Dental Caries in Chinese Elderly People: Findings from the 4th National Oral Health Survey

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Objective: *To investigate the dental caries status and related factors in Chinese elderly people, using data from the 4th National Oral Health Survey of China.*

Methods: *In this cross-sectional study, a multistage, cluster strategy was used to recruit 4,431participants (2,222 male and 2,209 female) aged 65 to 74 years from all 31 provinces, autonomous regions and municipalities of the mainland of China. The survey was performed according to the diagnostic standard proposed by the World Health Organization (WHO). Socio-demographic information was collected with a closed questionnaire.*

Results: *The caries prevalence in 65 to 74-year-olds was rather high; the report shows it was 98.0% (DMFT ≥ 1) among elderly people in China. The mean DMFT, DT, MT and FT was 13.33 ± 9.32, 3.33 ± 4.17, 9.50 ± 8.66 and 0.49 ± 1.41, respectively. The filling rate was very low, assessed as 12.8%. The number of DMFT related to gender, residential district type, educational level, level of annual household income, toothbrushing frequency, consumption frequency of desserts, attitudes to oral health and oral health-related knowledge.*

Conclusion: *The prevalence of dental caries in Chinese elderly people is rather high and a lot of decayed teeth still need to be filled and suitable prevention and treatment for this group is urgently needed.*

Key words: *caries, elderly people, prevalence, risk factors, the 4th National Oral Health Survey*

Chin J Dent Res 2018;21(3):213–220; doi: 10.3290/j.cjdr.a41077

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Dental caries is an alarming public health problem worldwide, ranked among the 10 most prevalent chronic diseases globally[1,2]. According to a World Health Organization (WHO) report, oral disease is a determining factor for quality of life[3]. Its high morbidity increases the financial burden on both families and communities[4], let alone the impact on individuals in terms of pain and suffering, and reduced quality of life impairment of function[1].

Epidemiological studies on elderly people are recommended by the WHO as age is an important factor to describe and analyse the cumulative damage of caries in oral health over the years[5]. Some studies have found

This study was supported by "Scientific Research Fund of National Health Commission of the People's Republic of China (201502002)".

that elderly people with poor oral health were more likely to suffer from malnutrition[6,7]. And proper oral health services can enhance nutrition and general health for the elderly. According to the 6th National Population Census[8], the 60+ age group in China accounted for 13.26%, and with the acceleration of the ageing process and the arrival of an ageing society, elderly people's oral health problems need more attention.

The oral health survey is one of the main means of obtaining this information and helping to draft suitable public health policies. In China, previous national oral health surveys (previously conducted in 1983, 1995 and 2005) had shown a high prevalence of dental caries in the population of 65 to 74-year-olds. The methods and criteria used in the 4th National Oral Health Survey satisfied the standards recommended by the WHO, the 5th edition of Oral Health Surveys-Basic Methods[9], and provided necessary data in the past 10 years (from 2006 to 2015) of China's oral health status.

Materials and methods

The study was revised and approved by the Stomatological Ethics Committee of Chinese Stomatological Association (Approval no. 2014-003).

Study design and sample selection

The clinical data collection of the 4th National Oral Health Survey in China was conducted between October 2015 and September 2016.

To obtain a representative sample of the national population in China, participants were chosen from all 31 provinces, autonomous regions and municipalities of the mainland of China.

Sample selection followed a multistage, cluster strategy. In the first stage, two districts and two counties from each province, autonomous region and municipality of the mainland of China were chosen randomly by the probability proportional to size (PPS) method. In the second stage, three neighbourhood committees in each district and three village committees in each country were selected randomly. In the third stage, participants were recruited by quota sampling. The PPS method was used to make the sampling more credible.

The sample size was calculated by the formula

$$n = deff \frac{\mu^2_\alpha p (1-p)}{\delta^2}$$

The design efficiency deff = 4.5, the level of confidence $\mu\alpha = 1.96$, the acceptable error $\delta = 10\%p$, according to the 3rd National Oral Health Survey in China, the prevalence of caries in people at aged 65 to 74 years was $P = 86.0\%$ and the non-response rate was 20%. Finally, a total of 4,431 subjects of 65 to 74-year-olds completed the survey.

Data collection

Data were collected through an oral examination conducted by trained and accredited dentists. According to the diagnostic standard proposed by the WHO[9], status of dental caries was examined under the artificial light with a plane dental mirror and Community Periodontal Index (CPI) probe. The kappa value of the examiners was 0.97. A structured questionnaire including socioeconomic and demographic information, knowledge and attitude to oral health, and oral health promoting behaviours were recorded by trained recorders in face-to-face interviews.

According to criteria recommended by the WHO[9], 32 teeth were taken into consideration and caries status was evaluated on both crown and root. DT (decayed teeth with crown or root caries), MT (missing teeth due to caries or other reasons) and FT (filled teeth without any primary or secondary caries) were employed to assess tooth status. Decayed, missing, and filled teeth (DMFT index, sum of all the DT, MT and FT) were also calculated to describe the severity of dental caries. The prevalence of dental caries was counted as the percentage of respondents who suffered from crown or root caries to the total number of respondents. The filling rate reflects the workload of caries filling and the level of oral health care[10]. This index was calculated by the following formulate: (total number of FT/ total number of DT and FT) × 100%.

Data analysis

For analysis of results, the sample was stratified in relation to the presence of teeth, in addition to sociodemographic variables such as gender, residential district type, education level, per capita annual household income, and individual features: toothbrushing habits, dental appointments, attitude and knowledge levels regarding oral health (Table 1).

A descriptive analysis was used to analyse the severity of dental caries. Because the DMFT index and its components were not normally distributed, a kind of non-parametric test (Mann-Whitney U-test or Kruskal-WallisH-test) was used to compare the index according to participants' socio-economic and demographic characteristics, and their behaviours relating to oral health status.

Table 1 Variables related to dental caries analysis.

Variable		Description
Gender	Male	
	Female	
Residential areas		
	Urban	
	Rural	
Educational level		
	Low	1/3 participants with lowest educational level, most of whom are illiterate
	Medium	1/3 participants with medium educational level
	High	1/3 participants with high educational level
Income level		
	Low	1/3 participants with lowest annual income, less than ¥5,000/person
	Medium	1/3 participants with medium annual income, ¥5,000 to ¥15,000/person
	High	1/3 participants with highest annual income, more than ¥15,000 /person
Frequency of dessert consumption		
	High	Consume sweet food or drinks ≥ twice a day
	Low	Consume sweet food or drinks < twice a day
Frequency of toothbrushing		
	High	≥ Once a day
	Low	< Once a day
Oral health attitude		
	Positive	Correct ≥ 2 questions out of 4
	Passive	Correct < 2 questions out of 4
Oral health knowledge		
	Low	Correct < 4 questions out of 8
	High	Correct ≥ 4 questions out of 8

The prevalence of dental caries and the filling rate are reported as percentages and compared by Pearson's χ^2 analysis.

Statistical analyses were performed by SPSS Statistics v. 19.0 (IBM, Armonk, NY, USA). $P < 0.05$ was considered to be significant.

Results

In total, 4,431 subjects aged 65 to 74 years were selected – 2,222 (50.1%) male and 2,209 (49.9%) female; 2,247 (50.7%) living in urban areas and 2,184 (49.3%) from rural areas. The demographic characteristics of subjects are shown in Table 2.

Table 2 also presents that among 65 to 74-year-olds prevalence of caries was 98.0% (DMFT ≥ 1), with prevalence among females higher than males, and rural residents higher than urban residents. The mean DMFT was 13.33 ± 9.32 and the filling rate was 12.8% across the country. The filling rate in females is higher than that in males and the difference is significant, and the difference between rural and urban is obvious (6.8% vs 18.8%). The mean DMFT and its components show a tendency that participants with a higher income and

Table 2 Dental caries status of 65 to 74-year-olds in China, 2015 to 2016.

		Number of subjects (%)	Prevalence (DMFT ≥1)	DMFT		DT		MT		FT		Filling rate
				x	s	x	s	x	s	x	s	
Gender	Total	4,431 (100)	98.0%	13.33	9.32	3.33	4.17	9.50	8.66	0.49	1.41	12.8%
	Male	2,222 (50.1)	97.8%	12.87	9.23	3.00	3.84	9.51	8.70	0.36	1.10	10.7%
	Female	2,209 (49.8)	98.3%	13.78	9.39	3.67	4.45	9.50	8.61	0.61	1.66	14.3%
Residential areas	Urban	2,247 (50.7)	98.4%	12.71	8.96	3.02	3.81	8.99	8.29	0.70	1.70	18.8%
	Rural	2,184 (49.3)	97.7%	13.96	9.64	3.65	4.48	10.04	8.99	0.27	0.99	6.9%

Table 3 Dental caries status related to socio-economic status of 65 to 74-year-olds in China, 2015 to 2016.

		Number of subjects (%)	Prevalence (DMFT ≥ 1)	DMFT		DT		MT		FT		Filling rate
				x	s	x	s	x	s	x	s	
Total		4,431 (100)	98.0%	13.33	9.32	3.33	4.17	9.50	8.66	0.49	1.41	12.8%
Level of education	Low	1,033 (23.3)	98.9%	15.38	9.91	4.16	4.80	11.00	9.39	0.22	0.92	5.02%
	Medium	1,648 (37.2)	97.7%	13.61	9.38	3.50	4.27	9.75	8.83	0.37	1.24	9.56%
	High	1,750 (39.5)	97.8%	11.85	8.64	2.70	3.51	8.40	7.86	0.76	1.73	21.97%
Personal income	Low	1,760 (39.7)	98.0%	14.25	9.62	3.80	4.55	10.15	9.00	0.30	1.14	7.4%
	Medium	1,515 (34.2)	97.5%	13.07	9.37	3.31	4.10	9.39	8.70	0.37	1.19	10.2%
	High	1,156 (26.1)	98.8%	12.25	8.64	2.66	3.51	8.68	7.97	0.91	1.90	25.6%

those with a higher level of educational have less caries and a higher filling rate (Table 3).

Figure 1 shows that participants with better knowledge of oral health had lower mean DMFT scores. Figure 2 also shows that participants with a more positive attitude to oral health had better oral health status. Those people who had better oral health promoting behaviours such as eating less sweet food or drinks, who brush their teeth at least once a day, use toothpicks at least once a day, and use toothpaste containing fluoride had less dental caries than those who do not (Fig 3).

The DMFT and its components' scores of 65 to 74-year-olds according to different exposure variables are shown in Table 4.

The number of DMFT related to gender, residential district type, educational level, annual household income level, frequency of toothbrushing, frequency of consuming desserts, attitudes to oral health and oral health-related knowledge. The inequality in the DT score was associated with gender, residential district type, educational level, annual household income level, toothbrushing frequency, attitude to oral health and oral health-related knowledge. The number of MT related to residential district type, educational level, annual household income level, toothbrushing frequency, the frequency of dessert consumption, attitudes to oral health and oral health-related knowledge. The number of FT related to gender, residential district type, educational level, annual household income level, toothbrushing frequency, frequency of eating dessert, attitudes to oral health and oral health-related knowledge. The multivariate logistic regression analysis of DMFT shows that a high annual household income and frequent toothbrushing are protective factors in preventing dental caries (Table 5).

Table 4 Mean DMFT and its components according to exposure variables of 65 to 74-year-olds in China, 2015 to 2016.

Variable	P value			
	DMFT	DT	MT	FT
Gender				
Male	0.001*	0.000*	0.691*	0.000*
Female				
Residential area				
Urban	0.000*	0.000*	0.000*	0.000*
Rural				
Educational level				
Low				
Medium	0.000**	0.000**	0.000**	0.000*
High				
Income	0.000*	0.000*	0.000*	0.000*
Low				
Medium				
High				
Toothbrushing				
< 1/day	0.000*	0.000*	0.002*	0.000*
≥ 1/day				
Frequency of dessert consumption				
High	0.030*	0.134*	0.016*	0.000*
Low				
Attitude	0.000*	0.000*	0.011*	0.000*
Positive				
Passive				
Knowledge	0.000*	0.000*	0.000*	0.000*
Low				
High				

*Mann-Whitney U-test. **Kruskal-Wallis H(K) test.

Table 5 Multivariate logistic regression analysis of DMFT.

Variable		OR	95% CI
Gender	Male	0.831	0.627-1.101
	Female	1	
Residential area			
	Urban	0.869	0.642-1.175
	Rural	1	
Educational level			
	Low	1	
	Medium	0.784	0.627-0.979
	High	0.615	
Income level			
	Low	1	
	Medium	0.938	0.771-1.142
	High	0.880	
Frequency of dessert consumption			
	High	1.050	0.999-1.103
	Low	1	
Frequency of toothbrushing			
	High	0.781	0.715-0.854
	Low	1	
Oral health attitude			
	Positive	1	
	Passive	1.074	0.917-1.258
Oral health knowledge			
	Low	1	
	High	0.999	0.917-1.088

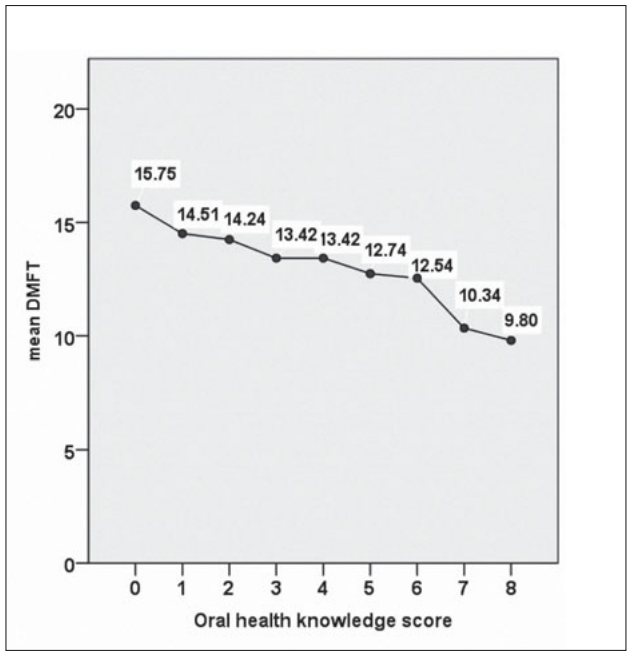

Fig 1 Trend of dental caries status related to oral health attitude of 65 to 74-year-old people (higher score means more positive attitude to oral health care).

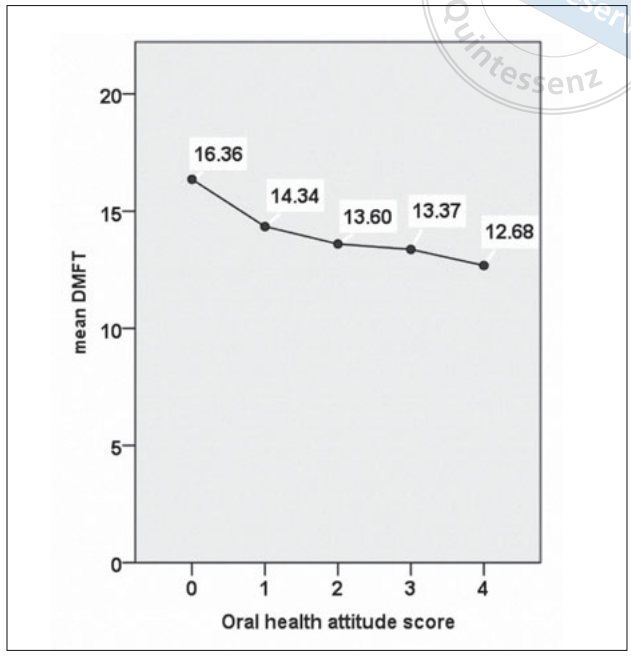

Fig 2 Trend of dental caries status related to oral health knowledge of 65 to 74-year-old people (higher score means more right answers).

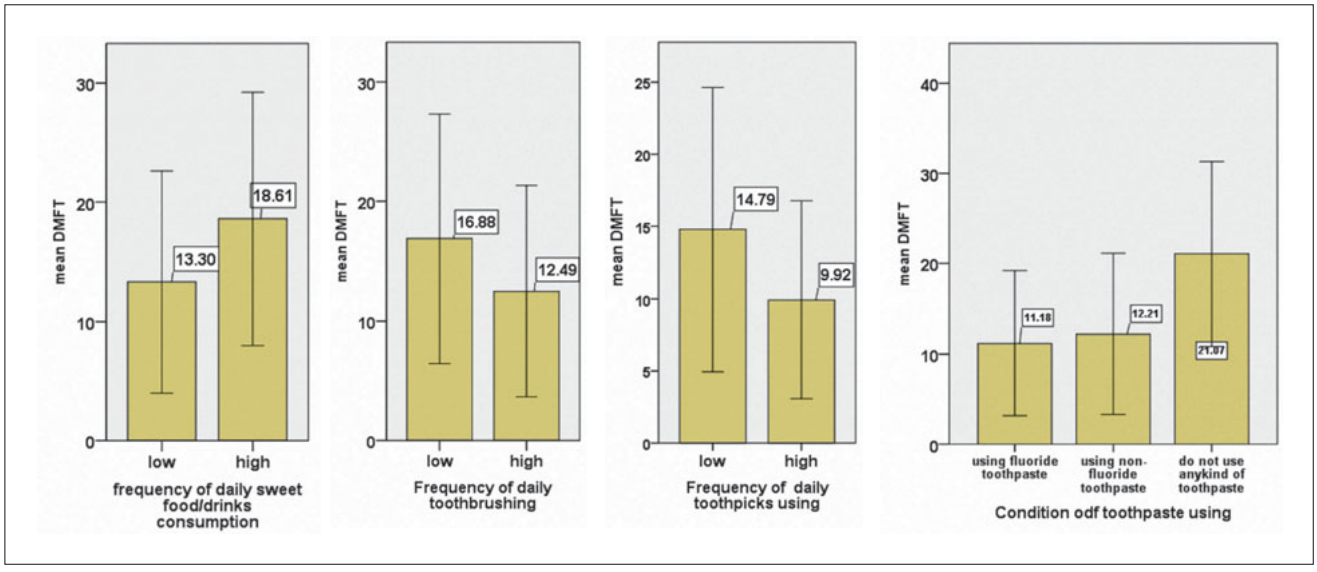

Fig 3 Distribution of dental caries related to oral health behaviours, including frequency of sweet food/drinks consumption, frequency of daily toothbrushing, frequency of daily use of toothpicks, and type of toothpaste used by 65 to 74-year-olds.

Discussion

As a vulnerable group, elderly people usually have poor oral health status. This survey revealed a high prevalence of dental caries, and a high number of DMFT and its components in this elderly group, which was in accordance with the 3rd oral health survey in China.

Although worldwide there has been a decline in dental caries, the distribution of caries becomes more unfair because of social-economical inequalities. But most studies were aimed at a younger population, with only a small amount of attention paid to older people[11].

This study provides national information about dental caries in the Chinese elderly population. The DMFT

index and its components reflect lifetime experience of dental caries, rather than specifying each current moment[12]. The results revealed that the severity of dental caries was apparently associated with levels of educational.

Participants with a higher level of educational had a lower severity of dental caries. The survey shows that average education levels of female participants was lower than males, which was in accordance with the severity of caries. The level of educational background affects occupation and income, and thus influences one's health service usage, oral cleaning habits, and diet[13,14].

Some studies found that people with a lower educational level were more likely to have tooth extractions without receiving a prosthesis and they usually had the poorest oral clinical outcomes, including the presence of decay, existence of untreated decay and deep periodontal pockets[15,16].

Therefore, oral health projects targeting this sector of the population are needed to help them to prevent and treat oral health diseases. Children should also be prevented from dropping out of school, especially in remote areas.

Annual household income was closely related to educational level[1] and also related to the severity of dental caries and filling rates. Because in some areas of China dental treatment fee are not included in the insurance and not all treatments can be paid by the insurance, people have to foot these bills themselves. According to our survey, more than two-thirds of Chinese elderly people have a low per-capita annual household income (< ¥15,000/year), which cannot support their need for dental treatment. Economic development levels of districts are another influencing factor in oral health status. Usually people living in a more developed district will have better access to visit dental practitioners and receive some treatments and advice. This is one of the reasons why people living in rural countries have more decayed teeth and a lower filling rate. We need more programmes to provide oral health service resources in less developed parts of China and encourage dental practitioners to work there.

It is also often inconvenient for the elderly to go to a hospital or clinic for treatment, especially when they are living alone. Some projects for the elderly to receive oral health examinations and treatment at home or in the community are needed.

Brushing teeth at least twice a day is a recommended oral health care method, but among elderly Chinese, only 30% of participants reported this was achieved. The difference in DMFT scores is obvious between the group who brush their teeth less or more than twice a day (14.79 vs 9.92). So, we still need to carry out more public educational programmes to promote proper oral health selfcare skills.

Dental caries status reported in China was less serious than that reported in Uruguay[18] and Chile[19], but higher than that reported in Malawi[20] and Cambodia[21]. As everyone knows, the health status including oral health status of disadvantaged populations was closely related to per-capita gross domestic product and public health projects.

In conclusion, the prevalence of dental caries in elderly Chinese people is rather high and a lot of decayed teeth still need to be filled. The oral health burden on Chinese dental practitioners and the government is still high to achieve WHO goals Suitable prevention and treatment for this group is urgently needed.

Conflicts of interest

The authors reported no conflicts of interest relating to this study.

Author contribution

Dr Yi Bo GAO analysed the data and drafted the manuscript; Drs Tao HU and Xue Dong ZHOU guided the analysis of the data and helped to draft the manuscript; Drs Rui SHAO and Ran CHENG provided statistical advice; Drs Guo Song Wang, Ying Ming YANG and Xue LI helped with the revision of the manuscript; Drs Bo Yuan and Ting XU inputted the data; Drs Xing WANG, Xi Ping FENG, Bao Jun TAI, De Yu HU, Huan Cai LIN, Bo WANG, Yan SI, Chun Xiao WANG, Shu Guo ZHENG, Xue Nan LIU, Wen Sheng RONG, and Wei Jian WANG trained the investigators, designed and supervised the survey; Dr Wei YIN conceived the study and designed the statistic exploration.

(Received May 31, 2018; accepted June 25, 2018)

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