Dental caries and risk indicators for patients with leprosy in China

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Background: In leprosy, oral health is often neglected and poorly understood. This study aimed to evaluate the prevalence and risk indicators of dental caries in patients with leprosy in China. **Methods:** This cross-sectional, multicentre study included 613 patients with leprosy and 602 control subjects. Based on the established standards of the World Health Organization, we investigated dental caries in cluster samplings from six so-called 'leprosy villages' in three Chinese provinces. Clinical oral examinations were performed and data were reported as decayed (D), missing (M) and filled (F) teeth (DMFT scores). **Results:** The average DMFT scores were 10.39 in patients with leprosy (D = 4.43; M = 5.94; and F = 0.02) and 4.39 in control individuals (D = 2.29; M = 2.02; F = 0.08). The DMFT scores were statistically significantly different in patients with different ages, educational backgrounds and daily brushing frequency (P < 0.05). High DMFT scores were related to age, low educational levels and poor toothbrushing habits. **Conclusions:** The results indicate that patients with leprosy have a high prevalence of severe dental caries. Effective therapy and oral health education should be enhanced for this group of patients.

Key words: Dental caries, leprosy, risk indicators, health education

INTRODUCTION

Leprosy is a chronic infectious disease that results from infection with *Mycobacterium leprae*. Infection with this species of bacterium affect the host immune and inflammatory responses; symptoms include cutaneous lesions, peripheral nerve lesions and orofacial manifestations[1,2]. However, oral mucosa may be a secondary site of *M. leprae* transmission[3], and oral infections may exacerbate leprosy reactions[4–6]. A national leprosy survey showed that in December 2010, 6032 cases of leprosy were registered in China[7]. Our previous study included 613 patients with leprosy in China, and we found that most subjects with leprosy lacked self-care knowledge about dental health. Indeed, people with leprosy had very high normative dental treatment needs; 55.6% needed fillings for dental caries[8]. The questions that often arise are how serious are dental caries in people affected by leprosy, and what are the possible causes for the high incidence of caries in this group. However, there is no data on the status of dental caries in patients with leprosy in China. Most dentists focus little attention on people with leprosy, because in China, most patients with leprosy live in remote 'leprosy villages' and remain isolated because of unreasonable negative attitudes of the general public[9]. Also, professionals who work at the Center for Disease Control and Prevention of Leprosy are not involved in patients' oral care. Thus, the oral health situation of patients with leprosy needs attention from dentists.

Oral health improvement is a significant challenge in many developing countries; moreover, dental caries remain a severe health problem in many developed countries[10,11]. The World Health Organization (WHO) has developed indices for definitions, diagnostic criteria and classifications of caries that can be used to quantify oral health status within clinical practice and in epidemiological studies[12]. For example, to describe the prevalence of dental cavities, the number of decayed (D), missing (M) and filled (F) teeth (DMFT) are combined to give the DMFT

score[13,14]. This index could be used to compare the oral health of individuals not diagnosed with leprosy with that of patients with leprosy, and related risk indicators could be identified to improve oral health and to devise effective measures for preventing oral disease. This approach could strengthen public health programmes worldwide. Therefore, dentists can use DMFT scores to assess caries conditions of patients with leprosy.

However, medical workers in only three countries, namely India, Spain and Brazil, have examined the status of dental caries in people affected by leprosy. In India, one group reported a mean DMFT score of 2.26 for 50 patients[15], and another group found that the mean DMFT score was 3.42 for 43 patients who visited the Bombay Leprosy Project clinics in Mumbai[16]. A study in Fontilles, Spain, evaluated 76 patients with leprosy compared with control subjects. They found that the DMFT scores were similar between the leprosy and control groups (19.06 ± 0.84 *vs.* 17.25 ± 5.15, respectively). However, the leprosy group exhibited more missing teeth and fewer filled teeth compared with the control group[17]. Another study performed in Serra, Brazil, also examined oral disease in a cohort of 99 patients with leprosy. They found a high mean DMFT score (14.4), which indicated that patients with leprosy received insufficient oral health-preventive measures, treatment, and access to dental care[18]. Therefore, differences among countries in the DMFT score for patients with leprosy were observed, with this score being very high in some countries and lower in others. Consequently, for Chinese patients with leprosy, it is necessary to obtain a specific DMFT score to develop health policies that conform to conditions in China.

The aim of this paper was to assess the status of dental caries in patients with leprosy compared with the status in healthy individuals in China. Moreover, this research investigated the influences of age, leprosy classification, educational background and daily toothbrushing frequency on dental caries among patients with leprosy and healthy individuals. This systematic characterisation of dental caries provides a reference point for determining health-care policies for this patient group. Those policies can guide dentists in China regarding appropriate oral hygiene for patients with leprosy and to design effective treatments, with the ultimate goal of relieving some of the burden of leprosy and improving the quality of life of patients with this disease.

MATERIALS AND METHODS

This cross-sectional study implemented cluster sampling from September 2010 to December 2010 in six leprosy villages of China, which are located in Nanjing, Taixing and Jiangyan in the Jiangsu province; in Hanzhong and Shangluo in the Shanxi province; and in Yongzhou in the Hunan province. The study samples were collected from a total population of 1329 individuals who had been released from treatment after having had leprosy in the past. Among 1215 people surveyed, this research included 613 patients with leprosy (480 male patients and 133 female patients, ratio 3.6:1). For the control group, 602 individuals who lived near the leprosy villages, but did not have leprosy or any systemic disease, were selected (459 male subjects and 143 female subjects, ratio 3.2:1).

Questionnaires and oral examinations were performed in six leprosy villages of China, according to the WHO's established standards in 'Oral Health Surveys. Basic Methods'[19]. Questionnaires were filled in and recorded by local leprologists/dermatologists who worked in the leprosy villages. The questionnaires collected basic information about the subjects, the type of leprosy and daily toothbrushing frequency. According to clinical, pathological, bacilloscopy and immunological criteria, that is, the Ridley–Jopling five-degree international classification of leprosy, patients with leprosy were allocated into five types: lepromatous (LL); borderline-lepromatous (BL); mid-borderline (BB); tuberculoid (TT); and borderline-tuberculoid (BT)[20]. Daily toothbrushing frequency was determined according to guidelines from the WHO Collaborating Center for Community Oral Health Programs and Research[21]. Clinical oral examinations were conducted by dentists at the Second Xiangya Hospital of Central South University. The oral examinations were performed by four dentists and four assistants. All dentists who participated in the survey conducted calibration trials to ensure an inter-examiner consistency of at least 85% in their observations. The calibration trial included 20 patients who were evaluated but were not included in the main study. Interexaminer agreement was measured using Cohen's kappa statistic.

Dental caries was assessed according to WHO criteria (1997), based on the numbers of decayed, missing, and filled teeth (i.e. DMFT scores)[19]. This research defined tooth decay as the clear presence of a cavity, undermined enamel, a soft floor or wall upon probing, the presence of a temporary filling, a filling accompanied by decay or the complete destruction of a crown because of caries, where only the root remained. The presence or absence of each tooth was recorded and, for each missing tooth, the participant's report for the underlying reason (e.g. decay, trauma, periodontics-related extraction, periodontal disease) was recorded. If the reason for tooth loss could not be given by the patients with leprosy, then the tooth was excluded from the 'missing teeth' category. A

tooth was considered missing only when it had been extracted because of dental caries. All clinical examinations were carried out using a dental mirror, an explorer and a periodontal probe, as recommended in WHO guidelines.

This study was approved by the Ethics Committee of the Second Xiangya Hospital of Central South University. This research was conducted in full accordance with the World Medical Association Declaration of Helsinki. The participants were informed both verbally and in writing about the purposes of the investigation, and written consent was obtained. Statistical analysis was performed using SPSS version 17.0 for Windows (SPSS Inc., Chicago, IL, USA). Data are expressed as mean ± standard deviation (SD). Differences between groups were analysed using one-way analysis of variance (ANOVA). $P < 0.05$ was considered significant.

RESULTS

Demographics and DMFT scores of patients with leprosy

Table 1 shows the characteristics of patients with leprosy and healthy individuals. The age range of 613 patients with leprosy was 25–93 years, and the age range of 602 healthy individuals without leprosy or any systemic disease was 33–91 years. The leprosy classification analysis indicated that most (51.8%) patients had class LL leprosy. In addition, most patients were illiterate (46.6%) or had only primary school education (45.8%). In contrast, most healthy individuals had primary school education (53.2%), and more than one-third (37.2%) of individuals had secondary school, high school or more than high school education. Survey of toothbrushing frequency showed that 49.3% of patients brushed their teeth once every day, and 28.1% never brushed. In contrast, 48.8% of healthy individuals brushed their teeth twice or more per day.

The average DMFT score was statistically significantly higher ($P < 0.05$) in patients with leprosy (DMFT = 10.39: D = 4.43; M = 5.94; F = 0.02) (*Table 2*) than in healthy individuals (DMFT = 4.39: D = 2.29; M = 2.02; F = 0.08; data not shown). Thus, the average individual in the leprosy group had 4.43 unfilled carious teeth, 5.94 teeth were extracted because of dental caries and only 0.02 teeth were restored after caries removal.

Factors related to DMFT scores

Among individuals with leprosy, the DMFT scores were significantly ($P < 0.05$) related to age, low educational levels and poor toothbrushing habits, but not

Table 1 Characteristics of individuals with (patients) and without (healthy) leprosy

Variables	Patients ($n = 612^†$)	Healthy subjects ($n = 602$)
Gender		
Female	133 (21.7)	143 (23.8)
Male	480 (78.3)	459 (76.2)
Age*		
25–34 years	5 (0.8)	1 (0.2)
35–44 years	17 (2.8)	24 (4.0)
45–54 years	53 (8.6)	102 (16.9)
55–64 years	172 (28.1)	271 (45.0)
65–74 years	251 (40.9)	135 (22.4)
≥ 75 years	115 (18.8)	69 (11.5)
Leprosy classification		
TT	71 (11.6)	–
BT	147 (24.0)	–
BB	14 (2.3)	–
BL	63 (10.3)	–
LL	317 (51.8)	–
Education*		
Illiterate	283 (46.6)	58 (9.6)
Primary school	278 (45.8)	320 (53.2)
Secondary school	35 (5.8)	167 (27.7)
High school and above	11 (1.8)	57 (9.5)
Toothbrushing frequency*		
Never	172 (28.1)	42 (7.0)
Less than once a day	56 (9.1)	55 (9.1)
Once a day	302 (49.3)	211 (35.0)
Twice a day or more	83 (13.5)	294 (48.8)

Values are given as n (%).
*Patients with leprosy were statistically significantly different from healthy individuals; $P < 0.05$ in all education categories.
†One patient had no leprosy classification.
/Healthy subjects had no leprosy classification.
BB, mid-borderline leprosy; BL, borderline-lepromatous leprosy; BT, borderline-tuberculoid leprosy; LL, lepromatous; TT, tuberculoid leprosy.

Table 2 Distribution of decayed (D), missing (M) and filled (F) teeth (DMFT) scores for the whole dentition, the upper jaw and the lower jaw, among individuals with leprosy

Region	Average value ($n = 613$)
All regions	
D	4.43
M	5.94
F	0.02
DMFT	10.39
Upper jaw	
D	2.43
M	3.16
F	0.01
DMFT	5.60
Lower jaw	
D	2.00
M	2.78
F	0.01
DMFT	4.79

to leprosy classification (*Figure 1* and *Table 3*). Older patients were affected most severely (*Figure 1*; $R^2 = 0.418$). When we analysed teeth in the upper and
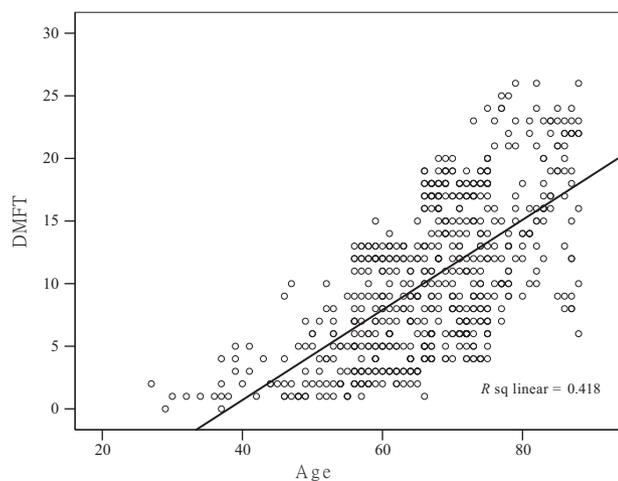
Figure 1. Relationship between age and decayed, missing and filled teeth (DMFT) score among individuals with leprosy ($n = 613$). The DMFT scores of all dental regions increased with patient age ($R^2 = 0.418$).

Table 3 Distribution of decayed (D), missing (M) and filled (F) teeth (DMFT) score, or its individual components, among individuals with leprosy

Variables	D	M	F	DMFT
Leprosy classification				
TT ($n = 71$)	5.96	7.10	0.01	13.07
BT ($n = 147$)	4.63	5.98	0.01	10.62
BB ($n = 14$)	4.29	4.86	0	9.15
BL ($n = 63$)	3.24	5.16	0.03	8.43
LL ($n = 317$)	4.24	5.89	0.03	10.16
Average value ($n = 612^\dagger$)	4.43	5.95	0.02	10.40
P	0.162	0.246	0.870	0.077
Education				
Illiterate ($n = 288$)	4.90	6.81	0.01	11.72
Primary school ($n = 279$)	4.22	5.65	0.03	9.90
Secondary school ($n = 35$)	2.77	2.14	0	4.91
High school and above ($n = 11$)	1	3.45	0.09	4.54
Average value ($n = 613$)	4.39	5.95	0.02	10.36
P	0.002*	<0.001*	0.147	<0.001*
Toothbrushing frequency				
Never ($n = 172$)	5.58	10.08	0.00	16.38
Less than once a day ($n = 56$)	4.77	5.55	0.00	10.32
Once a day ($n = 302$)	3.92	3.63	0.04	7.59
Twice a day or more ($n = 83$)	3.36	4.55	0.02	8.20
Average value ($n = 613$)	4.43	5.94	0.02	10.39
P	0.016*	<0.001*	0.145	<0.001*

*Compared with different categories; $P < 0.05$ is considered significant.
†One patient had no leprosy classification.
BB, mid-borderline leprosy; BL, borderline-lepromatous leprosy; BT, borderline-tuberculoid leprosy; LL, lepromatous; TT, tuberculoid leprosy.

lower jaws separately, the upper jaw had a higher DMFT score than the lower jaw (*Table 2*). However, in the two jaws, we noted equivalent effects of age on the DMFT scores (the R^2 values were 0.421 and 0.411 for the upper and lower jaws, respectively;

data not shown). Interestingly, the DMFT scores were not related to the leprosy classification ($P > 0.05$; *Table 3*). In contrast, the educational background was related to severity. Patients who were illiterate or had a primary school education had DMFT scores of 11.72 and 9.90, respectively, which were nearly twice as high as the DMFT scores of patients with secondary or high-school education and above. Finally, this research found that toothbrushing frequency (*Table 3*) had a statistically significant impact on D ($P < 0.05$), M ($P < 0.001$) and DMFT ($P < 0.001$). The DMFT scores among patients who had never brushed their teeth was 16.38, or was twice as high as that of patients who brushed their teeth twice or more each day. As expected, subjects with the highest daily toothbrushing frequencies tended to have the lowest DMFT scores.

DISCUSSION

The results of this study indicate that patients with leprosy experience more dental caries than healthy controls. The number of decayed and missing teeth was higher in subjects with leprosy than among controls. Our study suggests that the high risk of caries among patients with leprosy was probably related to aging, low educational levels and poor oral-health habits.

In this study, the mean DMFT score of patients with leprosy was 10.39, which is higher than those reported in two studies performed in India (DMFT = 2.26 and 3.42)[15,16]. In one of them, the mean age of leprosy patients was 35.9 years, which was lower than that of the subjects in our study and meant that they had the chance to be diagnosed and treated earlier. A separate study in Spain showed that leprosy patients had less advanced dental caries because they lived in a sanatorium, where the patients received earlier diagnosis and treatment[17]. In contrast, our study involved patients who were older, had more advanced leprosy and lived in leprosy villages, where effective multidrug therapy is not readily available. So, the lower DMFT scores reported in the studies performed in India and Spain[15–17] compared with those in the present study, can be explained. However, it is noteworthy that the DMFT scores for patients with leprosy were higher than those found for the general populations in India, Spain and China[16,17,22,23]. In contrast, Brazilian patients with leprosy had lower DMFT scores than the healthy Brazilian population[18]. All patients included in that study were literate and lived in an urban area. Therefore, the possibility of literacy rates among leprosy patients and their living standard having an impact on the DMFT scores cannot be disregarded.

Explanation of the high DMFT scores in China is still to be determined. One of the factors could be aging. Dental caries represents one of the most

significant oral health concerns in public health. Data from the last epidemiological survey conducted by the National Committee for Oral Health revealed that tooth caries was found in nearly 75.2% of Chinese adults[23]. Cumulative DMFT scores indicated that the severity of dental caries was age-related, and an upward trend with age was reported. Our results indicate that, among individuals with leprosy, as age increased, dental caries became more severe (*Figure 1*), and the change from adolescence into adulthood was marked. Moreover, the F value (0.02) was extremely low compared with that of the general population. We found that, when patients had visited a dentist, they frequently underwent tooth extractions, which is common among disadvantaged groups. In addition, this research observed higher rates of dental caries in the upper jaw than in the lower jaw. This finding might be explained by the observation that disabled patients had difficulty brushing teeth in the upper jaw[24]; indeed, facial scarring made it difficult for such patients to open their mouth sufficiently wide to brush the teeth in the back of the mouth[25].

This research also showed that the DMFT scores were related to the educational background of patients with leprosy, suggesting that increased education might enhance an awareness of oral health care and reduce the prevalence of dental caries (*Table 3*). It should be pointed out that most patients with leprosy were found to be illiterate or to have little education, which affected both their quality of life and dental health, and both contributed to the high morbidity from dental caries[9,26,27].

The daily toothbrushing frequency could also add to the severity of dental caries[28]. The patients in our study exhibited peripheral neuropathy, which led to hand and foot deformities (e.g. claw hand or hand ulcer). Difficulty in maintaining oral hygiene was also observed in patients with leprosy[29]. In other countries, advocates have improvised measures for assisting patients with hand deformities to utilise various implements (e.g. pens and toothbrushes)[16]. However, this approach was seldom implemented in China, which may partly explain why Chinese patients with leprosy brushed their teeth less frequently and had more dental caries than patients with leprosy in other countries. To correct this problem, Chinese dentists should maintain contact with patients with leprosy and enhance their oral health education by encouraging proper oral hygiene and teaching correct toothbrushing methods. Interestingly, this research found no differences in DMFT scores among patients with different forms of leprosy. However, the disease types studied were unevenly distributed among groups, and the groups were small.

In conclusion, in China, patients with leprosy experienced more dental caries than healthy controls. Severe dental caries might be related to aging, illiteracy and poor oral hygiene. We should consider oral health an important issue in patients with leprosy; our results suggest that we might reduce the prevalence of caries and improve the quality of life in patients with leprosy by increasing oral care education and providing required oral health care. A few steps that can be taken include gradual resettlement of leprosy patients from the leprosy villages to rehabilitation centres, so that oral health education and dental treatment services can be conveniently provided.

Conflict of interest

None declared.

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