were diagnosed and cured [3]. The new leprosy case detection rate has dropped from 0.56 per 100,000 in 1958, to 0.037 per 100,000 in 2018 [4]. Leprosy remains a public health problem in southwest China and still causes significant fear and stigma [5].

The new leprosy case detection rate and prevalence rate in Shenzhen were both highest in 1980, and less than 0.5 in 100 000 and 1.0 in 100 000 in 1989, respectively [6], which indicated a low endemic level. Shenzhen is an important area of interprovincial migration in China. Mobile leprosy cases in Shenzhen accounted for 35.7% of the total cases in Guangdong Province [7]. Most leprosy patients in Shenzhen are

mobile population from endemic provinces including Yunnan, Guizhou, Sichuan and Hunan [6, 8]. In order to maintain and strengthen the achievement of the control and elimination of leprosy, Shenzhen has continued to established and improved an effective leprosy referral system from 2000, general practitioner in Social Health Centre, physical examination physician, neurologists and dermatologists are supposed to refer individuals with suspicious lesion or peripheral neurological manifestation to leprosy unit or designated hospital [9]. In 2012, Leprosy Self-care Program was developed by Shenzhen leprosy unit with the goal of giving self-care counselling and information for leprosy patient, supervising self-care groups implementing disability care activities. In 2018, Implementation Plan of Leprosy Suspicious Symptoms Surveillance was officially endorsed by the Shenzhen Ministry of Health, with the general goal of early detection and minimizing the occurrence of physical disability in newly detected cases. The leprosy control program in China is intergrated into basic public health care services in 2019, and leprosy services is provided in 137 community health service centers in all the 10 Streets of the District.

Here, to understand the characteristic of newly detected mobile leprosy patients at low endemic situation and the current status of mobile leprosy management effort in Baoan, Shenzhen, we review the achievements and experiences over the past 30 years and identified the challenges for better mobile leprosy control.

## Material And Methods

Bao'an District is located in the west of Shenzhen City, Guangdong Province. In 1980 it had an estimated population of 129,900 inhabitants. With the economic development of Shenzhen Special Zone, the number of mobile population in Bao'an has increased to 2.69 million in 2019, accounting for 80.5% of total population [10]. Extensive records for all leprosy cases detected in Baoan District were maintained at the Baoan Center for Chronic Disease Prevention and Treatment, where is responsible for the control and elimination of leprosy. By December 31, 2020, there were 134 cases newly detected in Baoan District. Among them, 39 cases were detected during 1963 to 1990; these cases did not have sufficient clinical information and were excluded from the current analysis. During the period, a "clue survey" was widely carried out, by which the specialized institution of leprosy control organized group examination in the area according to a special clue provided by rural doctor. In recent years, case detection was mainly passive through primary health care institution and self-report.

In this study, the delay in diagnosis was defined as the length of time between symptom onset and diagnosis was more than 24 months. Leprosy diagnosis and treatment of choice were performed according to WHO recommended strategies and health standards in China [11–17]. The patients had Grade 0, Grade 1 or Grade 2 disability according to WHO disability grading system for leprosy [11–12].

Baoan District constantly explored and implemented the secondary referral system since 2000, by which health staff found one patient with suspected sign or symptom consistent with the illustrated 8 clues during the outpatient service, he was asked to offer referral services. All leprosy patients were referred to and subsequently confirmed by the leprosy unit.

The main detection modes as follow:

Voluntary reporting: actively or voluntarily reporting the suspected leprosy symptoms by patient himself/herself to medical institution.

Skin clinic: seeking medical care for skin lesions in skin clinic, the lesions having not been considered as leprosy by the patient.

Community health center: seeking medical care for skin lesions in community health center, the lesions having not been considered as leprosy by the patient. Community health center reported the suspected leprosy symptoms and the patient was referred to dermatology department or skin clinic.

Pathology laboratory: seeking medical care for skin lesions in skin clinic, the lesions having not been considered as leprosy by the patient and dermatologist. Pathological biopsy was suspected by lab technician.

**Statistical analysis.** Chi-square ( $\chi^2$ ) test was applied for statistical analysis of categorical data. Wilcoxon Signed Rank Test was applied to identify differences in the nerve damage and physical disability between the time at diagnosis and after RFT. Data analyses were performed using Statistical Package for the Social Sciences (SPSS) version 19.0. In all analyses, a *p*-value less than 0.05 was considered statistically significant.

## Results

A total of ninety five patients were newly detected in Baoan District from 1991 to 2020, with the new case detection rate per 100,000 ranging from 0.14 to 0.07, while the prevalence rate per 100,000 ranging from 0.48 to 0.37. The new case detection rate decreased in fluctuation, with a peak (0.33 per 100,000 mobile population) in 1996, and the prevalence rate stayed below 1 per 100,000, reflecting the achievement of leprosy elimination since the 1990s (Table 1).

Most were male (71.6%) with a median age of 34 years (range 16-78). There were no childhood cases and relapse cases. Patients originated from 13 provinces and regions, with Guangdong (25.3%), Hunan (12.6%), Sichuan (11.6%), Jiangxi (10.5%), Guangxi (9.5%) being the most frequent provinces of origin. 83.2% of mobile patients coming from southwestern and mid-southern provinces were detected. By leprosy clinical classification most patients were lepromatous leprosy (LL) accounting for 36.6%. By WHO classification 72 patients (75.8%) were multibacillary (MB) and 23(24.2%) were pauci-bacillary (PB). The proportion of MB patients among annually detected cases was remarkably high (86%; with the exception of 2015). The median length of time between symptom onset and diagnosis was 31 months (range, 3-296 months). Nearly two third patients had nerve damage at diagnosis, and one third of patients had a reaction and neuritis at some point, either at the time of diagnosis, or during treatment. We observed a significant increase of the proportion of delay in diagnosis and neuritis frequency during 1991 to 2020. The median number of doctors visited before diagnosis was 3(range, 1-11 doctors). Upon disability

assessment using the disability grade standardized by the WHO, 16.8% had a disability of Grade 2 and 25.3% of Grade 1; the remaining cases had no disability associated with leprosy (Table 1, Table 2).

Detection of mobile leprosy cases through dermatologic clinic is the main modes of case-finding, accounting for 80.0%. Detection through community health center and pathology laboratory may play an important role at low endemic situation (Table 2).

Nerve involvement was assessed at the time of diagnosis and at each follow-up visit thereafter. 61.1% of patients had nerve damage at the time of diagnosis. Ulnar nerve was the most commonly involved nerve in nearly 50.0% of total patients in the study, involvement was symmetrical in 36 (37.9%) and asymmetrical in 11 (11.6%) patients followed by involvement of Nervus peroneus communis in 31 (32.6%) of patients, Tibial nerve in 20 (21.5%) patients, Great auricular in 16 (16.8%) patients, Medianus nerve in 11 (11.6%) patients and Musculospiral nerve in 6 (6.3%) patients respectively (Table 3).

Among these deformities, leprosy deformities involving hand were 22 (23.2%), feet were 30 (31.6%), eye were 4 (4.2%), respectively. This suggests that feet and hand are more commonly affected by deformities. Hand deformity is manifested as sensory disorder and various functional deformities. Most common functional deformity in hand was claw hand in 7 (7.4%) patients followed by monkey's hand 4 (4.2%), palm ulcer 3 (3.2%) and ankylosis 1 (1.1%). Feet deformity is mainly manifested as sensory disorder in 28 patients. Functional deformity in feet mainly was ulcer of sole 2 (2.1%), foot drop 1 (1.1%) and rahagades 1 (1.1%) (Table 4).

A total of 76 patients have completed MDT treatment and none of them relapsed. 4 patients were lost to follow-up and 15 patients moved back to their household registered location. Among the 76 patients, there was significant difference in nerve damage and WHO grade of disability between the time at diagnosis and at RFT ( $Z_1=3.983$ ,  $P_1=0.000$ ;  $Z_2=2.828$ ,  $P_2=0.00$ ). These findings revealed nerve damage and deformities improved at RFT. 25% and 14.9% patients showed improvement of nerve damage and impairment status, respectively.

Table 1

Trends in mobile leprosy detection and prevalence in Baoan, Shenzhen, China, from 1991 to 2020

Year	Case detection		Prevalance		MB	Female	G2D	G2D rate
	Cases	Rate*	Cases	Rate*	Proportion (%)	proportion (%)	proportion (%)	per 100,000 population
Total	95	0.13		0.35	75.8	28.4	16.8	0.02
1991	0	0	2	0.48	-	-	-	-
1992	0	0	0	0	-	-	-	-
1993	1	0.14	1	0.14	0	0	0	0
1994	1	0.12	2	0.24	100	0	0	0
1995	2	0.23	2	0.23	0	50	50.0	0.09
1996	3	0.33	4	0.45	100	0	0	0
1997	1	0.10	3	0.31	0	100	0	0
1998	1	0.10	3	0.30	0	100	0	0
1999	3	0.29	4	0.39	100	0	0	0
2000	0	0	3	0.17	0	0	0	0
2001	1	0.05	2	0.11	100	0	0	0
2002	2	0.16	4	0.32	0	50	50.0	0.07
2003	2	0.14	5	0.35	0	100	100	0.12
2004	3	0.14	5	0.23	66.7	0	33.3	0.04
2005	3	0.10	5	0.17	66.7	0	66.7	0.06
2006	5	0.17	6	0.20	100	0	20.0	0.03
2007	4	0.13	7	0.23	100	25.0	25.0	0.03
2008	8	0.26	13	0.43	75.0	25.0	0	0
2009	6	0.19	17	0.55	66.7	0	16.7	0.03
2010	6	0.17	18	0.50	100	50.0	16.7	0.02
2011	6	0.15	18	0.45	66.7	33.3	16.7	0.02
2012	6	0.15	19	0.47	100	16.7	0	0

\* The New case detection rate and prevalence rate are expressed per 100,000, MB=Multibacillary, G2D= Grade 2 disability

Year	Case detection		Prevalance		MB Proportion (%)	Female proportion (%)	G2D proportion (%)	G2D rate per 100,000 population
	Cases	Rate*	Cases	Rate*				
2013	3	0.07	20	0.50	100	0	0	0
2014	3	0.07	21	0.52	66.7	33.3	0	0
2015	3	0.07	20	0.49	33.3	66.7	33.3	0.02
2016	3	0.07	19	0.45	100	66.7	0	0
2017	7	0.16	22	0.50	85.7	28.6	14.3	0.02
2018	7	0.16	21	0.47	85.7	57.1	14.3	0.02
2019	1	0.02	17	0.38	0	0	100	0.02
2020	4	0.07	21	0.37	100	25.0	0	0

\* The New case detection rate and prevalence rate are expressed per 100,000, MB=Multibacillary, G2D= Grade 2 disability

Table 2

Demographic and clinical characteristics of newly detected mobile leprosy in Baoan, Shenzhen, China, from 1991 to 2020

Variable	Time period			Total n=95	Missing
	1991- 1999	2000- 2010	2011- 2020		
Age					n=0
≤30	8(66.7)	18(45.0)	19(44.2)	45(47.4)	
31-45	3(25.0)	17(42.5)	15(34.9)	35(36.8)	
≥45	1(8.3)	5(12.5)	9(20.9)	15(15.8)	
Sex					n=0
Male	9(75.0)	31(77.5)	28(65.1)	68(71.6)	
Female	3(25.0)	9(22.5)	15(34.9)	27(28.4)	
Education*					
Primary school	8(66.7)	10(25.0)	6(14.0)	24(25.3)	
Secondary school	4(33.3)	20(50.0)	23(53.5)	47(49.5)	
High school	0	8(20.0)	9(20.9)	17(17.9)	
Academic	0	2(5.0)	5(11.6)	7(7.4)	
Marital status*					
Single	5(41.7)	13(32.5)	11(25.6)	29(30.5)	
Married	6(50.0)	27(67.5)	20(46.5)	53(55.8)	
Divorced	1(8.3)	0	12(27.9)	13(13.7)	
Leprosy classification *					n=2
BB	2(18.2)	0	2(4.8)	4(4.3)	
BT	4(36.4)	12(30.0)	7(16.7)	23(24.7)	
TT	2(18.2)	5(12.5)	3(7.1)	10(10.8)	
BL	3(27.3)	11(27.5)	8(19.0)	22(23.7)	
LL	0	12(30.0)	22(52.4)	34(36.6)	
Therapy classification					n=0

\* $p < 0.05$

Variable	Time period			Total n=95	Missing
	1991- 1999	2000- 2010	2011- 2020		
PB	5(41.7)	10(25.0)	18(18.6)	23(24.2)	
MB	7(58.3)	30(75.0)	35(81.4)	72(75.8)	
Source of infection					n=0
Family	0	6(15.0)	11(25.6)	17(17.9)	
Community	2(16.7)	5(12.5)	4(9.3)	11(11.6)	
Unknown	10(83.3)	29(72.5)	28(65.1)	67(70.5)	
Detection mode					n=0
Skin clinic	9(75.0)	36(90.0)	33(76.7)	78(82.1)	
Community health care	0	1(2.5)	3(7.0)	4(4.2)	
Voluntary	3(25.0)	3(7.5)	3(7.0)	9(9.5)	
Pathology laboratory	0	0	4(9.3)	4(4.2)	
Early detection*					n=0
Early detection	9(75.0)	24(60.0)	16(37.2)	46(48.4)	
Delay in diagnosis	3(25.0)	16(40.0)	27(62.8)	49(51.6)	
Reaction frequency					n=9
None	12 (100.0)	37(92.5)	39(90.7)	88(92.63)	
Type 1	0	1(2.5)	4(9.3)	5(5.3)	
Type 2	0	2(5.0)	0	2(2.1)	
Nerve damage present at diagnosis	9(75.0)	24(60.0)	25(58.1)	58(61.1)	n=0
Neuritis frequency *	1(9.1)	6(16.7)	24(55.8)	31(34.4)	n=5
Grade 2 disability	1 (8.3)	10(25.0)	5(11.6)	16(16.8)	n=0
*p<0.05					

Table 3  
Nerve involvement among newly detected mobile leprosy patients in Baoan,  
Shenzhen, China, from 1991 to 2020

Nerve	Symmetrical (%)	Asymmetrical (%)	Total (%)
Ulnar	36(37.9)	11(11.6)	47(49.5)
Nervus peroneus communis	23(24.2)	8(8.4)	31(32.6)
Great auricular	11(11.6)	5(5.3)	16(16.8)
Tibial	9(9.5)	11(11.6)	20(21.1)
Medianus	6(6.3)	5(5.3)	11(11.6)
Radialis	4(4.2)	2(2.1)	6(6.3)

Table 4  
Grade of deformities among newly detected mobile leprosy in Baoan,  
Shenzhen, China, from 1991 to 2020

Grade	Symmetrical (%)	Asymmetrical (%)	Total (%)
Grade 1 deformity			
Hand	7 (7.4)	9(9.5)	16(16.8)
Feet	16(16.8)	12(12.6)	28(29.5)
Eye	2(2.1)	1(1.1)	3(3.2)
Grade 2 deformity			
Hand			
Claw hand	1(1.1)	6(6.3)	7(7.4)
Monkey's hand	2(2.1)	2(2.1)	4(4.2)
Ankylosis	1(1.1)	0	1(1.1)
Palm ulcer	1(1.1)	2(2.1)	3(3.2)
Feet			
Foot drop	0	1(1.1)	1(1.1)
Ulcerofsole	0	2(2.1)	2(2.1)
Rahagades	0	1(1.1)	1(1.1)
Eye			
Iridocyclitis	1(1.1)	0	1(1.1)
Lagophthalmos	1(1.1)	0	1(1.1)

## Discussion

Bao'an District used to be the leprosy epidemic area. After decades of efforts, the number of new leprosy patients decreased year by year. According to WHO's criterion of disease elimination [18], Bao'an District had achieved the goal of elimination of leprosy as a public health problem in 1993. Multiple strategies were made to early detection and reducing the number of new patients diagnosed with G2D. The detection rate of leprosy maintained at less than 0.5/100,000 while the prevalence rate maintained at less than 1/100,000 over the last three decades. It was reported 0.168/100,000 in 1991 while 0.029/100,000 in 2020, indicating more than 80% decline. As to prevalence rate, it was reported 0.673/100,000 in 1991, while it was only 0.295/100,000 in 2020, indicating a reduction of 56.2%. Our findings demonstrate a long duration of symptomatic illness (median, 31 months). It is interesting to note that this mean delay was higher in local patients (4 patients, median, 37.5 months). In Guangdong province, the mean delay in diagnosis was 26.37 months [19]. Factors can significantly affect delay in diagnosis including older, higher level of education, BL and LL, MB, people who had reaction or neuritis. The increased proportion of MB reflects a situation of low endemicity and indicates delays in detection [20]. New case had a reaction or neuritis was more likely to delay in diagnosis. We did not observe an association between nerve damage and delay in diagnosis, consistent with a previous study of leprosy patients at a United State clinic [21]. Factors that may affect the length of symptoms before diagnosis include patients having inadequate awareness of the disease, weak willingness to seek care for non-painful and non-itching skin lesions, not seeking care for fear of being isolated from the community, not having health insurance. Misdiagnosis and missed diagnosis of leprosy occur occasionally due to the insidious onset, long incubation period, and diverse characteristics of skin lesions.

The amount of fund given from 2011 to 2020 by the local government was 10.37 million CNY (US \$1.6 million). The leprosy control strategies include suspicious sign and symptom surveillance, contact chasing, focused survey, extensive training to sustain leprosy capacity among health staff, health education, effective referral system, monitoring system to test possible adverse drug reactions, self-care activities supplying counselling and disability care information. In the late 1990s, case-finding activities among mobile populations were implemented in Shenzhen. An increase in the detection of new cases was observed from 2002 to 2013 in Bao'an; this resulted from a widespread case finding attempt (the integration of leprosy services into general health service) implemented in 2000. The activities include training health staff, such as dermatologists, neurologists, general practitioner in Social Health Centre and physical examination physician, establishing and improving an effective leprosy referral system, formulating an evaluating system and reward system for primary health care and medical institution, et al. In 2020, more than 1400 health workers can offer leprosy referral service and the physician training rate is over 90%. In the past 3 decades, about 93.0% of new cases of leprosy in Baoan District originated from other provinces and cities. There is no new child cases and relapses. 9.5% (9/95) of new mobile cases population were detected through self-reporting, 4.2% were detected through community health center referral and 6.3% were through Pathology laboratory referral. It means that 89.5% of newly detected leprosy cases were detected through passive modes, active case-finding in this area is insufficient,

It is notable that 61.1% of patients had nerve damage at diagnosis, higher than the 36.4% rate of nerve damage reported in the literature [21]. MB disease, presence of neuritis and reactions were identified as contributing factors of nerve damage [22]. These numbers show the large burden of peripheral nerves damage. With the progress of the disease, sensory changes may become irreversible and eventually leads to the appearance of disabilities. A causal relationship between nerve damage and D2G has been showed in the past [23–25], thorough neurological examination is essential at diagnosis and at each follow-up visit thereafter. Some of D2G, such as claw hand, monkey's hand, and foot drop caused by nerve impairment, may be irreversible. However, one patient in our study happened Foot drop in the course of treatment and recovered finally owe to timely discovery and treatment. Regular follow-up, improving patient's understanding of the influence of leprosy on peripheral nerve, reporting any illness changes timely, may prevent the deformity caused by neuritis or make the deformity residual improvement during the treatment process. In most cases, the examination and assessment of neuritis or nerve damage depend on experienced doctors in the practice of leprosy. Nerve function was assessed monthly in patients under MDT treatment and repeated every three months in patients released from MDT. Quantitative assessment means or smart tools have not applied to detect the severity of nerve damage, which may influence the accuracy of assessment results. Compared with other areas, the proportion of cases with grade-2 disabilities among newly detected cases has been low in Bao'an [4–5]. The proportion of new cases with G1D increased from 25.0% during 1991 to 1995, to 31.8% during 2016 to 2020, while the proportion of new cases with G2D decreased from 25.0–13.6%, representing a reduction of 45.6%. The findings of this research indicated that the new case detection and disability rehabilitation of leprosy has achieved success. Patients were detected and treated in an early stage, which may prevent further aggravation of deformity. Early detection, early diagnosis and early treatment are still the key measures to prevent deformity.

Records of WHO grade of disability and EHF score provide a crude measure of the effectiveness of disability prevention activity, some patients deteriorated. Factors that could have affected prevention effect including bacterial density index greater than 4, long length of symptoms before diagnosis, substandard treatment process and lepromatous leprosy subtype. Positive is that nerve damage and impairment show improvement significantly after RFT.

Challenges to achieving the goal of NLEP are early detection and management of reactions, neuritis and disabilities among mobile leprosy. Both the number and proportion of newly detected cases diagnosed among transient and mobile populations have increased since 1991. More than 90% were mobile leprosy cases in recent ten years. Transient and mobile leprosy almost had no fixed abode and job, it is a challenge for specialists to carry out regular follow-up, monitoring contacts and surveillance. Mobile leprosy cases are young, with high working intensity and poor compliance with physical examination and medical treatment, it is difficult for early discovery and treatment of neuritis, leprosy reactions and disabilities. Another challenge is that majority (75.8%) of newly detected leprosy was MB cases. Both the absolute number and proportion of MB cases among newly detected leprosy increased since 1991, from 7 and 58% at time period 1 (1991-2000) to 24 and 80% at time period 3 (2011-2020), respectively. The

situation may indicate delays in detection or reflect the continually adjusted WHO clinical definition of MB and PB [20, 26].

The main limitation is the fact that no case interview is conducted which results in information bias as patients' perception about the disease, treatment and recovery do not known.

For the next stage in the better mobile leprosy control in Baoan District, the following problems should be resolved. First, skills in detecting and management leprosy patients among general health staffs are inadequate while newly detected leprosy cases decreased year by year at low endemic situation. Second, leprosy administrative staffs are instable, personnel welfare benefits have not been well implemented, and lack of clinical professionals in leprosy prevention and control. Third, insufficient leprosy knowledge in public and social discrimination persists. Fourth, government commitment to leprosy control is low.

## **Conclusion**

The case finding and management of mobile leprosy has made remarkable progress in Bao'an District over three decades. The challenges for mobile leprosy elimination in the next stage are multi-sectoral coordination, involvement of the whole society, sustainable support and investment from the local government, stable professional workforce, regular follow-up and tracking survey, establishing an effective surveillance network and referral system.

## **Declarations**

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### **Authors' contributions**

Y.Y contributed to the preparation of the proposal, drafted the manuscript and substantively revised it. Z.H supervised the design and execution of the study, collected the data, read and approved the final submitted version. Y.H contributed to the preparation of the proposal, collected the data, read and approved the final submitted version. L.L contributed to the preparation of the proposal, collected the data. J.L, J.H and H.L contributed to the preparation of the proposal, collected the data. All authors have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work.

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## Availability of data and materials

The dataset analyzed during the current study is available from the corresponding author on reasonable request.

## Ethics approval and consent to participate

We confirm that all methods were performed in accordance with the relevant guidelines and regulations. We have obtained informed consent from each patient at the time of diagnosis and before their treatment. Patients' content for the demographic characteristics and clinical features to appear in the manuscript were obtained. Patients' names, initials, phone numbers and hospital admission numbers did not appear in the text or in illustrative material. For data use for the current study, the analysis of the Leprosy Management Information System in China (LEPMIS) data is a routine public health practice. In addition, we obtained an ethical review and approval from the research ethics review committee of the Baoan Center for Chronic Disease Control and Prevention.

## Consent for publication

Not applicable.

## Competing interests

There are no conflicts of interest.

## Author details

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