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Awareness of the Benefits and Risks Related to **Using Fluoridated Toothpaste Among Doctors:** A Population-Based Study

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Background:

This study aimed to assess the awareness of dentists and non-dental doctors regarding the benefits and risks

of using fluoridated toothpaste.

Material/Methods:

A self-administered questionnaire was used to collect information in this study. Multistage cluster sampling method was used to enroll doctors in 5 districts or counties in Chongqing, China. A total of 403 doctors (160 dentists and 243 non-dental doctors) completed the questionnaire.

Results:

The awareness of the anti-caries efficacy and the usage of fluoridated toothpaste in dentists was significantly higher than those of non-dental doctors (P<0.001). Most (about 60%) dentists and non-dental doctors had concerns about fluoridated toothpaste. Only 31.3% of dentists and 25.9% of non-dental doctors had a good understanding of the benefits and risks of use of fluoridated toothpaste in children under 3 years of age to 49.4% of dentists and 73.3% of non-dental doctors did not understand the benefits and risks in children 3~6 years old. and 40.0% of dentists and 67.5% of non-dental doctors did not understand the risks and benefits in individuals living in high-fluoride areas. Most dentists (76.3%) and non-dental doctors (87.3%) did not understand the benefits and risks in pregnant women.

Conclusions:

Dentists and non-dental doctors were concerned about the potential risks of use of fluoridated toothpaste, and they lacked adequate knowledge about the benefits and risks of use of fluoridated toothpaste. Health education is needed to improve doctors' knowledge about use of fluoridated toothpaste.

MeSH Keywords:

Awareness • Fluorides • Toothpastes • Risk Assessment

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Background

As the most common oral disease, caries occurs when the dynamic equilibrium of demineralization and re-mineralization of the dental hard tissue is upset due to the influence of biofilm and various other factors [1–3]. Fluoridated toothpaste contains fluoride (F), which can control caries by reducing demineralization of enamel, promoting the re-mineralization of enamel and inhibiting the metabolism of bacteria [4–7]. Several studies have confirmed that fluoridated toothpaste is an effective method to control dental caries, and the demineralization of enamel is negatively correlated with the concentration of fluoride in toothpaste in both permanent or deciduous enamel, as well as root dentin [7–9].

Although fluoridated toothpaste has certain anti-caries effects, excessive intake may cause some adverse effects such as skeletal fluorosis and dental fluorosis [10,11]. In addition, studies have found that the accidental swallowing of fluoridated toothpaste in children may be 2–3 times the safe limit, suggesting that use of fluoridated toothpaste may be a risk factor for dental fluorosis [12,13]. Therefore, the risks of using fluoridated toothpaste should not be ignored, the benefits and risks of using fluoridated toothpaste also need to be properly assessed.

Poor knowledge of oral health results in inappropriate oral hygiene behaviors [14,15]. Moreover, according to the fourth Chinese Oral Health Epidemiological Survey, the knowledge of fluoridated toothpaste among Chinese was still at a relatively low level [16]. Thus, it is particularly important to carry out oral health education regarding knowledge and use of fluoridated toothpaste. As directors of medical activities, doctors' awareness regarding health care issues affects their decisions and advice given in clinical practice, and also influences the awareness of patients and the public [17,18]. However, few studies have specifically focused on the awareness of doctors regarding fluoridated toothpaste, and no studies have investigated doctors' awareness of the risks of using fluoridated toothpaste.

Therefore, the present study assessed the awareness of dentists and non-dental doctors (NDDs) about use of fluoridated toothpaste, especially use of fluoridated toothpaste among some special groups of individuals, including children aged under 3 years old, children age 3–6 years old, individuals living in high-fluoride drinking water areas, and pregnant women.

Material and Methods

Ethics statement

The study was performed in accordance with the Declaration of Helsinki, and all the participants provided verbal consent. This cross-sectional study was approved by the Ethics Committee of Chongqing Medical University (2017.06.23).

Participants

This population-based study was conducted in Chongging, China from July to August in 2017. We used multistage cluster sampling to enroll doctors. In the first stage of sampling, the 40 districts or counties of Chongqing are divided into 5 levels according to the gross regional product of 2016, and 1 district or county from each of the 5 levels was randomly chosen - Yuzhong, Banan, Qijiang, Fengdu, and Wulong were chosen. In the second stage of sampling, 1 town or block was randomly selected from each of the 5 districts or counties chosen in the first stage. In the third stage, all of the dentists and NDDs from all the legal hospitals or clinics (totally 439) in the selected towns or blocks were invited to take part in this study. Six dentists and 9 NDDs refuse to participate in the study, and the questionnaires of 21 doctors (6 dentists and 15 NDDs) were excluded because of missing data. Finally, the responses of 403 doctors (160 dentists and 243 NDDs) who completed the questionnaire were analyzed (Figure 1).

Study design

The self-administered questionnaire was designed for the target population (dentists and NDDs), and included 3 parts: (1) demographic characteristics of participants; (2) awareness of the anti-caries efficacy and the usage of fluoridated toothpaste; (3) knowledge about the correct use of fluoridated toothpaste in different populations.

Prior to the survey, the investigators were trained in relevant knowledge about fluoridated toothpaste, communication skills, and the implementation of the survey. The questionnaire was pilot tested with 39 doctors (15 dentists and 24 NDDs), revisions were made accordingly, and after repeated discussions with experts, the final version of the questionnaire was developed.

Statistical analysis

SPSS software (version 19.0) was used to analyze the data. Frequencies were calculated for all categorical variables. Comparisons between dentists and NDDs were conducted using the chi-square test, and P<0.05 was considered statistically significant.

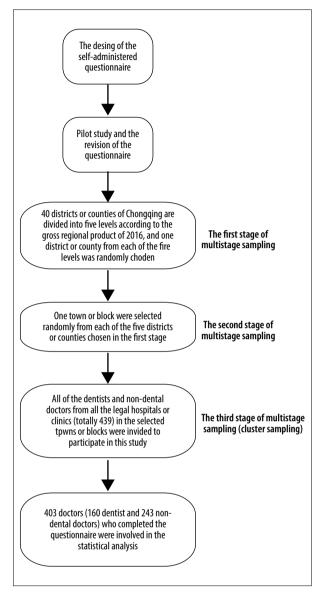


Figure 1. Study flow diagram.

Results

Demographic characteristics of study population

A total of 403 doctors (160 dentists and 243 NDDs) completed the questionnaire, and their questionnaires were included in the analysis. Table 1 shows the demographic characteristics of study population.

Awareness of the anti-caries efficacy and use of fluoridated toothpaste

We found that 90% of dentists and 54.3% of NDDs were aware of the anti-caries efficacy of fluoridated toothpaste, and the difference was significant (χ^2 =56.927, P=0.000). The use of

fluoridated toothpaste among dentists was 58.8%, which was significantly higher than among NDDs (χ^2 =17.629, P=0.000) (Table 2).

Main concerns about using fluoridated toothpaste

Concern about using fluoridated toothpaste was reported by 59.4% of dentists and 60.1% of NDDs – 31.3% of dentists and 16.5% of NDDs worried about swallowing fluoridated toothpaste, and the difference was statistically significant (χ^2 =12.165, P=0.000); 21.9% of dentists and 28.4% of NDDs worried about dental fluorosis; and a higher proportion of NDDs (7.0%) worried about skeletal fluorosis than dentists (1.3%) (Table 3).

Awareness of fluoridated toothpaste use in different populations

Due to lack of knowledge, 18.1% of dentists and 50.2% of NDDs could not assess the benefits and risks of fluoridated tooth-paste use in children aged under 3 years old; 50.6% of dentists and 23.9% of NDDs thought there was no risk or that the risks were outweighed by the benefits. Only 31.3% of dentists and 25.9% of NDDs had sufficient knowledge (knowing that the risks outweigh the benefits), but the difference between the 2 groups was not statistically significant (P>0.05) (Table 4).

As regards the use of fluoridated toothpaste in children age 3 to 6 years old, 50.6% of dentists had sufficient knowledge (knowing that the benefits outweigh the risks), which was significantly higher than the proportion of NDDs (χ^2 =23.805, P=0.000). Among NDDs, 47.3% could not assess the risks and benefits because of lacking of relevant information (Table 4).

Sixty percent of dentists and 32.5% of NDDs correctly believed that the risks outweighed the benefits, and the difference was statistically significant (χ^2 =29.676, P=0.000), whereas 40.0% of dentists and 67.5% of NDDs could not correctly assess the risks and benefits (Table 5).

When asked about the use of fluoridated toothpaste in pregnant women, 31.3% of dentists and 54.7% of NDDs could not assess the risks and the benefits, and 27.5% of dentists and 24.8% of NDDs thought that the risks outweighed the benefits. Only 23.8% of dentists and 12.8% of NDDs chose the correct answer that the benefits outweighed the risks regarding the use of fluoridated toothpaste in pregnant women (Table 6).

Discussion

The discovery of the anti-caries effect of fluoride opened up a new field in the control of caries. Fluoride can form a reservoir of calcium fluoride or can be taken in and develop

 Table 1. Demographic characteristics of study population.

Characteristics			Dentists n (%) N=160		NDDs n (%) N=243	
Gender	Male	54	(33.8)	62	(25.5)	
	Female	106	(66.2)	181	(74.5)	
	<30 years	114	(71.3)	154	(63.4)	
Ago	30~44 years	34	(21.2)	59	(24.3)	
Age	45~60 years	10	(6.3)	20	(8.2)	
	>60 years	2	(1.2)	10	(4.1)	
	Yuzhong	44	(27.5)	73	(30.0)	
	Banan	21	(13.1)	34	(14.0)	
District	Qijiang	38	(23.8)	69	(28.4)	
	Wulong	32	(20.0)	36	(14.8)	
	Fengdu	25	(15.6)	31	(12.8)	

NDDs - non-dental doctors.

Table 2. The awareness of the anti-caries efficacy and the usage of fluoridated toothpaste.

Perspective		ntists N=160		IDDs) N=243	Chi-square value	P value
Awareness on the anti-caries efficacy of fluoridated toothpaste					56.927	0.000*
Agree	144	(90.0)	132	(54.3)	_	-
Disagree	4	(2.5)	25	(10.3)	-	_
Not sure because of lacking relevant knowledge	12	(7.5)	86	(35.4)	-	-
Are you using fluoridated toothpaste?					17.629	0.000*
Certainly	94	(58.8)	98	(40.3)	-	_
Certainly not	48	(30.0)	82	(33.7)	-	_
Not sure because I don't know how to identify it	18	(11.2)	63	(25.9)	-	_

NDDs – non-dental doctors. * P value <0.05 indicates significant difference.

 Table 3. The main concerns of using fluoridated toothpaste.

Perspective	Dentists n (%) N=160	NDDs n (%) N=243	Chi-square value	P value
Swallowing	50 (31.3)	40 (16.5)	12.165	0.000*
Dental fluorosis	35 (21.9)	69 (28.4)	2.142	0.143
Skeletal fluorosis	2 (1.3)	17 (7.0)	7.090	0.008*
Have concerns but don't know what the concerns are	8 (5.0)	20 (8.2)	1.557	0.212
Without any concerns	65 (40.6)	97 (39.9)	0.020	0.887

NDDs - non-dental doctors. * P value < 0.05 indicates significant difference.

Table 4. The consideration on the use of fluoridated toothpaste in children at different age among doctors.

Perspective	Dentists n (%) N=160	NDDs n (%) N=243	Chi-square value	P value
In children aged under 3 years				
No risks exist	17 (10.6)	7 (2.9)	_	-
Benefits outweigh risks	64 (40.0)	51 (21.0)	_	-
Risks outweigh benefits#	50 (31.3)	63 (25.9)	1.355	0.244
Could not assess that because of lacking relevant knowledge	29 (18.1)	122 (50.2)	-	-
In children aged between 3-6 years				
No risks exist	27 (16.9)	15 (6.2)	_	-
Benefits outweigh risks#	81 (50.6)	65 (26.7)	23.805	0.000*
Risks outweigh benefits	23 (14.4)	48 (19.8)	_	_
Could not assess that because of lacking relevant knowledge	29 (18.1)	115 (47.3)	-	_

NDDs - non-dental doctors. # The answer which is relatively reasonable. * P value <0.05 indicates significant difference.

Table 5. The consideration on the use of fluoridated toothpaste in the individuals living in high-fluoride drinking water areas among doctors.

Perspective	Dentists n (%) N=160	NDDs n (%) N=243	Chi-square value	P value
No risks exist	5 (3.1)	15 (6.2)	-	-
Benefits outweigh risks	33 (20.6)	35 (14.4)	-	<u>–</u>
Risks outweigh benefits#	96 (60.0)	79 (32.5)	29.676	0.000*
Could not assess that because of lacking relevant knowledge	26 (16.3)	114 (46.9)	-	-

NDDs – non-dental doctors. # The answer which is relatively reasonable. * P value <0.05 indicates significant difference.

Table 6. The consideration on the use of fluoridated toothpaste in pregnant women among doctors.

Perspective	Dentists n (%) N=160	NDDs n (%) N=243	Chi-square value	P value
No risks exist	28 (17.5)	19 (7.8)	-	-
Benefits outweigh risks#	38 (23.8)	31 (12.8)	8.216	0.004*
Risks outweigh benefits	44 (27.5)	60 (24.8)	_	-
Could not assess that because of lacking relevant knowledge	50 (31.3)	133 (54.7)	_	_

NDDs - non-dental doctors. # The answer which is relatively reasonable. * P value <0.05 indicates significant difference.

fluorhydroxyapatite (HA), which can re-mineralize early enamel caries [1,4,19–21]. The crystal layer of HA can make the enamel more stable and difficult to dissolved [22]. Calcium fluoride

can store fluoride ions in neutral or lower PH conditions and release fluoride ions, so as to increase the concentration of ions in the demineralization center and reduce or even control the demineralization of enamel. The formation of calcium fluoride on the surface of the enamel can persist for a long time. When the pH of the tooth surface decreases to lower than 6, this calcium fluoride can release fluoride ions, and finally form HA, which promotes re-mineralization [23,24]. Fluoridated toothpaste is made by adding sodium fluoride monofluorophosphate, stannous fluoride, and other fluoride compounds in toothpaste. It can improve the level of fluoride in the oral cavity and the surface of teeth, which can persist for more than 10 h after tooth brushing [25]. Moreover, sufficient evidence-based studies and basic research have shown that using fluoridated toothpaste is a practical and feasible measure to control dental caries [4,7–9].

This study assessed the awareness of dentists and NDDs about using fluoridated toothpaste and assessed their knowledge regarding the risks and benefits of fluoridated toothpaste use to provide evidence for guiding public health policies and health education. The results of this study showed that the use of fluoridated toothpaste among dentists was significantly higher than that among NDDs, and this may be associated with the higher proportion of dentists who understood the efficacy of fluoridated toothpaste in the control of caries. However, nearly half of the dentists and most NDDs were not using or were unsure whether they were using fluoridated toothpaste, although 90% of dentists and 54.3% of non-dentists knew the anti-caries effect of fluoridated toothpaste, suggesting that doctors may have poor behavioral compliance or have concerns. The results showed that most of participants in the 2 groups had concerns about the potential risk of using fluoride. Animal experiments and clinical studies showed that excessive intake of fluoride can cause functional impairment of organs (e.g., liver, kidney, stomach, and brain) and can also be cytotoxic [26-32]. However, it should be noted that these serious adverse effects occurred when high concentrations or doses of fluoride were ingested. The concentration of fluoride in fluoridated toothpaste is much lower than the toxic levels, and many studies have confirmed that using fluoridated toothpaste is safe for adults with normal swallowing function [4] and the possibility of fluorosis caused by toothpaste intake is low. Therefore, excessive caution about the potential risks of fluoridated toothpaste may be a barrier to the use or recommendation of fluoridated toothpaste by doctors.

Wright et al. reported that improper use of fluoridated toothpaste can lead to fluorosis if the total fluoride intake exceeds the safe limit. Therefore, it was proposed that there were certain risks in the use of fluoridated toothpaste in children [33]. Marinho et al. [34] also found that children swallow 30~50% of the total amount of toothpaste when brushing their teeth, and the amount of swallowing is positively correlated with the amount of toothpaste used [35,36]. Moreover, the swallowing function of children under 3 years old is not fully developed or complete, so the dose of toothpaste that was swallowed by mistake was high and can easily cause fluorosis. Fluoride intake can induce serious adverse effects on the intelligence and physical development of children [37-41]; therefore, the risks of using fluoridated toothpaste outweigh the benefits in children under 3 years old. The American Dental Association Council reported that caries risk assessment is a critical step before recommending fluoride therapies for children who are at high risk of developing caries; however, there are no validated caries risk assessment tools with known sensitivity and specificity for children, which makes it challenging to base therapeutic recommendations on the risk of future disease development [42]. The results of this study showed that the majority of the dentists and the NDDs could lacked sufficient knowledge about fluoridated toothpaste use, and the proportion of dentists who assessed the risks and benefits correctly was not significantly higher than that of the NDDs on this issue. These results suggest that the awareness on the risks of using fluoridated toothpaste in children aged under 3 years old was insufficient among doctors and that the decision they made may cause risks to children under 3 years old.

Regarding use of fluoridated toothpaste in children 3~6 years old, the literature suggests that children aged 3 or older can safely use a small amount ("pea" size) of fluoridated toothpaste [42,43], and their parents or teacher need to supervise them while brushing the teeth. In addition, the sugar intake of young children may be increasing [44,45], and the incidence of caries in deciduous teeth is high in this age group [46,47]. Therefore, the benefits of using fluoridated toothpaste will be greater than the risks if there is adequate parental supervision. Doctors who believed that the benefits outweighed the risks may mainly worry about the risks, especially swallowing, and ignore or weaken the dose requirements as well as the supervision and guidance of parents. However, the parental responsibility (accompanying their children to brush thee teeth) and the concerns of some doctors also indicated that it was imperative to conduct surveys and health education on the awareness of fluoridated toothpaste among the parents of children.

Drinking highly fluoridated water was the primary factor that affects the prevalence of dental fluorosis and skeletal fluorosis [48–50], and the use of fluoridated toothpaste may aggravate this fluorosis [51,52]. In addition, studies showed that the prevalence of dental fluorosis among fluoridated toothpaste users in high-fluoride areas was about twice that of those who did not use fluoridated toothpaste [53,54]. Therefore, the risks outweighed the benefits of using fluoridated toothpaste in individuals living in high-fluoride drinking water areas. About 40% of dentists and 67.5% of non-dentists could not correctly assess the risks and benefits, which may affect the ability of these doctors to make reasonable decisions and assess risks.

Some animal experiments reported that fluoride can affect the reproductive system and show reproductive toxicity at different stages of gestation [55,56], but toxicity depends on the dose and concentration, and there appear to be reports that using fluoridated toothpaste has adverse effects on pregnant women or their babies. Moreover, normal pregnant women have complete swallowing function and clear consciousness, so there is scant risk of accidental swallowing. Because fluoridated toothpaste has an obvious anti-caries effect that reduces the risks of caries and its secondary diseases during pregnancy, the benefits of using fluoridated toothpaste outweigh the risks. However, the results of this survey showed that most dentists and NDDs could not correctly assess the benefits and risks. These results suggest that further studies are needed to assess the benefits and potential risks of using fluoridated toothpaste in pregnant women, which may become the focus of health education.

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Conclusions

In conclusion, both dentists and NDDs were concerned about the potential risks of using fluoridated toothpaste and lacked adequate knowledge about the between benefits and risks of fluoridated toothpaste, which may impair doctors' decisions and the discourage patients from using fluoridated toothpaste. Health education for doctors is needed to improve their knowledge about fluoridated toothpaste. Further health education research is needed on doctors' assessment of the benefits and risks of fluoridated toothpaste.

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Conflict of interest

None.

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