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Epidemiology and preventive direction of periodontology in China

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Abstract

Objective: The aim of this work was to estimate the present periodontal problems of people in China, based on an epidemiological investigation of adults.

Material and Methods: The data were collected from the northwest, southwest, northeast and east regions (400 subjects from each region) of China. All subjects were over 25 years of age. About half of the subjects were farmers and about half were urban professionals. Everyone was asked to fill out a questionnaire and to undergo a professional oral examination. Periodontal health status was evaluated by a simplified oral hygiene index (OHI-S), gingival index (GI), bleeding on probing (BOP), probing pocket depth (PD), clinical attachment loss (CAL), and tooth mobility.

Results: Of the 1590 subjects enrolled in this investigation, 45.7% were male, 45.5% were farmers, and the remaining were urban professionals, and 27.7% of the subjects were smokers. There was a significant difference in the educational background but not smoking between the rural and urban groups. While 34.9% of the subjects in the urban group brushed only once per day, 56.1% of the subjects in the rural group did so. The prevalence of bleeding during brushing was 71.1%, while about 61.4% of the subjects know nothing about scaling. All periodontal indices were significantly higher in males than in females and higher in the rural group than in the urban group. PD, CAL and tooth mobility increased with age. The percentage of sites with CAL > 3 mm in the rural group (49.5%) was significantly higher than that in the urban group (37.5%). Both current and former smokers showed increased CAL than non-smokers.

Conclusion: Gingivitis and periodontitis are common findings in China. Most Chinese have no knowledge of common periodontal prevention and treatment and very few have regular dental care. The data of this study suggest that age, smoking, and limited education are significantly associated with Chinese adult periodontal attachment loss. Preventive periodontal care and education should be reinforced in the future by establishing relevant oral health projects.

Key words: adult; epidemiology; periodontal health; prevention; risk factors

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China is a developing country with a large population. While the prevalence of chronic periodontitis has been historically high, reliable periodontal health data have been lacking since the 1990s. Two national oral health surveys were conducted in China in 1985 and 1995 (Office of Chinese National Dental Prevention 1999). The third national oral health survey was completed in 2005, but the data are still being analysed. Information regarding Chinese periodontal health improvement in adults has been limited, and the severity of periodontal problems has generally been underestimated (Ouyang et al. 2004a, b). Knowledge regarding the current prevalence of chronic periodontitis in the Chinese population may provide a basis for promoting public dental care awareness and preventive strategies, establishing insurance programmes, and further reducing personal and public costs for treating advanced periodontitis.

The aim of the current cross-sectional study was to collect data regarding knowledge of periodontal disease, lifestyle, oral care habits, and periodontal

Conflict of interest and source of funding statement

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indices in order to estimate the prevalence and possible risk factors for periodontal disease in Chinese adults. This information may be used to guide the formulation of a practical periodontal prevention programme by the government.

Material and Methods

A total of 1609 subjects were selected according to stratified random sampling methods from four different regions in China (northwest, southwest, northeast, and east), with about 400 people from each region. Stratified sampling was performed with regard to the subjects' economic status, culture, dental service, and cooperation in each region. Random sampling was used to select subjects from different factories, schools, streets, and villages. In each of the four regions, 200 farmers and 200 urban professionals were selected based on where they lived and worked. All subjects were over 25 years of age and both groups had been living and working in the sampling area for over 5 years.

Individuals with fewer than 14 teeth in four quadrants, with systemic disease in the active stage (hepatitis, leukaemia, coronary heart diseases, diabetes mellitus), taking antibiotics or hormones for more than 5 days within the previous 2 months, or receiving periodontal therapy within 3 months were excluded. The reason for using 14 remaining teeth as the cutoff for subjects was that this would mean that at least half of their teeth remained. In addition, pregnant or lactating females were also excluded. Every subject had at least one incisor and one molar conserved in each quadrant. Each subject agreed to fill out a questionnaire and undergo a professional oral examination.

Periodontal health status was evaluated by a simplified oral hygiene index (OHI-S, scores 0–3), gingival index (GI, scores 0–3), bleeding on probing (BOP, scores 0–1), probing pocket depth (PD, from the gingival margin to the bottom of pocket), clinical attachment loss (CAL, from cementoenamel junction to the bottom of the pocket), mobility (scores 0–3), and missing teeth. All data in this study were obtained from six teeth in each subject (the teeth were usually 16, 11, 26, 36, 31, and 46, but proximal teeth were used if the marked teeth were missing). Periodontal probing was measured from six sites per tooth: mesiobuccal, buccal, distobuccal, mesiolingual, lingual, and distolingual. Each periodontal index was calculated using the mean value for each subject.

The periodontal examination was carried out by well-trained dentists. All dentists from each region were trained and repeated examinations several times in a subgroup of patients, and then calibrated the examination until an acceptable consistency was achieved. The statistical κ value was calculated, and was over 0.65 for each index (0.69 for OHI-S, 0.78 for GI, 0.84 for BOP, 0.81 for PD, and 0.77 for CAL), which suggests good reliability. The instruments used for examination were dental mirrors and calibrated manual UNC15 periodontal probes (Hu-Friedy, 0–15 mm).

All subjects enrolled in this study were volunteers. During sampling, over 92% of the people who were introduced to the study agreed to participate. The informed consent for participating in the study was approved by the Ethical Review Committee of the School of Stomatology, Fourth Military Medical University in Xi'an. This study was conducted simultaneously in the four major cities and suburbs of Xi'an, Chengdu, Shanghai, and Shengyang during a 3-month period from August to November in 2005.

Statistical analyses using the *t*-test, ANOVA, and χ^2 were applied to demonstrate the differences between the rural and urban groups. Logistic regression models were used to estimate the odds ratio and the influence of variables or confounding factors such as age, gender, smoking, brushing, prophylaxis, bleeding, and income and education levels on CAL. Odds ratio was calculated with 95% confidence intervals, and statistical significance was defined as $p < 0.05$.

Results

Socio-demographic characteristics such as health maintenance behaviour and medical history were obtained by the questionnaire. Of the 1609 subjects enrolled in this study, a total of 1590 participants with complete data (completed both questionnaire and oral examination) were included in the final data analysis. Nineteen subjects were excluded for the following reasons: three subjects were younger than 25 years, nine subjects had fewer than 14 teeth or had excessive previous dental restorations, and seven subjects had been taking antibiotics for more than a week. Only a few subjects were excluded from each category, which was not likely to bias the results.

There were 866 subjects in the urban group and 724 subjects in the rural group. Differences in age distribution were apparent in the youngest group (25–34 years old), with fewer young subjects in the rural group than those in the urban group. The sample was 45.7% male and 54.3% female. While 45.5% of the subjects were farmers, 54.5% were urban professionals including workers, teachers, doctors, and office staff. There was a significant difference in the educational background between the rural and urban group ($p < 0.01$), i.e. 98.4% of the subjects in the rural group and 52.5% in the urban group had an education level below high school; 41.8% of the subjects in the urban group had a college degree. There were no significant differences between the rural and urban groups with regard to smoking and 27.7% of the subjects smoked (Table 1). Most smokers were males and there was a positive correlation between smoking and CAL ($r = 0.134$; $p < 0.001$). Both current and former smokers showed increased CAL compared with non-smokers ($p < 0.05$) (Fig. 1).

About 25.0% of the subjects reported that their family members had similar periodontal signs or history, and there was no difference between the rural and urban groups. The average number of missing teeth was 3.68 in the rural group and 3.58 in the urban group. There was no significant difference between the two groups. Over 50% of the subjects had experienced a tooth extraction, 27.6% had their teeth extracted due to toothache or caries, and 15.0% because of tooth mobility or periodontitis.

The brushing status survey showed an improvement within the past decade. About 78.6% of the Chinese adults brushed at least once per day in 1995 (Office of Chinese National Dental Prevention 1999), whereas 89% of the adults brushed every day in 2005. However, 34.9% of the subjects in the urban group and 56.1% of the subjects in the rural group still brushed only once per day. The present study also shows that more than 30% of the subjects in both groups spent < 1 min. brushing every time.

It is astonishing that the prevalence of bleeding during brushing was about

Table 1. Demographics of the population

Item	Level	Farmers	Professionals	Total	
		n	*n*	*n*	%
Gender	Male	296	431	727	45.72
	Female	428	435	863	54.28
	Total	724	866	1590	100
Age	25–34 years	106	187	293	18.43
	35–44 years	244	247	491	30.88
	45–59 years	239	260	499	31.38
	Over 60 years	135	172	307	19.31
	Total	724	866	1590	100
Education	High school	687	453	1140	73.03
	College	7	361	368	23.57
	Postgraduate	4	49	53	3.4
	Total	698	863	1561	100
Income/month (yuan)	Below 500	473	94	567	37.55
	500–1000	162	282	444	29.4
	1001–2000	31	363	394	26.09
	Over 2000	6	99	105	6.95
	Total	672	838	1510	100
Smoking	Yes	201	229	430	27.71
	Ceased	34	56	90	5.8
	No	462	570	1032	66.49
	Total	697	855	1552	100
Bleeding while brushing	Often	80	80	160	10.19
	Sometimes	286	304	590	37.58
	Little	117	249	366	23.31
	No	228	226	454	28.92
	Total	711	859	1570	100
Brushing frequency (day)	Over 3	1	9	10	0.63
	3	8	36	44	2.78
	2	151	478	629	39.76
	1	403	301	704	44.5
	Below 1	156	39	195	12.33
	Total	719	863	1582	100
Brushing time	Over 3 min.	45	48	93	5.92
	3 min.	83	127	210	13.38
	2 min.	297	427	724	46.11
	1 min.	206	218	424	27.01
	Below 1 min.	78	41	119	7.58
	Total	709	861	1570	100
Scaling knowledge	Yes	114	432	546	34.98
	No	577	382	959	61.43
	Impair teeth	13	43	56	3.59
	Total	704	857	1561	100
Scaling history	2/year	4	18	22	1.44
	1/year	10	57	67	4.4
	1–2/life	39	207	246	16.14
	None	621	568	1189	78.02
	Total	674	850	1524	100

71.1%. In addition, 61.4% of the subjects had no knowledge of dental prophylaxis or scaling and root planing. Although the adult dental prophylaxis rate increased from 1.5% in 1995 (Office of Chinese National Dental Prevention 1999) to 21.9% in 2005, 92.1% of the subjects in the rural group and 66.8% of the subjects in the urban group had never visited a dental clinic for a dental cleaning. Approximately 2–5% of the subjects in each group even believed that dental cleaning may damage the teeth.

When asked about their reasons for visiting a dental clinic, 76.5% of the subjects said that they visited a clinic only when they had a toothache, while 19.5% of the subjects said that they visited a clinic when they had bleeding gums, tooth mobility, or missing teeth. Very few subjects stated that they went to dental clinics for regular dental care (only 2.8%). In addition, 75.4% of the subjects had not visited a dental clinic for either examination or treatment for over 1 year and 56.5% had not had dental care for over 2 years.

Over 88.6% of the teeth examined had detectable calculus when probing, while the proportion was 85.8% in the 1995 data (Office of Chinese National Dental Prevention 1999). In addition, 47.7% of the examined teeth showed bleeding on probing, which is significantly higher than the 18.6% found in the 1995 data (Office of Chinese National Dental Prevention 1999). About 30% of the periodontally probed sites showed pathological pocket readings and CAL in both groups. Because of noticeable gingival recessions in the periodontal tissue of subjects of both groups, the mean CAL is greater than the mean PD, as shown in Table 2.

All periodontal indices were much higher in male subjects than in females. The positive ratio of CAL over 3 mm increased with age and was higher in the rural group than in the urban group (Fig. 2). PD and mobility also increased with age, and there were statistical differences between the different age groups.

We used mean PD and CAL to represent the severity of periodontitis in a given subject because they are the cumulative results of previous periodontal destruction. We evaluated the influence of the variables with regard to whether average PD $\geqslant$ 3 mm and CAL $\geqslant$ 1, or $>$ 3 mm. When compared with the condition of PD $\geqslant$ 3 mm, there were more positive teeth in the rural group (61.3%) than in the urban group (57.8%). When compared with the condition of PD $\geqslant$ 3 mm and CAL $\geqslant$ 1 mm, there were still more positive teeth in the rural group (58.8%) than in the urban group (53.1%). Furthermore, we defined mean CAL $>$ 3 mm as moderate to severe periodontal destruction. The positive teeth in the rural group (49.5%) were also much more severe than those in the urban group (37.5%). The logistic regression indicated that age was the most prominent variable associated with mean CAL $>$ 3 mm (Table 3).

Discussion

Although the living standard and health care status of Chinese people have improved dramatically during the past decade, a comprehensive study of current oral health, especially periodontal health, and its change from the last decade has been lacking. It is essential that adequate data collected from

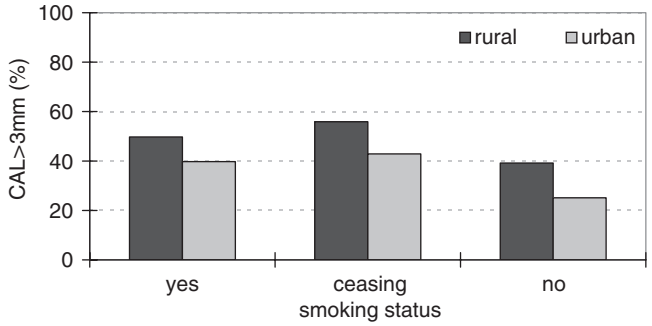

Fig. 1. Clinical attachment loss by smoking status.

Table 2. Personal mean periodontal indices

Variable	Group	Mean	Standard development	*n*	Statistic	*p*-value
GI	Rural	1.00	0.70	723	1.998	0.046
	Urban	0.93	0.66	865	–	–
	Total	0.96	0.68	1588	–	–
OHS-I	Rural	1.94	1.02	723	11.895	0.000
	Urban	1.42	0.74	865	–	–
	Total	1.66	0.92	1588	–	–
BOP	Rural	0.40	0.32	723	3.110	0.002
	Urban	0.35	0.32	861	–	–
	Total	0.37	0.32	1584	–	–
PD	Rural	2.26	0.66	723	2.295	0.022
	Urban	2.18	0.70	865	–	–
	Total	2.22	0.69	1588	–	–
CAL	Rural	2.91	1.54	723	7.304	0.000
	Urban	2.36	1.46	863	–	–
	Total	2.61	1.52	1586	–	–

OHI-S, oral hygiene index; GI, gingival index; BOP, bleeding on probing; PD, probing pocket depth; CAL, clinical attachment loss.

well-prepared oral health surveys and examinations be used for oral health policy making and establishment of preventive dental care programmes. This multi-city periodontal health study of people sampled from urban and suburban areas in the northwest, southwest, northeast, and east regions of China included subjects of different ages, genders, educational backgrounds, oral health habits, and other aspects of socio-economic status. We believe that the results of this study represent the current condition of the periodontal health of the Chinese people.

The present findings show that knowledge of adequate oral care in China is still insufficient. Most people visit a dental clinic only when they have dental problems, while only a few see a dentist for regular dental care. Many people are unfamiliar with scaling and fewer people have regular oral examinations. In general, the rural group shows relatively poorer oral hygiene: lower brushing frequency, shorter brushing time, and fewer dental care visits. This may relate to differences between the two groups in terms of the cultural background, income level, brushing habits, dietetic habits, work intensity, and medical conditions.

All measurement indices were significantly higher in males than females, which may be related to their different living habits (such as smoking), brushing habits, and oral care knowledge. Similar results have been found in other countries (Tanner et al. 2005, Torrungruang et al. 2005a, b). The number of female subjects in this investigation was higher in the rural group, partially due to the fact that today, more young males work away from home in the countryside of China. More and more young farmers work in cities and leave the women, children, and the elderly at home for farm work.

Comprehensive periodontal examination is considered to be the gold standard for accurate measurement and periodontal diagnosis. Although it is required for periodontal treatment, it can be time-consuming and costly for the average Chinese patient. This may have deterred many patients from cooperating with dentists for further treatment. In this study, a comprehensive periodontal examination was not used because of the above reasons and the large sample size. Periodontal examination of selected teeth and sites is practical, convenient, and quick, and is applied in most cross-sectional epidemiological studies. However, the prevalence and extent of diseases may be underestimated (Torrungruang et al. 2005a, b). In this study, only six marked teeth were used for periodontal examination because these teeth are considered to be the most periodontally involved and can be used to represent the extent of periodontitis in subjects.

Besides radiographic assessment of alveolar bone loss at different time points, periodontal measurements of CAL and PD have been used as key parameters for the identification and classification of periodontal severity because they represent cumulative periodontal destruction over time (Collins et al. 2005, Mombelli 2005). Generally, a threshold of PD $>$ 3 mm or CAL $>$ 1 mm is used to define periodontal tissue loss. In this study, the risk for moderate periodontal destruction (CAL $\geqslant$ 3 mm) was investigated by multinomial logistic regression analysis. Several factors known to affect periodontal disease severity (age, gender, education, brushing, bleeding, prophylaxis, income, and smoking) were included in the model.

The CAL positive ratio correlated with patients' clinical complaints and periodontal symptoms. Among subjects with CAL over 3 mm, more tooth mobility and missing teeth were observed in both groups. As may be expected based on brushing habits reported in the questionnaire, the subjects in the rural group showed higher periodontal indices than that of the urban group.

Because most subjects lacked regular periodontal prophylaxis and the present study is only a cross-sectional investigation, the results of this study do not show a positive correlation between scaling and CAL. This suggests that a cohort study is required to clarify the effects of scaling on periodontal health improvement in Chinese people.

The mean CAL was higher among males, smokers, the elderly, and those who had poor oral hygiene. Many other epidemiological studies, in China and other countries, have had similar results.

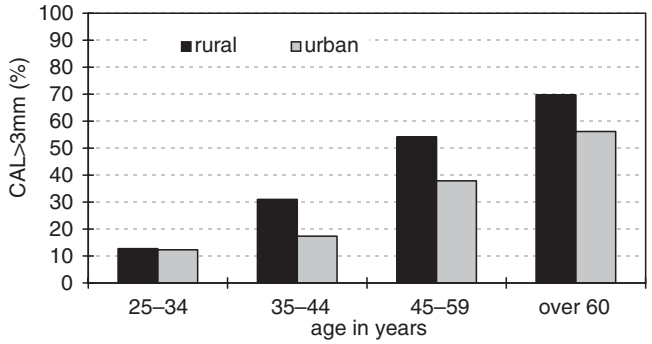

Fig. 2. Clinical attachment loss by age.

Table 3. Results of logistic regression analysis of variables with average clinical attachment loss (CAL) $\geqslant 3$ mm

Variables	OR	95% CI
Smoking (yes or no)	1.495	1.091–2.049*
Brush frequency (below or over 2 times/day)	1.158	0.900–1.489
Brush bleeding (yes or no)	1.063	0.821–1.376
Scaling (no or yes)	1.116	0.818–1.522
Age (over or below 60 years)	3.816	2.862–5.089**
Gender (male or female)	1.339	0.980–1.828
Education (high school or college)	1.504	1.078–2.096*
Income (below or over 1000 yuan)	1.203	0.886–1.634

All variables were compared with the standard of whether the average CAL was greater than or equal to 3 mm in each subject. Smoking was separated as smoking (both currently and formerly) and non-smoking.
*$p<0.05$, **$p<0.01$.
CI, confidence interval; OR, odds ratio.

For example, studies have found that cigarette smoking leads to deterioration of periodontal health in Japanese adults (Ojima et al. 2006, Okamoto et al. 2006). Similar to the findings in many other epidemiological studies, we speculate that the severity of CAL in elderly people mostly reflects cumulative tissue destruction rather than an intrinsic age-related abnormality(Torrungruang et al. 2005a, b).

The data are insufficient to explain the high percentage of family members with periodontal history in both groups solely based on heredity (Ronderos & Ryder 2004), because both the rural and urban subjects have poor oral hygiene and inadequate dental care. The current study indicates that the high prevalence and severe chronic periodontitis in Chinese adults are possibly the result of poor dental care knowledge, brushing frequency and quality, educational level, and access to regular professional dental care. The rural group showed more periodontal destruction than the urban group. This observation was also noted in a study in another developing country (Oliveira Costa et al. 2007). Some authors reported that Asians displayed relatively poor periodontal conditions; appropriate strategies for the prevention and management of periodontal disease should focus on oral hygiene improvements in the diverse continent of Asia (Corbet 2006).

Some limitations should be considered when interpreting the present results. Firstly, the results of this study should not be generalized and applied to the whole Chinese population. Our investigation was carried out in major cities and their suburban villages, and so it may have underestimated periodontal problems in remote areas where even poorer medical and dental care conditions exist. Another limitation is that the remaining teeth are likely to have less severe periodontal disease than that had afflicted the lost teeth (Torrungruang et al. 2005a, b). Therefore, our findings need to be further confirmed in a longitudinal study conducted in a population with better oral hygiene.

Conclusion

We conclude that educational level, smoking status, and age may be potential risk factors for chronic periodontitis in this study population, and this may also be true for other Chinese people. Smoking, old age, and educational level are significantly associated with moderate or severe periodontal CAL. The practical steps to control periodontitis in China should be to educate people, to provide more dental hygienists for professional prophylaxis and professional dental care education, to maintain a balance between community clinics and professional hospitals, and to establish an effective social insurance system for dental health. All these steps should be taken by both dental professionals and the government.

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Clinical Relevance

Scientific rationale for the study: The current condition of periodontal health of Chinese adults was investigated epidemiologically by a dental health questionnaire and professional examination using a stratified random sampling method.

Principal findings: Periodontal destruction is particularly severe in males, farmers, and smokers, and worsens with age. Public knowledge of dental care, effective toothbrushing, and access to dental care need to be improved.

Practical implications: The severity of the condition of periodontal health in China may be underestimated. The health institutions involved should pay more attention to periodontal disease and its prevention. New policies and programmes to improve dental care and preventive measures need to be established.