

Dental Caries Status among the Elderly in the Rural Areas of Yunnan Province, China: A Cross-Sectional Study

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Abstract

Background Elder population is considered as a vulnerable group with high risk of dental caries. The older adults living in rural areas of Yunnan province account for approximately half of the province's total population. However, few studies have addressed their dental caries status. The purpose of the present study was to investigate the dental caries status and its associated factors among 65-74 years old people in the rural areas of Yunnan province, China. **Methods** This cross-sectional study recruited participants through a multistage and stratified strategy, and comprised a clinical oral examination and a questionnaire survey. Two trained and calibrated dentists, wearing LED headlights, conducted the clinical assessment with dental mirrors and CPI probes. Caries experience was measured using the DMFT and DF-root indices. A face-to-face questionnaire survey was conducted to collect the participants' socio-demographic information, oral health-related knowledge and practices. A multi-factor ANCOVA test was used to detect the factors influencing dental caries. **Results** 1175 elderly residents aged 65-74 were included. Of them, a majority of the surveyed elderly respondents (87%) experienced dental caries (DMFT>0), and 56% of the respondents had root caries. Their overall mean DMFT and DF-root scores were 10.4±10.9 and 2.4±3.8, respectively. In total, 12% of the participants were edentulous. In the final model, female, divorced or widowed elderly who living in Jianchuan district had higher mean DMFT scores. **Conclusion** The dental caries status among 65-to 74-year-old in the rural areas of Yunnan province, China, was poor. Their caries experience varied by gender, marital status and location. Cost-effective prevention and treatment programs should be implemented.

Background

Although the overall oral health status has improved markedly in the world over the last few decades, the burden of dental caries among the elderly is still significant [1]. In 2016, untreated dental caries in permanent teeth remained the most common oral disease, affecting 2.4 billion people in the worldwide [2]. The third peak in the prevalence of dental caries was identified to reach its third peak at around 70 years old [3]. Certainly, dental caries is a chronic cumulative disease, but it will not necessarily increase due to aging [4]. One of the main reasons for the extensive caries status among the elderly was attributed to the increased exposure of their tooth surfaces [5]. Furthermore, recent studies have also reported saliva flow and buffering capacity, the qualitative and quantitative microbiological changes, as well as inappropriate usage of the fixed and removable dentures can also be contributors for caries [6, 7].

Cariou lesions can cause pain and affect masticatory function. Without treatment, it may progress to pulp necrosis and periapical pathology, or even lead to systematic infection [8]. Severe dental caries can also lead to tooth loss, edentulism or poor nutrition as well as impact people's self-esteem, social functioning and interaction [9, 10]. Consequently, dental caries lead to a considerable economic burden on both individuals and society, including direct costs (e.g., diagnosis, medicine and treatment) and indirect costs (e.g., absenteeism from work and cost for research). In 2010, the total costs for dental caries accounted for US\$ 442 billion globally [11].

China is the second-largest global economy, with the largest population in the world of 1.4 billion people. In 2017, China had 158 million elderly individuals aged 65 or above (11% of the total population in China) [12]. According to the United Nations' aging standards, China is already considered an aging nation. The Chinese Health and Family Planning Commission predicted a massive elder population explosion in China by 2050, with up to 400 million people aged 65+ [13]. An upward trend in the prevalence of dental caries among the elderly population has also been observed, increasing from 65% in 1995 to 98% in 2015, based on the national oral health surveys [14, 15].

Yunnan province is ethnically heterogeneous, with Han people as the predominant population. It is situated in the southwestern frontiers of China, bordering Myanmar, Laos and Vietnam. The gross domestic product of Yunnan province was ranked 20th among the 31 provinces in China [16]. Overall, it is an underdeveloped province. Based on the latest national population census, the total population in Yunnan is 46 million, with over 3 million elderly residents. Around half of the population lives in rural areas [17]. In 2016, the annual personal income in these areas was around US\$1300 (only one-third of the average income in urban areas of Yunnan) [18].

Currently, few studies have investigated the dental caries status among the elderly population in Yunnan province. One study conducted in 2016-2018 reported that 69% of the people aged 60-93 years old in Kunming City, the capital city of Yunnan province, experienced dental caries [19]. The participants in that study were not the index age group recommended by the WHO. Therefore, comparisons with other studies were not possible. But it is reasonable to speculate that the dental caries status among the elderly people in the rural areas of Yunnan province is even more severe. Furthermore, there is only one dentist per 20,000 people in Yunnan, which is double the ratio of China and four times the ratio recommended by the World Health Organization (WHO) [20, 21]. Thus, without proper prevention and treatment strategies, it will be a major challenge for the local authorities to address the dental health problems among the vulnerable older adults in Yunnan, especially in rural areas.

Epidemiological studies are essential tools for the stakeholders to surveil disease patterns and take immediate action on disease control and prevention. Therefore, the primary aim of the present study was to investigate the dental caries status among 65-to 74-year-olds in the rural areas of Yunnan province and to analyze the influencing factors.

Methods

This cross-sectional study, approved by the Ethics Committee of the Affiliated Stomatological Hospital of Kunming Medical University, was performed from November 2018 to May 2019.

Study design and participant selection

The participants selection followed a multistage and stratified strategy. All rural districts in Yunnan province were invited and divided into two strata according to the average per capita disposable income of Yunnan province in 2017 (US\$1400) [22]. In the first stage, two districts were selected to represent the two

strata. Then, two villages were randomly selected from the two districts. In the third stage, three communities in each village were selected [15]. All local residents aged between 65-74 years old were recruited. Participants excluded were those with physical illness and with mental diseases. They were not able to complete the clinical assessment and could not cooperate during the questionnaire survey, respectively.

According to the previous study, the caries prevalence was set at 69% [19]. The sample size was 913, with a confidence interval width of 6% ($n = 4 \times 1.96^2 \times p \times [1-p]/L^2$; [n: no. of elderly, p: prevalence, and L: width of the 95% confidence interval]). We estimated 90% response rate, and the participants needed to be at least 1014.

Clinical examination

Two trained and calibrated dentists, wearing headlights, carried out the clinical oral health status assessment with plane dental mirrors and ball-ended probes in a community center at each village. Dental caries status was evaluated with the DMFT and DF-root indices followed the instructions of the World Health Organization (WHO) [23]. All permanent teeth, including the wisdom teeth were evaluated. Coronal and root caries were recorded separately for each decayed tooth (DT). If an unmistakable cavity was present on the crown surface, it was coded as coronal caries. A filled crown with caries or a tooth with a temporary filling was recorded as coronal caries. We recorded root caries as present when a lesion feels soft or leathery on probing with the CPI probe. If any doubt existed, caries was not recorded. The categorization of missing tooth (MT) was used for teeth that were extracted due to caries or other reasons. A filled crown or filled root (FT) was recorded as tooth with fillings, without caries, on crown or on the root. The intra- and inter-examiner reliability were evaluated throughout the study by re-examining approximately 10% randomly selected participants.

Questionnaire survey

After the clinical examination, a structured questionnaire developed base on the national oral health survey conducted in 2015 was administered to the participants [15]. Trained interviewers performed the face-to-face interviews. The questionnaire consisted of three parts:

(i) the elderly's socioeconomic and demographic information, specifically gender, ethnicity, education level, place of residence, marital status and annual family income;

(ii) the elderly's oral health-related behaviours, specifically dental visit history and tooth-brushing habits;

(iii) the elderly's oral health-related knowledge about the dental diseases' cause and prevention. For each multiple choice question, a maximum of three alternatives could be chosen, excluding "I don't know" and "no answer". One score was given to each correct answer. The total dental knowledge score was calculated, which ranged from 0 to 12 [24].

Statistical analysis

Before the statistical analysis, proofreading and a logic check were conducted. One research assistant conducted the data analysis using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, New York, United States). Descriptive analysis was conducted to describe the overall measurements of the dental caries, including their distribution, central tendency and dispersion. Chi-square tests were employed to compare the differences in the percentages between groups. Independent t-tests (two groups) and one-way ANOVA (more than two groups) were used to analyze the differences in dental caries experience (mean DMFT scores) between groups. When a variable with more than two subgroups was statistically associated with the caries experience (mean DMFT scores), a Bonferroni test was performed to detect the differences within the subgroups. A multi-factor ANCOVA test was used to identify the factors influencing caries status. The dependent variable was the mean DMFT scores. All independent variables, such as the socioeconomic and demographic determinants as well as oral health-related knowledge scores were entered into the model. An alpha of 0.05 was used as the cut off for statistical significance.

Results

This study was conducted at the community centers of the two selected districts. The ratio of participants from both districts was around 1:1. Initially, a total of 1205 residents were recruited. Of them, 10 elderly could not cooperate and 20 participants were absent from the study. The final study sample comprised 1175 persons. The response rate for the study was 98%. The kappa value for DMFT and DF-root indices assessment were 0.92. There were 524 (44%) males and 651 (66%) female participants. A majority of them were married or cohabited (76%). Approximately half of them (53%) received primary education. Around two-thirds of them (70%) belonged to ethnic minorities.

As illustrated in Table 1, a large number of the participants (87%) experienced dental caries (DMFT>0), and 55% of them had root caries. Their overall mean DMFT and DF-root scores (\pm SD) were 10.4 ± 10.9 and 2.4 ± 3.8 , respectively. More than half of the carious teeth were untreated or had secondary caries (68%). Only 12% of the participants had fillings without caries and their mean FT score was 0.3 ± 1.2 . Among the participants, almost half of them (47%) had missing teeth. Women had a significantly higher caries prevalence (DMFT>0) and higher mean DT, MT and DMFT scores than men ($p<0.05$). No significant difference was detected in the prevalence of root caries by gender ($p<0.05$). In total, 12% of the participants were edentulous.

Figure 1 displays the dental caries status by teeth type. Upper teeth and lower teeth showed the similar probability of having dental caries experience (78% vs 76%, respectively, $p>0.05$). In both maxillary and mandibular arch, caries prevalence was higher in molars, followed by premolars, and no significant statistical difference was found between the prevalence of dental caries of incisors and canines.

A majority of the participants (91%) had daily tooth-brushing habit. Almost half of them (45%) brushed their teeth for around one minute. A large number of the respondents (77%) had no experience with dental attendance. Table 2 illustrates the association between the mean DMFT scores and the studied variables. A higher mean DMFT scores was found in Women than men ($p<0.001$). Ethnic minority people experienced more dental caries than the Han people

($p < 0.001$). Participants living in Jianchuan district had higher mean DMFT scores than the other place ($p < 0.001$). Divorced or widowed participants had the highest mean DMFT than those with the two other marital statuses ($p < 0.001$). Education level was not related to the caries experience ($p = 0.074$). The highest mean DMFT scores were also found in the elderly with annual family income between RMB 15,000-30,000 ($p < 0.001$). Participants who did not brush their teeth daily had higher mean DMFT scores ($p = 0.005$). Dental attendance experience was not related to the caries experience, ($p = 0.608$). Respondents with some dental knowledge experience had lower mean DMFT scores than those who had none ($p < 0.001$).

In the final multivariate model using ANCOVA analysis (Table 3), higher mean DMFT scores were detected among elderly women who were divorced or widowed and who lived in Jianchuan district.

Discussion

As life expectancy rise, the older adults is a rapidly growing proportion of the world's population [25]. With aging, the exposure to risk factors may increase the progression of dental caries. In the present study, we reported the caries status using both the DMFT and DF-root indices, which was consistent with the latest National Oral Health survey and most of the previous studies [4, 15]. In this way, the results could be easily compared. However, in many cases, we were unsure if teeth were missing due to caries or periodontal diseases, so dental caries experiences could be overestimated.

In this study, the majority of the participants had experienced dental caries (87%), although this percentage was lower than the national survey (98%) [15]. However, it was significantly higher than the percentage in Sichuan (77%) and the northeastern provinces of China (64%) [26, 27]. Previous studies showed differences in the prevalence of root caries among elderly worldwide, ranging from 25%-100% [28]. The prevalence of root caries in our study (55%) was found lower than that in the national survey (64%). In general, the dental caries burden in both crowns and roots was still heavy among the elderly in the rural areas of Yunnan province.

Note that the prevalence of the edentulousness in this study was twice the percentages reported in Sichuan and Hong Kong [26, 29]. Tooth loss is a robust measurement of the combined burden of untreated dental caries or unsuccessfully treated periodontal disease [30]. Our results show that this high prevalence of edentulism could mainly cause by the lack of prevention and treatment for both dental caries and periodontal disease. As mentioned before, the financial barriers and limited access to oral health care could have contributed to their poor oral health status. Therefore, oral health strategies should be implemented to provide accessible and affordable dental care services throughout rural areas to further improve tooth retention.

Although many previous studies have reported a negative correlation between education level and caries, a statistically significant correlation was not detected in this study [31]. This may be due to the generally low education level among the participants. Meanwhile, we found that the most of the participants had inadequate dental knowledge, even though the national oral health education programs, such as "Love Teeth Day" campaign [32], were carried out every year to pass on the oral health care knowledge. This study showed that changes should be considered when providing oral health promotion programs, focusing on oral health knowledge and awareness, and the importance of regular visits to the dentist, especially for these with a low education level.

In the final model, gender was significantly associated with the caries experience. Women were more likely to experience dental caries than men. This was consistent with many previous studies [15, 27]. One explanation is the earlier tooth eruption among women than men. This prolonged tooth exposure in the oral environment could have increased the susceptibility to dental caries. Nevertheless, the traditional belief in China that women should not brush their teeth in the first month after childbirth could also be considered a factor that led to their higher caries rate. Additionally, marital status is also an essential factor that influenced the caries prevalence among the elderly, which is consistent with previous studies [27]. Divorced or widowed elderly had the highest mean DMFT scores. However, the reason for this phenomenon remain unclear.

Some socio-demographic factors, such as ethnicity and annual household income, are usually defined as risk factors for dental caries [31, 33]. In this study, these influence on dental caries experience was less than geographic variable. Therefore, they were not included in the finally model. People living in the less developed district (Jianchuan district) had higher mean DMFT scores than the participants living in Ninger district. Considerable inequalities in dental caries due to the place of residence were also observed among the older population in other parts of China [15].

This study had a high response rate, due to the support of the local health department. A multistage stratified sampling method was used because it was a convenient method that could provide a high statistical precision by choosing participants from all of the strata. Besides, a face-to-face interview method was employed, which significantly improved the reliability of the data. However, it should be noted that the massive internal urbanization occurred in 1980s [34]. Elderly with immigration experiences could access better oral health services in urban cities. This might had played a positive effect on their oral health status. However, this confounding factor was not investigated in the present study. Meanwhile, according to the available data in Yunnan, there were 2% of the elderly staying in the elderly homes, but they were not included in this study [12]. Therefore, the results of this study should still be interpreted with caution.

Conclusion

The prevalence of dental caries among the 65-to 74-year-olds in Yunnan was high, and their caries experience varied by gender, marital status and place of residence. Considering the shortage of dentists in Yunnan, oral health policymaker should recognize the challenge in providing professional dental care. Cost-effective preventive and treatment programs for caries management should be implemented to benefit the elderly population in the rural areas of Yunnan province.

List Of Abbreviations

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Affiliated Stomatological Hospital of Kunming Medical University. Written consent forms were received from the participants before the fieldwork.

Consent for publication

Not applicable

Availability of data and materials

The data set generated and/or analyzed during the current study are available from the first author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

SZ and HD conducted the data analysis and prepared the manuscript. XS and LC designed and cooperated in the fieldwork. LP and YL assisted in data collection. LY performed critical revision of the manuscript. All the authors read, revised and approved the final manuscript.

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Tables

Table 1 Dental caries status of the elderly according to gender

*Significant difference between gender groups (P<0.05)

Gender	Subjects (N)	Edentulous (% , N)	Mean DT	Mean MT	Mean FT	Mean DMFT	DMFT>0 (%)	Mean DF-root	DF-Root>0 (%)
Male	524	8*	2.8 (3.7)*	6.1 (9.8)*	0.2 (1.0)	9.1 (10.0)*	85*	2.1 (3.3)*	54
Female	651	14*	3.6 (4.3)*	7.6 (11.4)*	0.4 (1.4)	11.5 (11.3)*	89*	2.7 (4.0)*	56
All	1175	12	3.2 (4.1)	6.9 (10.8)	0.3 (1.2)	10.4 (10.9)	87	2.4 (3.8)	55

Table

2 Dental caries experience (DMFT) and studied variables

Variables (% , N)	DMFT (SD)	P-value
Gender		<0.001
Male (44%, 524)	9.1 (10.2)	
Female (66%, 651)	11.5 (11.3)	
Ethnicity		<0.001
Han (30%, 351)	6.6 (10.2)	
Ethnic minority (70%, 824)	12.0 (10.7)	
Place of residence		<0.001
Jianchuan District (45%, 533)	15.6 (10.0)	
Ninger District (55%, 642)	6.1 (9.7)	
Marital status		<0.001 (c<a<b)
Married or cohabited ^a (76%, 893)	10.4 (10.6)	
Divorced or Widowed ^b (9%, 107)	17.2 (10.4)	
Single or others ^c (15%, 175)	6.3 (10.3)	
Education level		0.074
Illiterate (28%, 330)	11.5 (11.3)	
Primary (53%, 619)	9.8 (10.7)	
Secondary or above (19%, 226)	10.3 (10.5)	
Annual family income (RMB)		0.001 (a=c<b)
<15000 ^a (31%, 368)	9.5 (10.7)	
15000-30000 ^b (37%, 435)	11.9 (11.2)	
>30000 ^c (32%, 372)	9.5 (10.4)	
Daily toothbrushing		0.003
No (9%, 107)	13.4 (12.5)	
Yes (91%, 1068)	10.1 (10.6)	
Tooth brushing time		0.236
≤1min (45%, 488)	9.7 (10.5)	
2-3min (50%, 544)	9.9 (10.8)	
>3min (5%, 58)	12.2 (10.0)	
Dental attendance experience		0.608
No (77%, 904)	10.5 (11.1)	
Yes (23%, 271)	10.1 (9.9)	
Oral health-related knowledge		<0.001
Score=0 (60%, 704)	12.0 (11.2)	
Score>0 (40%, 471)	8.1 (10.0)	

Table 3 Relationship between dental caries experience and selected independent variables (final model of multi-factor ANCOVA)

Independent variables	Group	Beta	SE	Eta-squared	P-value
Gender	Male	-2.774	0.584	0.019	<0.001
	Female ^a				
Place of residence	Jianchuan District	9.030	0.630	0.149	<0.001
	Ninger District ^a				
Marital status	Married or cohabited	0.611	0.871	0.000	0.035
	Divorced or Widowed	3.138	1.309	0.005	
	Single or others ^a				
DMFT		6.791	0.742	0.067	<0.001

^a Reference Category, Adjusted R² =0.211

Figures

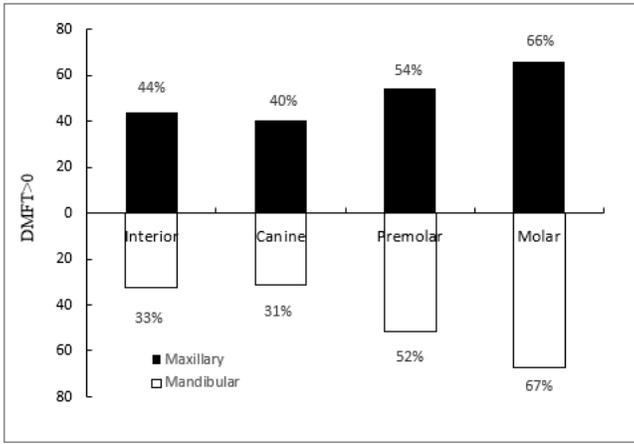


Figure 1

Prevalence of dental caries (DMFT > 0) by teeth type