Root caries patterns and risk factors of middle-aged and elderly people in China

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Du, M. Q., Jiang, H., Tai, B. J., Wu, B., Bian, Z. (2009). Root Caries Patterns and Risk Factors of Middle-aged and Elderly People in P.R. China. *Community Dentistry and Oral Epidemiology, 37(3), 260-266.*

Abstract:
The objectives of this study were to describe root caries patterns of Chinese adults and to analyze the effect of selected demographic and socioeconomic factors on these patterns. A total sample of 1080 residents aged 35–44-years-old and 1080 residents aged 65–74-years-old from three urban and three rural survey sites in Hubei Province participated in both an oral health interview and a clinical oral health examination. Root surface caries prevalence rates were 13.1% in the middle-aged group and 43.9% in the elderly group. The mean number of teeth affected by caries in the middle-aged group was reported at 0.21 and 1.0 in the elderly group. Mean Root Caries Index (RCI) scores of the middle-aged were reported at 6.29 and elderly subjects were reported at 11.95. Elderly people living in rural areas reported a higher RCI score (13.24) than those living in urban areas (10.70). A significantly higher frequency of root surface caries was observed in elderly participants ($P < 0.001$, OR = 3.80) and ethnic minorities ($P < 0.001$, OR = 1.93). In addition, smokers, nontea drinkers, and those with an annual household income of 10 000 yuan or less tended to have higher caries prevalence. RCI figures for the different tooth types ranged from 1% to 16%, indicating a wide variation in attack rates. In conclusion, our study suggests that root surface caries occurrence is high among the Chinese adult population, especially older adults. With an increasing number of retained teeth in both middle-aged and elderly people, root caries is a growing disease in the People's Republic of China which deserves more attention in future research.
Key words: Chinese; root caries; root caries index

Article:

At the end of 2006, the number of people in China over 60-years-old swelled to 144 million, accounting for half of the over 60 population in Asia, close to half of the U.S. population, and one fifth of the world's total. In addition, this age group is growing by nearly six million a year (1). It is estimated that by 2040, China's elderly population will reach 400 million – almost 30% of the total population (2). Increasing life expectancy is considered one of the major contributors to China's increasing elderly population, which has increased by 29 years in the past half century (2). This increase, along with improvements in oral health, will ensure that many individuals will retain more teeth during the later stages of life. Thus, in the coming decades, dental practitioners will face the challenge of providing dental care for the growing number of adults who have better teeth retention.

Root caries data in China was quite limited prior to the 1990s. Since then, several prevalence and incidence studies on root surface caries indicate that it is becoming an extremely pressing public health problem in older adults (3–5). Aside from China, root surface condition assessment has also been recently considered part of national oral health examination surveys in the United States.

Widespread fluoride toothpaste use has been found to be a major factor in the decline in dental caries prevalence and severity in some developed countries. China is not too far behind: at the turn of the century, fluoride toothpaste accounted for more than 90% of the Chinese toothpaste market. In addition, the ratio of dental professionals to the general population improved to 1 in 25 000 in 2005, compared with 1 in 50 000 during the 1990s (6). Community-based dental clinics have also been widely established in China, which could attribute to the increased trend of retained teeth.

The current edentulous rate for older adults aged 65–74 is 11% (7). Several epidemiological studies on dental caries were conducted in the 1990s in places such as Germany and Brazil; however, only limited results from representative samples are available. Meanwhile, most oral health surveys conducted in Mainland China have been targeted at children and adolescents. Until now, few studies have reported both root caries status and the affecting factors among Chinese adults. As indicated above, China has experienced significant changes in both the size and proportion of older adults during the past two decades, which is projected to continue for the next 50 years. There-fore, oral health research among older adults becomes increasingly vital.

The study objectives were to describe root caries of the 35–44 year old age group and the 65–74 year old age group from both urban and rural areas in China, and to determine various demographic and socioeconomic factors that influence root caries in these populations.

Methods

Sampling method

The survey employed a multistage, stratified, nongeometric proportional randomized sample, representing civilians aged 35–44 and 65–74- years-old (World Health Organization standard age groups) living in cities or counties in Hubei Province. Each age group consisted of 1080 participants, evenly divided between male and female. Hubei, known as the heart of Central China, covers an area of 185 900 km^2. At the end of 2004, Hubei had a population of about 60 million people, with 56% of those living in rural areas.

The final study sample comprised of 2160 individuals. To be included in the sample, adults who lived in the area for more than 6 months were considered permanent residents. Study protocols were approved by the Ethics Committee of the School of Dentistry at Wuhan University, Wuhan, China, prior to study implementation.
In brief, 36 sampling units (18 cities and 18 counties) were selected through multi-stage stratified sampling. In the first stage, three cities and three counties in Hubei were chosen. Cities were divided into large, medium, and small sizes according to the population. Wuhan City, Shiyan City, and Xiantao City were randomly selected to represent each level. Next, one district was randomly chosen from each of the three cities. Counties were divided according to high, medium, and low GDP levels. Songzi, Jinchun, and Wufeng were then selected to represent each level in the rural areas. Then, by means of two-stage stratified simple random sampling, three urban sub-districts and three rural townships were chosen, while two resident communities and 2 villages were selected from each sub-district and township to serve as survey sites. In the third stage, 30 subjects were randomly included from each resident community/village among each of the two age groups. The sample list was delivered to the local Community Neighborhood Committee or Rural Committee 3 weeks before the study was carried out. Replacement sampling strategies were then used to recruit 30 subjects; if some subjects were absent, samples were randomly drawn from the same sampling pool to guarantee 30 subjects participated in the study at each survey site. Prior to the survey launch, each subject received an informed consent that explained study purposes and procedures.

Interview

A face-to-face interview using a structured questionnaire was conducted to collect the following information: sociodemographic characteristics, brushing frequency, dentist visit frequency, dental care product use, and sugar consumption. The participants were also asked about smoking habits and both tea and alcohol consumption.

Clinical examination

The dental examinations were performed by four examiners, all dentists, who were requested to participate in an initial calibration trial. The Kappa statistic was used to assess inter-examiner reliability. All final Kappa scores exceeded 0.85. No more than 15 subjects were examined by one examiner on each day. To test inter-examiner reliability during the survey period, about 10% of the subjects each day were randomly re-examined between two examiners; Kappa values ranged from 0.75 to 0.95.

Clinical assessment was performed using WHO guidelines. The examination was conducted in a portable dental chair with artificial light along with a mouth mirror and a CPI explorer. The teeth were neither cleaned nor dried before the assessment. However, food debris obscuring visual inspection was removed. No radiographs were taken. Root caries were recorded in a full mouth design, excluding the third molars. Root caries were recorded when an area possessed a darkened appearance that was discolored and well-defined and also allowed easy penetration with the CPI explorer. In addition, gingival recessions, where the apical surface of the cement-enamel junction was visible, were recorded in order to calculate the Root Caries Index (8). Score criteria were as follows: Score 0–Sound, with exposed root; Score 1-Decayed; Score 2-Filled, with decay; Score 3-Filled, no decay; Score 4-Residual root; Score 5-Unexposed root; Score 6-Not recorded. The last code used under root status to indicate that either the tooth has been extracted or that calculus is present to such an extent that a root examination is not possible.

Statistical analysis

Data from the paper questionnaires and clinical examinations were entered into a computer using spss v12.0. In the further descriptive statistical root caries distribution analysis, mean values (decayed root surface; RDS/filled root surface; and RFS) and standard deviations were calculated and subdivided for both age groups and teeth types. Differences in RDS/RFS of both groups were then statistically tested. Statistical significance was set at $P < 0.05$.

The Root Caries Index (RCI) was used for the evaluation, which expresses the ratio of teeth with carious root lesions and root restorations compared with the number of teeth with exposed root surfaces (RCI = No. of teeth with root caries lesions/No. of teeth with gingival recession X 100).

When using RCI for evaluation, the residual root (score 4) was excluded. RCI scores for individuals without gingival recessions (score of 5) could not be calculated and were thereby excluded. There were 389 exclusions in total.

A Chi-squares test was used for categorical variables. All explanatory variables that were significant at a level of $P < 0.05$ in a bivariate analysis were then included in a multiple logistic regression analysis to determine the independent effect of each explanatory variable on the dependent variable, while controlling for other variables.

Measures

Dependent variables were the proportion of subjects with RCI. This variable was dichotomized; ‘subjects with RCI >0 was given a value of 1, and ‘subjects with RCI = 0' a value of 0. Independent variables included age, gender, location, ethnicity, education level, smoking and alcohol consumption, tea consumption, tooth brushing frequency, dental visit frequency, household income in the last year, and sugary food or drinks consumption. Independent variables were then entered in a single step. Odd ratios (ORs) with 95% confidence intervals (95% CI) were calculated for discrete variables in the logistic regression model.

Results

Both root caries experience occurrence and RCI in the two age groups based on location are given in Table 1.

Table 1. Root caries experience, prevalence, root caries index (RCI) by locations

Age (years)	Location	*N*	Number of subjects with gingival recession	Prevalence (%)	Mean number of teeth with root caries (SD)	Mean number of teeth with gingival recession (SD)	Root Caries Index (%)
35–44	Urban	540	346	11.9	0.17 (0.55)	4.74 (6.07)	6.42 (19.07)
	Rural	540	414	14.4	0.24 (0.74)	5.81 (6.19)*	6.18 (18.09)
	All	1080	760	13.1	0.21 (0.65)	5.27 (6.15)	6.29 (18.53)
65–74	Urban	540	513	43.5	0.90 (1.47)	11.13 (6.65)	10.70 (19.68)
	Rural	540	508	44.3	1.10 (1.74)*	10.23 (6.56)*	13.24 (20.64)*
	All	1080	1011	43.9	1.00 (1.62)	10.68 (6.62)	11.95 (20.19)

*$P < 0.05$.

Caries prevalence rates were reported at 13.1% for the middle-aged and 43.9% for the elderly. The average number of teeth affected in the middle-aged group was reported at 0.21 and 1.00 teeth for the elderly group. The mean number of teeth with gingival recession per subject was 5.27 in the group of 35–44-year-olds. In the older group, the mean number of teeth with gingival recession was 10.68. The mean RCI was 6.29 in the middle-aged group and 11.95 in the elderly. Those aged between 65 and 74-years-old living in the counties had a statistically significant higher RCI score than those living in the cities (13.24 versus 10.70). However, the RCI difference of 35–44-year-olds living in the two areas was not significant.

Table 2 revealed the association between various factors and the percentages of respondents with RCI >0 using Chi-square tests. The occurrence of decayed/filled root surfaces were significantly associated with age, gender, ethnicity, education level, smoking, alcohol consumption, tea consumption, tooth brushing frequency, dental visit frequency, and household income.

Table 2. The percentages of respondents with RCI > 0 by background variables

Variables		*N*	Percentages of respondents with RCI > 0 (n = 616)
Age	35–44 years	759	18.7
	65–74 years	1012	46.9***
Gender	Male	898	30.4
	Female	873	39.3***
Location	City	859	34.8
	Rural	912	34.8
Ethnic	Han	1470	33.1
	Others	301	43.2**
Education	9 years or more	731	23.7
	0–8 years	1040	42.6***
Smoking	Never	647	29.8
	Ever	140	30.7
	Yes	984	38.6**
Drinking alcohol	Never	747	29.0
	Ever	110	39.1
	Yes	914	38.9***
Drinking tea	Yes	1203	32.2
	No	568	40.3**
Frequency of tooth brushing	Twice a day or more	205	31.2
	Once a day	1085	33.9
	Less than once a day	481	47.8***
Dental visit	Yes	925	39.6
	No	846	29.6***
Family income in the last year	10 000 yuan or more	889	30.0
	Less than 10 000 yuan	882	39.6***
Frequency of sugary drinks or foods	High (10–27)	409	33.3
	Low (5–9)	1362	35.2

*P < 0.05, **P < 0.01 ***P < 0.001.

The results of the multiple logistic regression analysis are shown in Table 3. A significantly higher likelihood of root surface caries was observed in elderly participants aged 65–74-years-old, almost four times observed in middle-aged subjects (OR = 3.80). Ethnic minorities were found to be almost twice as likely to be affected by root caries compared with those who were ethnic Han adults (OR = 1.93). Smokers, nontea drinkers and those with an annual household income <10 000 yuan in the previous year tended to have higher caries prevalence. Conversely, those who never visited a dentist before were more likely to be free of root caries than those who had visited a dentist in the past 12 months (OR = 0.67).

Table 3. Logistic regression analysis results for root caries with RCI > 0 among Chinese adults (n = 1771)

Independent variable		*P*	OR	95% CI
Age	35–44 years			
	65–74 years	<0.001	3.80	3.02, 4.76
Ethnic	Han			
	Others	<0.001	1.93	1.45, 2.56
Smoking	Never			
	Ever	0.005	1.39	1.10, 1.75
	Yes	0.006	1.76	1.18, 2.63
Drinking tea	Yes			
	No	0.001	1.51	1.19, 1.91
Dental visit	Yes			
	No	<0.001	0.67	0.54, 0.83
Family income in the last year	10 000 yuan or more			
	Less than 10 000 yuan	0.012	1.31	1.06, 1.63

Figures 1 and 2 display RCI scores of Chinese 35– 44-year-olds and 65–74-year-olds based on teeth type. The RCI figures ranged from 1 % to 16%, indicating a wide variation in attack rates. In the middle-aged group, upper arch premolars were the most frequently found to have caries. In the elderly, decayed or filled lesions in molars were common. In both age groups, mandibular incisors had few root surface caries and/or fillings.

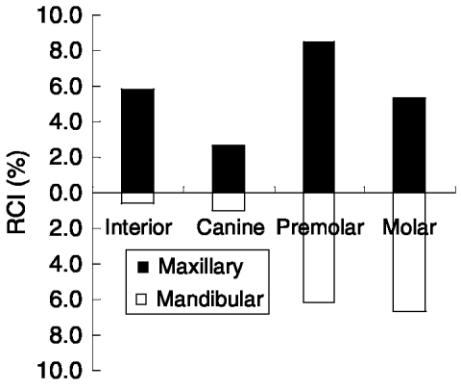

Fig. 1. Root Caries Index according to teeth type in 35–44-years-old adults in Hubei Province.

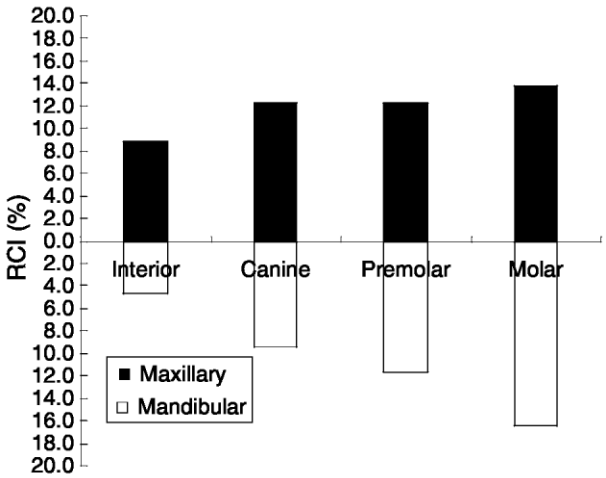

Fig. 2. Root Caries Index according to teeth type in 65–74-years-old adults in Hubei Province.

Discussion

The present study provided much-needed data for middle-aged and elderly individuals in China. Root surface decay prevalence, mean decayed/ filled root surface scores and RCI scores were all used to evaluate survey results. The first two criteria were the most commonly used in the previous epidemiologic survey, for root caries can reflect disease severity and can be easily compared among different populations (4). with regards to the prevalence of root surface decay, mean decayed/filled root surface criteria could not represent the relationship between root caries and gingival recession. Therefore, RCI is often used to describe root caries nowadays (9).

The middle-aged group reported a 13.1% prevalence rate while the elderly reported a 43.9% occurrence rate. This prevalence rate was lower than free-living elderly in other Asian countries. Kularatne and Ekanayake (5) reported almost a 90% prevalence rate in Sri Lanka, while the elderly in India displayed a 67% prevalence rate (10). In China, previous reports for 35–44-year-olds showed a 5.5% prevalence rate and 65–74-year-old adults a 23.4% rate (11). In addition, the 35–44- year-old age group possessed a mean decayed/ filled root surface rate of 0.11 while the 65–74-year-old group was reported at 0.45. Compared with the previous survey, the present result (13.1% for middle age, 43.9% for the elderly) demonstrated a dramatic increase of both root caries prevalence and the average decayed/filled root surface rate of adults for both age groups. As indicated earlier, this caries increase in the current study might stem from a trend of adults with better teeth retention.

In terms of RCI scores, which expresses the risk of developing caries disease because of root surface exposure to the buccal environment, the observed value among the individuals in 35–44 years and 65–74-years-old of this study were 6.29% and 11.95% respectively, which was slightly different to the 26% estimated rate for older British adults (12) and that of a survey conducted in Brazil (16.3%) (4). In contrast, Pomeranian adults had low RCI scores, ranging between 4.6% and 10.6% (9).

As described above, a significantly higher prevalence of root surface caries was observed in elderly participants aged 65–74-years-old, as well as ethnic minorities, nontea drinkers, and those whose household income was <10 000 yuan in the past year. A number of studies demonstrated a significant association between sugary food consumption frequency with root surface caries prevalence (13, 14). However, the results of our analysis did not reach similar statistical significance. This might derive from the difficulty of collecting accurate dietary data, which is a common shortcoming in this area of research. There are obviously many factors, such as an individual's physical health, cognitive function, and attitudes toward oral health, that could contribute to root surface caries but are unavailable in the data set. Some other factors were included but were difficult to measure, which might include a wide range of subtle factors such as teeth position, and exposed root surface amount. In addition, smokers included in the present study tended to have a higher caries occurrence rate than those who have never smoked. Aguilar-Zinser et al. (15) found that drivers who smoked displayed both the highest number of large cavities and missing teeth. Tomar and Winn (16) also reported that current users of chewing tobacco were more than four times likely to have root-surface caries than those who have never used tobacco.

When comparing the different tooth types, RCI figures ranged from 1% to 16%, which as mentioned above indicated a wide attack variation rate. Hellyer et al. (17) reported that maxillary canine and mandibular premolars were the most commonly affected by root caries. In two other studies, Katz et al. (18) and Wallace et al. (19) found that mandibular molars were the most frequently attacked teeth, followed by the mandibular premolars and maxillary canines. Our findings confirmed that premolars and molars are the most susceptible. A similar attack pattern has also been observed in Swedish (20) and Brazilian (4) subjects. However, it is worth noting these patterns might be related to the high recession frequency in these types of teeth.

Our study also found that individuals who visited a dentist in the previous year were more likely to have root caries than those who did not. Put simply, preventative dental visit is still a relatively new concept in China, which is especially the case for older adults. The purpose of dental visits is most likely dental treatment, not preventative. Therefore, those who visited a dentist would obviously have a worse oral health report (21). However, given the nature of this cross-sectional study, the results are inconclusive. Longitudinal studies are needed to further examine the relation-ship between root caries and dental care utilization.

Another study limitation is that root surface caries were assessed only by tooth type and not by the exact root surface. This might have underestimated the caries problem extent to a certain degree. In addition, there is no available information on the number of present teeth, which might have lowered caries prevalence comparison values between the different teeth.

It was evident from the study that root surface caries occur in high frequency in both middle-aged and elderly Chinese and deserves great attention when considering the extent of this epidemic in millions of Chinese adults. Therefore, more root caries studies should be conducted. Actions also need to be implemented to make future explorations of root caries epidemiology more productive. International conventions on diagnostic criteria and reporting such criteria need to be implemented as well. From a practical standpoint it is also important that risk factors are expressed in clinical terms so that preventive strategies can be targeted appropriately; such epidemiological information would be a great aid in establishing an effective dental health program for Chinese. Effective measures that could be readily implemented include a lifestyle-oriented health policy that emphasizes community-based health promotion and prevention.

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