Dental Caries Status and its Associated Factors among 3- to 5-year-old Children in China: A National Survey

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Objective: *To investigate the prevalence and severity of dental caries among pre-school children in China as part of the 4th National Oral Health Survey.*
Methods: *The sampling process was conducted with a multistage stratified cluster method. A total of 40,360 children aged between 3 and 5 years were recruited for this study. Each participant was clinically assessed according to the 5th edition of the oral health survey's basic methods recommended by the World Health Organization (WHO) and their parents or grandparents completed a questionnaire at a face-to-face interview. The status of dental caries was shown in the form of the mean dmft and the prevalence of dental caries. The logistic regression analysis was performed to study the relationships between the prevalence of dental caries and the selected variables.*
Results: *The prevalence of dental caries was 50.8%, 63.6% and 71.9% for 3-, 4- and 5-year-olds, respectively. The mean dmft was 2.28, 3.40 and 4.24, respectively. Logistic regression analysis showed that children who were mixed-fed had a higher chance of staying free of dental caries; children who had dessert before going to bed were associated with a higher probability of caries.*
Conclusion: *The status of dental caries among preschool children in China is on the increase. The preschoolers' dental caries status related to their breastfeeding conditions within the first 6 months of life and their snacking habits.*
Key words: *China, dental caries, preschool children, epidemiology, the 4th National Oral Health Survey*
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Dental caries is one of the most widespread chronic diseases[1]. It is a major cause of pain, as well as local and systematic infection[2]. When it happens in childhood, a child's eating patterns, the development of permanent dentition and general health will be impacted[3]. Notably, dental caries among preschool children has seen an alarming increase and is a major public health issue for children globally[4]. Preventing preschool children from dental caries is of great importance and there should be no delay.

The People's Republic of China, a developing country in East Asia, has a multiracial population of 1.34 billion[5]. The National Oral Health Survey aims to obtain the current prevalence trends and treatment status of oral disease and to make policies to decrease its prevalence. The first survey was conducted in 1983, and the second and third were in 1995 and 2005, respectively. The status of dental caries among 5-year-old children

is one of its most important parts. The results of these surveys showed a decline in mean dmft and the prevalence of dental caries for 5-year-old children, although these indexes remained high and most caries remains untreated[6,7]. According to a meta-analysis about early childhood caries in China from1987 to 2013, the pooled prevalence of dental caries for children aged 3 to 5 years was 40.2%, 54.4% and 64.1%, respectively. A declining trend was shown in the prevalence of dental caries from 1987 to 2004[8].

Since the most recent national survey in 2005, dramatic changes have happened in China. Due to demographic alterations (including population growth and ageing) and economic changes, corresponding dietary structure, nutritional status and psychosocial development changes have also occurred. Moreover, the government has implemented policies aimed at preventing and curing dental caries. All of these factors have an effect on its status among preschool children.

This study formed part of the 4th National Oral Health Survey, which was conducted between 2015 and 2016. It enrolled 3-, 4- and 5-year-old children; previously national surveys on the prevalence of dental caries among preschool children in China only recruited children aged 5 years. It is the first time the National Oral Health Survey in China has enrolled all three ages.

The aim of this part of the study was to investigate the prevalence, severity and the intraoral distribution of dental caries among preschool children in China. The information on the children's oral health-related behaviours and their guardians' socioeconomic status was obtained. In addition, the study reported the factors affecting caries status in this population. The results of this study would be useful for dental professionals and policy makers in the planning of dental services for preschool children.

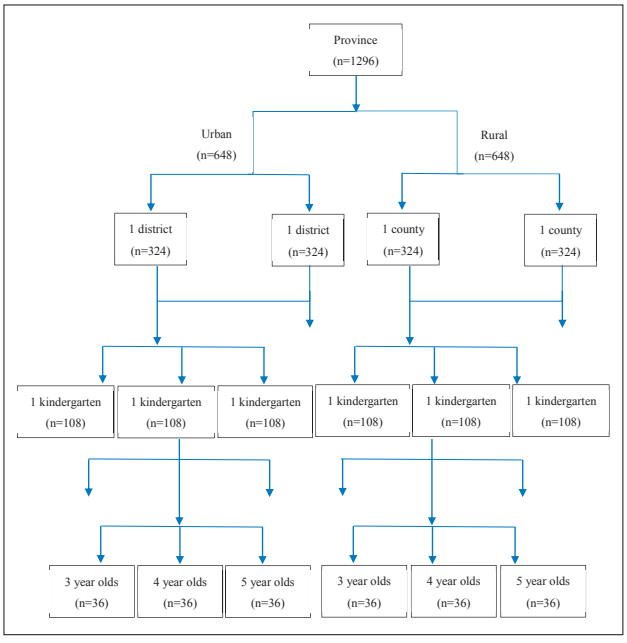

Fig 1 Sampling process.

Materials and methods

Ethical clearance

This cross-sectional survey was a national study undertaken by the Chinese Stomatological Association. Ethical approval (Approval no. 2014-003) for the study was obtained from the Ethics Committee of Chinese Stomatological Association and informed consent was obtained from the guardian of each child.

Selection of subjects and sampling design

The targeted subjects were 3- to 5-year-old children who had lived in the survey area for more than 6 months, and their ages were calculated according to the survey month.

By considering estimated caries prevalence rate (P = 66.0%)(the prevalence of dental caries among 5-year-old children in the 3rd National Oral Health Survey, 2005), the design effect (deff = 4.5), the significance level ($\alpha = 5\%$), the margin of error ($\delta = 10\%$), the calculating formula

$$n = \text{deff} \frac{u_\alpha / 2^2}{\delta^2} p(1-p)$$

and the non-response rate (20%), a study sample of 13,392 subjects was targeted for each age group.

For the first time, the survey enrolled all 31 provinces, autonomous regions and municipalities of the mainland of China. Multistage stratified cluster sampling was used to select participants. As presented in Figure 1, in the first stage, probability proportional to size (PPS) design was used to randomly select two urban areas and two rural areas from each province after the division of urban and rural areas in each province. In the second stage, the PPS method was used to select three kindergartens randomly from each area. In the third stage, a random sample of 36 children with equal sex distribution of each age group was recruited at each kindergarten. Some children were recruited from the local community when the chosen kindergartens could not provide enough subjects.

Clinical examination

Every participant received a clinical assessment according to the Fifth Edition of the Oral Health Survey Basic Methods, as recommended by the WHO[9]. The oral health assessment form included identification information (gender, age and ethnicity) and condition of the teeth (coronal caries). The subject sat on a mobile dental chair during the examination. Three trained examiners examined subjects with a plane mouth mirror and a Community Periodontal Index (CPI) probe under artificial light. Food debris was gently removed before the inspection. Caries experience was assessed in the form of the dmft index and scored according to WHO standard criteria. It means a tooth was recorded as decayed (dt) when a lesion had an unmistakable cavity, undermined enamel, or a detectably softened floor or wall; a tooth that was sealed but also decayed, was included as well. A tooth was recorded as missing (mt) when it was extracted due to caries. For missing primary teeth, this score should be used only if the subject is at an age when normal exfoliation would not be a sufficient explanation for absence. A tooth was recorded as filled (ft) when it was permanently filled without caries[9].

Three trained licensed dental practitioners who had been calibrated following WHO guidelines performed the examination. Three trained individuals with clinical experience served as recording clerks. Before the survey, every examiner was calibrated with the other two examiners and a fourth examiner, who acted as the standard examiner in the same setting. Each examiner then examined a group of 10 pre-selected subjects twice on the following day to assess the consistency. During the survey, a 5% random sample of the children was re-examined on the same day to assess the intra-examiner agreement. Moreover, an experienced dental epidemiologist re-examined half of the teeth for five of the subjects who had been assessed by other examiners. Kappa values were calculated and inter- and intra-examiner reproducibilities were > 0.80.

Questionnaire

The subject's parents or grandparents completed a questionnaire through a face-to-face interview. Two trained individuals with clinical experience acted as investigators, with one in charge of the quality of the questionnaire survey. In districts where dialect was difficult to understand, a local person also acted as an assistant.

The questionnaire consisted of four parts:

- The respondent's relationship to the child;
- Early life factors: birth weight, feeding approaches within the first 6 months of life;
- Oral health-related behaviours: toothbrushing behaviour, sugar intake behaviour, dental attendance experience;
- Family factors: household income, parents' education levels, parents' dental knowledge and attitude.

Statistical analysis

Data analysis was performed using the SPSS (PC version 21.0) software with the level of statistical significance set at $P < 0.05$. Children with missing data were excluded from the analysis. Initially, we performed descriptive analyses and the dental caries status was shown in the form of the mean dmft and the prevalence of dental caries. In addition, the Significant Caries Index (SiC, the mean dmft of one-third of the population with the highest caries scores) was calculated.

Then the chi-square test was performed to test the association of the prevalence of dental caries with the selected variables. ANOVA was employed to study the distribution of dmft scores according to different variables. Afterwards, the logistic regression model was taken into account to study the relationships between the prevalence of dental caries and the selected variables. The enter method was used in the logistic regression. Odds ratios (ORs) and 95% confidence intervals (95% CI) were reported as the measure of association.

Results

In total, 12,390 3-year-olds, 13,978 4-year-olds and 13,992 subjects aged 5 years respectively, were recruited for the study. Each child was clinically examined and their parents or grandparents were invited to complete questionnaires.

The prevalence of dental caries was 50.8%, 63.6% and 71.9% for 3-, 4- and 5-year-olds, respectively. The mean dmft (SD) was 2.28 (3.41), 3.40 (4.15) and 4.24 (4.48), respectively. The Significant Caries Index (SiC) (SD) was 6.04 (3.57), 8.24 (3.65) and 9.61(3.40), respectively. The constituent ratio of ft was 1.5%, 2.9% and 4.1%, respectively. Table 1 presents the prevalence of dental caries, the mean dmft and the SiC according to gender, age and area. All of these indices showed an increasing trend with age. And all of these values were higher in rural areas than in urban areas. No difference was found for gender in all of the three age groups.

A positively skewed distribution of the dmft score was revealed, with skewness values of 2.0, 1.4 and

Table 1 The caries status of 3- to 5-year-old children of China (2015–2016).

Variables	N	Prevalence of dental caries	dt (SD)	mt (SD)	ft (SD)	Mean dmft (SD)	SiC(SD)
3 years							
Total	12,390	50.8%	2.25 (3.38)	0.00 (0.07)	0.03 (0.36)	2.28 (3.41)	6.04 (3.57)
Area							
Urban	6,366	48.9%	2.08 (3.26)	0.00 (0.06)	0.05 (0.45)	2.13 (3.32)	5.71 (3.60)
Rural	6,024	52.8%	2.42 (3.48)	0.00 (0.07)	0.02 (0.24)	2.44 (3.50)	6.38 (3.51)
Gender							
Male	6,186	50.9%	2.27 (3.38)	0.00 (0.08)	0.03 (0.35)	2.30 (3.41)	6.07 (3.55)
Female	6,204	50.6%	2.23 (3.37)	0.00 (0.04)	0.04 (0.37)	2.27 (3.42)	6.01 (3.60)
4 years							
Total	13,978	63.6%	3.29 (4.07)	0.01 (0.10)	0.10 (0.63)	3.40 (4.15)	8.24 (3.65)
Area							
Urban	7,031	61.7%	2.99 (3.81)	0.01 (0.11)	0.15 (0.77)	3.14 (3.94)	7.72 (3.55)
Rural	6,947	65.6%	3.60 (4.29)	0.01 (0.08)	0.05 (0.43)	3.66 (4.33)	8.77 (3.68)
Gender							
Male	7,028	63.7%	3.37 (4.11)	0.01 (0.10)	0.10 (0.65)	3.47 (4.19)	8.40 (3.60)
Female	6,950	63.6%	3.22 (4.03)	0.01 (0.10)	0.10 (0.61)	3.32 (4.10)	8.08 (3.70)
5 years							
Total	13,992	71.9%	4.06 (4.39)	0.01 (0.16)	0.17 (0.79)	4.24 (4.48)	9.61 (3.40)
Area							
Urban	7,091	70.4%	3.78 (4.22)	0.01 (0.16)	0.23 (0.93)	4.03 (4.35)	9.23 (3.37)
Rural	6,901	73.4%	4.34(4.54)	0.01(0.16)	0.11(0.61)	4.47(4.60)	9.98(3.42)
Gender							
Male	7,031	72.2%	4.09(4.41)	0.01(0.15)	0.18(0.79)	4.27(4.49)	9.64(3.42)
Female	6,961	71.6%	4.03(4.37)	0.01(0.17)	0.17(0.78)	4.21(4.47)	9.57(3.40)

1.1 among 3-, 4- and 5-year-olds, respectively (Fig 2). Maxillary central incisors had the highest prevalence of dental caries, while mandibular incisors had the lowest. Among anterior teeth, the prevalence of dental caries in maxillary teeth was higher than that in mandibular teeth. In posterior teeth, the condition was opposite (Fig 3).

Tables 2 and 3 present the comparison of the prevalence of dental caries and mean dmft for selected variables respectively. Exclusively or predominantly breastfed, having dessert before sleep, having dessert more than twice a day, lower parental dental knowledge or attitude score, a lower parental level of education,

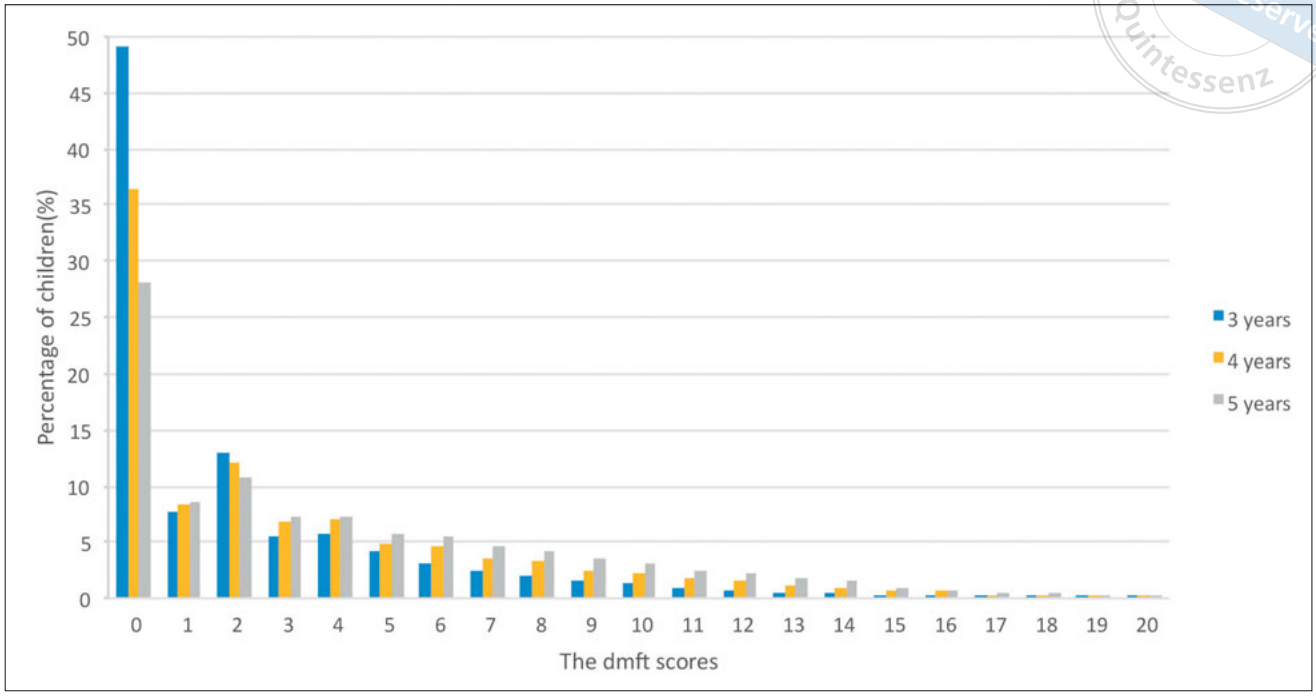

Fig 2 The frequency distribution of the dmft of the 3-, 4- and 5-year-old children.

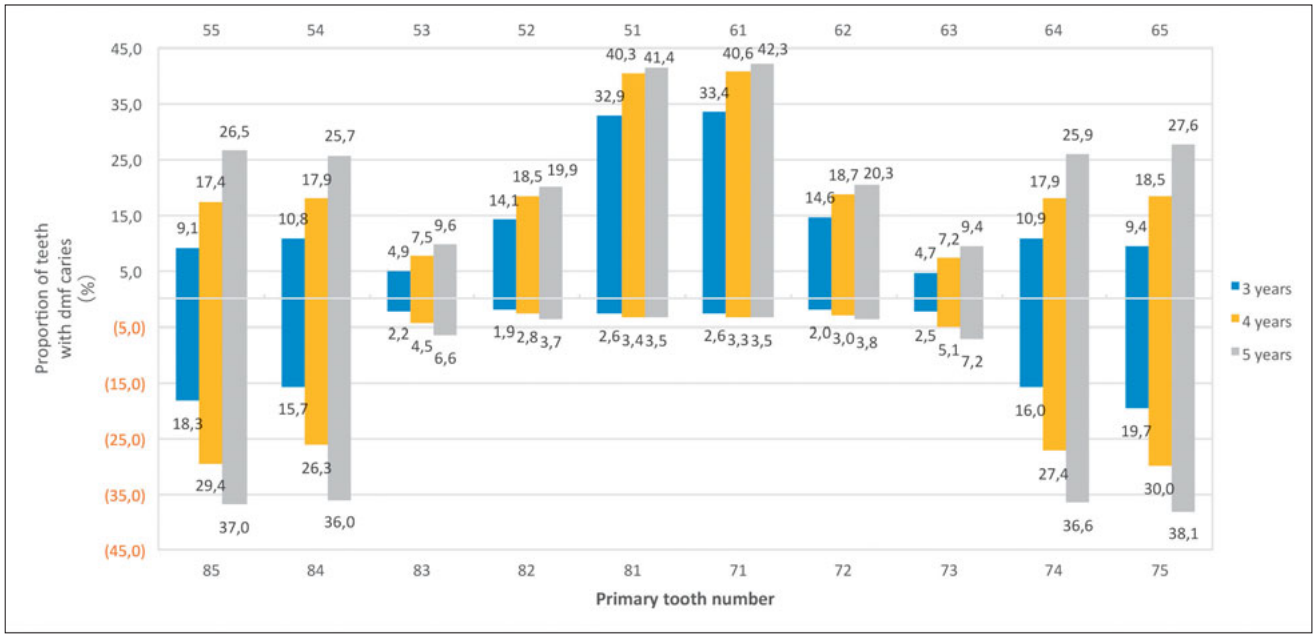

Fig 3 Distribution of teeth with dmf caries of the 3-, 4- and 5-year-old children by tooth position.

lower household income and starting toothbrushing at a later age were all associated with caries in the primary dentition in all three age groups. Three-year-old children with a normal birth weight had a higher prevalence of caries than those who did not, while no difference was found among children aged 4 and 5. Additionally, guardians' knowledge and attitude was described in detail and we found those living in urban areas had a higher awareness rate in terms of knowledge and attitude than those guardians from rural area (Figs 4 and 5).

Table 2 Chi-square test for relationship of the prevalence of dental caries and selected variables.

Categories	3 years		4 years		5 years	
	Prevalence	*P* value	Prevalence	*P* value	Prevalence	*P* value
Area		0.000		0.000		0.000
Urban	48.9%		61.7%		70.4%	
Rural	52.8%		65.6%		73.4%	
Birth weight		0.029		0.670		0.235
Low (< 2500 g)	43.9%		64.5%		68.6%	
Normal (≥ 2500 g)	50.8%		63.4%		71.6%	
Breastfeeding		0.000		0.000		0.000
Exclusively breastfed	54.6%		66.6%		74.8%	
Predominantly breastfed	53.9%		67.0%		73.2%	
Mixed fed (50/50)	39.7%		56.1%		65.4%	
Predominantly formula fed	47.2%		57.5%		67.0%	
Exclusively formula fed	47.4%		60.5%		69.3%	
Sugar intake frequency		0.000		0.000		0.000
Less often then daily	48.9%		62.1%		70.1%	
Once a day	50.7%		63.7%		71.4%	
Twice a day or more	54.3%		66.8%		77.2%	
Dessert before sleep		0.000		0.000		0.000
Often	58.0%		69.7%		78.1%	
Sometimes	53.7%		66.2%		74.7%	
Never	44.8%		58.4%		66.5%	
Toothbrushing		0.797		0.006		0.000
Yes	50.7%		62.9%		70.8%	
No	50.9%		65.3%		74.8%	
Age when toothbrushing started		0.044		0.000		0.000
Before or within first year	46.9%		55.4%		64.7%	
After the first year	50.7%		64.0%		72.1%	
Parental dental knowledge		0.000		0.000		0.007
Score 0–2	53.7%		66.9%		73.2%	
Score 3–5	52.5%		65.1%		72.8%	
Score 6–8	48.6%		61.3%		70.5%	
Parental dental attitude		0.022		0.000		0.016
Score 0–2	53.6%		66.8%		76.2%	
Score 3–4	52.4%		66.3%		71.9%	
Score 5–6	50.0%		62.3%		71.5%	

Categories	3 years		4 years		5 years	
	Prevalence	*P* value	Prevalence	*P* value	Prevalence	*P* value
Parental education level		0.000		0.000		0.000
Up to primary school	54.6%		65.2%		73.8%	
Junior middle school	53.5%		66.9%		74.1%	
Senior middle school	50.6%		63.4%		72.4%	
Higher education	47.3%		59.7%		67.9%	
Household income		0.018		0.000		0.008
Very low (< 6000 Yuan)	53.5%		67.2%		72.6%	
Low (6000-12000 Yuan)	51.2%		66.3%		72.8%	
Medium (12000-18000 Yuan)	51.0%		63.1%		70.4%	
High (18000-27000 Yuan)	50.4%		60.8%		68.4%	
Very high (≥ 27000 Yuan)	47.3%		59.1%		68.9%	

Table 3 ANOVA for relationship of mean dmft and selected variables.

	3 years		4 years		5 years	
	Mean dmft	*P* value	Mean dmft	*P* value	Mean dmft	*P* value
Area		0.000		0.000		0.000
Urban	2.13		3.14		4.03	
Rural	2.44		3.66		4.47	
Birth weight		0.346		0.298		0.521
Low (< 2500 g)	2.08		3.15		4.05	
Normal (≥ 2500 g)	2.28		3.39		4.21	
Breastfeeding		0.000		0.000		0.000
Exclusively breastfed	2.53		3.72		4.60	
Predominantly breastfed	2.47		3.53		4.35	
Mixed fed (50/50)	1.64		2.69		3.44	
Predominantly formula fed	1.98		2.89		3.67	
Exclusively formula fed	2.07		3.20		4.02	
Sugar intake frequency		0.000		0.000		0.000
Less often then daily	2.12		3.20		3.97	
Once a day	2.31		3.30		4.24	
Twice a day or more	2.57		3.92		4.98	
Dessert before sleep		0.000		0.000		0.000
Often	2.94		4.43		5.00	
Sometimes	2.49		3.61		4.56	
Never	1.83		2.84		3.63	

	3 years		4 years		5 years	
	Mean dmft	*P* value	Mean dmft	*P* value	Mean dmft	*P* value
Toothbrushing		0.648		0.000		0.000
Yes	2.27		3.28		4.12	
No	2.30		3.65		4.61	
Age when toothbrushing started		0.017		0.000		0.000
Before or within first year	1.97		2.63		3.40	
After the first year	2.27		3.43		4.27	
Oral health knowledge		0.000		0.000		0.000
Score 0–2	2.46		3.79		4.61	
Score 3–5	2.39		3.50		4.30	
Score 6–8	2.15		3.19		4.08	
Oral health attitude		0.226		0.001		0.007
Score 0–2	2.44		3.80		4.70	
Score 3–4	2.35		3.52		4.28	
Score 5–6	2.25		3.32		4.19	
Parental education level		0.000		0.000		0.000
Up to primary school	2.64		3.66		4.48	
Junior middle school	2.45		3.67		4.57	
Senior middle school	2.22		3.39		4.30	
Higher education	2.05		2.98		3.72	
Household income		0.000		0.000		0.001
Very low (< 6000 Yuan)	2.52		3.67		4.17	
Low (6000-12000 Yuan)	2.25		3.60		4.43	
Medium (12000-18000 Yuan)	2.46		3.23		4.00	
High (18000-27000 Yuan)	2.13		3.23		3.92	
Very high (≥ 27000 Yuan)	1.94		2.96		3.90	

Logistic regression analysis was used to assess variables contributing to dental caries in children. Table 4 illustrates the relationships among selected variables in the regression model. In all three age groups, children who were mixed-fed had a higher chance of remaining caries-free. Children who had dessert before sleep were associated with a higher probability of caries. Also, for children aged 4 and 5 years, those who began brushing their teeth later in life and ate more sugar more frequently had a higher probability of caries.

Discussion

The results of this study showed remarkable increasing trends of prevalence in both urban and rural areas among all three age groups.

Compared with the statistics obtained from the third national survey, the prevalence of caries had increased from 66.0% to 71.9% and the mean dmft changed from 2.71 to 4.23 in 5-year-old children[7], which was far from the goal of a no-caries rate of 50% in individuals aged 5 years established for the year 2020 by the WHO[10].

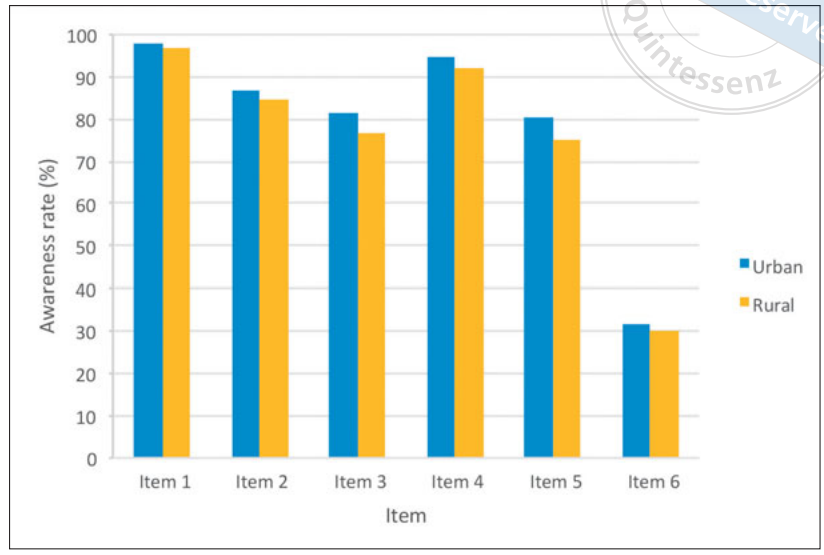

Fig 4 Oral health attitude: Item 1: Oral health is important; Item 2: Regular oral health examination is necessary; Item 3: The health of the teeth is not decided at birth and the efforts of yourself work as well; Item 4: Oral disease prevention mainly depends on yourself; Item 5: It is important to protect your children's first permanent molar; Item 6: The condition of maternal teeth will affect their children.

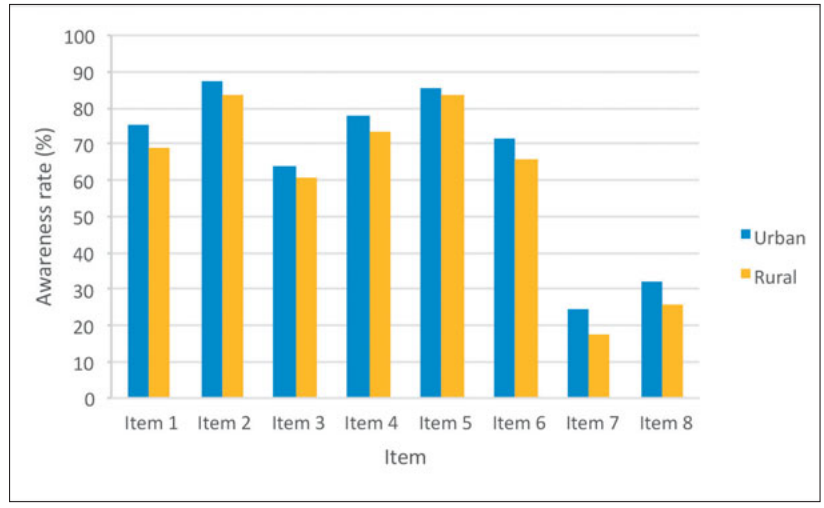

Fig 5 Oral health knowledge: Item 1: Gingival bleeding is abnormal when toothbrushing; Item 2: Bacteria can cause gingival inflammation; Item 3: Toothbrushing can prevent gingival bleeding; Item 4: Bacteria can cause dental caries; Item 5: Sugar intake can lead to dental caries; Item 6: Deciduous dental caries cannot be left alone; Item 7: Pit and fissure sealing can prevent children from dental caries; Item 8: Fluoride can protect teeth.

In Indonesia, a country whose per capita GDP is much lower than China, the prevalence of dental caries among 5-year-olds (90%) was much higher than that we found in China[11]. Compared with Thailand, a country similar to China in terms of per capita GDP, we found the two countries had similar prevalence (78.5%) and mean dmft (4.4)[12]. Compared with caries status found in many industrialised countries, the caries status in China was more severe. Among 5-year-olds, the prevalence in Japan[13] and Singapore[14] were only 39% and 49%, respectively. The caries level of 3- and 4-year-olds also increased compared with the caries status obtained in the previous study – from 41.4% to 50.8% and from 53.4% to 63.6%, respectively[8]. The prevalence reported in Japan was only 8.6% among 3-year-olds[13]. This difference between the two populations alarmed us that the prevalence of dental caries in China was severe even at a low age and it is therefore necessary to prevent children from dental caries at an earlier age in China.

There are many possible explanations for this increasing trend. Despite all the efforts to control the prevalence of dental caries, there was a marked increase

Table 4 Logistic regression analysis.

			95% C.I.	
	P value	Exp (B)	Lower	Upper
3 years				
Urban vs rural	0.277	1.054	0.959	1.159
Low birth weight vs normal birth weight	0.219	1.140	0.925	1.405
Breastfeeding				
Exclusively breastfed	0.000	Reference group		
Predominantly breastfed	0.305	0.936	0.826	1.062
Mixed fed (50/50)	0.000	0.481	0.413	0.559
Predominantly formula fed	0.001	0.745	0.625	0.887
Exclusively formula fed	0.000	0.705	0.616	0.806
Sugar intake frequency	0.309	1.021	0.981	1.064
Dessert before sleep	0.000	1.359	1.259	1.468
Toothbrushing vs not	0.043	0.903	0.819	0.997
Before or within first year vs later	0.471	1.079	0.878	1.326
Parental dental attitude	0.884	1.004	0.956	1.054
Parental dental knowledge	0.225	0.981	0.951	1.012
Parental education level	0.006	0.928	0.880	0.978
Household income				
Very low (< 6000 Yuan)	0.546	Reference group		
Low (6000-12000 Yuan)	0.264	0.916	0.786	1.068
Medium (12000-18000 Yuan)	0.404	0.937	0.803	1.092
High (18000-27000 Yuan)	0.843	0.984	0.839	1.154
Very high (≥ 27000 Yuan)	0.179	0.891	0.754	1.054
4 years				
Urban vs rural	0.178	1.066	0.971	1.171
Low birth weight vs normal birth weight	0.521	1.070	0.870	1.315
Breastfeeding				
Exclusively breastfed	0.000	Reference group		
Predominantly breastfed	0.334	0.941	0.831	1.065
Mixed fed (50/50)	0.000	0.671	0.581	0.774
Predominantly formula fed	0.000	0.626	0.530	0.740
Exclusively formula fed	0.000	0.769	0.672	0.879
Sugar intake frequency	0.001	1.070	1.027	1.116
Dessert before sleep	0.000	1.349	1.250	1.456
Toothbrushing vs not	0.931	1.004	0.908	1.111

			95% C.I.	
	P value	Exp (B)	Lower	Upper
Before or within first year vs later	0.010	1.318	1.068	1.627
Parental dental attitude	0.826	0.995	0.948	1.043
Parental dental knowledge	0.016	0.964	0.935	0.993
Parental education level	0.973	1.001	0.950	1.055
Household income				
Very low (< 6000 Yuan)	0.010	Reference group		
Low (6000-12000 Yuan)	0.507	0.952	0.822	1.101
Medium (12000-18000 Yuan)	0.092	0.877	0.753	1.022
High (18000-27000 Yuan)	0.004	0.795	0.680	0.930
Very high (≥ 27000 Yuan)	0.003	0.778	0.659	0.918
5 years				
Urban vs rural	0.598	1.027	0.931	1.133
Low birth weight vs normal birth weight	0.887	0.985	0.799	1.214
Breastfeeding				
Exclusively breastfed	0.000	Reference group		
Predominantly breastfed	0.113	0.900	0.791	1.025
Mixed fed (50/50)	0.000	0.670	0.578	0.777
Predominantly formula fed	0.018	0.797	0.661	0.963
Exclusively formula fed	0.000	0.771	0.670	0.886
Sugar intake frequency	0.000	1.159	1.106	1.216
Dessert before sleep	0.000	1.330	1.224	1.444
Toothbrushing vs not	0.348	1.055	0.943	1.181
Before or within first year vs later	0.001	1.469	1.165	1.852
Parental dental attitude	0.394	1.022	0.972	1.073
Parental dental knowledge	0.561	1.009	0.978	1.041
Parental education level	0.141	0.959	0.908	1.014
Household income				
Very low (< 6000 Yuan)	0.226	Reference group		
Low (6000-12000 Yuan)	0.960	1.004	0.862	1.169
Medium (12000-18000 Yuan)	0.268	0.915	0.782	1.071
High (18000-27000 Yuan)	0.057	0.854	0.726	1.005
Very high (≥ 27000 Yuan)	0.197	0.891	0.748	1.062

in economic development over the period of time reviewed in the survey[15]. The rise of the per capita GDP had increased significantly since 2005, compared with the period from 1995 to 2005. It resulted in a higher sugar intake, while access to oral healthcare was still absent[16]. This might be responsible for this trend[17].

What is more, the significant difference of the status of caries between urban and rural areas was still alarming. There were many possible explanations for the higher level of dental caries and lower level of teeth being filled in rural areas. The higher awareness rate in all items of guardians' knowledge and attitude in urban rather than rural areas may explain the difference. Another possible explanation was the lack of access to dental care in some rural areas[16].

Regarding guardians' dental knowledge and attitude, the proportion of people who knew that pit and fissure sealing can prevent children from dental caries and that fluoride can protect teeth was extremely low (Figs 4 and 5). Consequently, policy makers should pay more attention to the propaganda and the use of pit and fissure sealing and fluoride in its various forms.

What interested us was that the children in this study who were exclusively or predominantly breastfed in the first six months of life had a higher prevalence of dental caries, although this behaviour was recommended by the WHO[18]. Similar results were found in the previous national study conducted in 2005[19]. Furthermore, a longitudinal study in 2015 about the association of caries and breastfeeding among the Japanese population, found that 30-month-old infants who were exclusively or predominantly breastfed for the first six months of life had a higher risk of suffering dental caries compared with those who were not, and this association decreased with age[20]. While the relationship between breastfeeding and general health is sure, it is not clear what specific conditions associated with breastfeeding contribute to dental caries[21]. This means the information about breastfeeding delivered to parents should be accurate. Consequently, it is necessary to give appropriate guidance on breastfeeding considering the social context of China.

Low birth weight is not a risk factor among 3- to 5-year-olds. It has been reported that low birth weight may affect the tooth formation in utero, which will result in enamel hypoplasia[22]. It may increase the risk of early childhood caries[23]. However, this study could not find an association between low birth weight and the prevalence of dental caries, a result consistent with the previous study in China[19].

In conclusion, dental caries status among preschool children in China showed an increased trend compared with the last national survey. The preschoolers' dental caries status related to their breastfeeding conditions within the first half year of life and their snacking habits. It is important to identify the factors leading to the observed trends and corresponding action should be taken to prevent dental caries.

Conflicts of interest

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

Author contribution

Drs Min Quan DU, Han JIANG and Bao Jun TAI, designed the study, acquired the data and revised the manuscript; Dr Zhen LI analysed the data and prepared the manuscript; Drs Xing WANG, Xi Ping FENG, Bao Jun TAI, De Yu HU, Huan Cai LIN, Bo WANG, Shu Guo ZHENG, Xue Nan LIU, Wen Sheng RONG and Wei Jian WANG trained the investigators, designed and supervised the survey. All the authors have read and approved the final manuscript.

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