Periodontal Status of Chinese Adolescents: Findings from the 4th National Oral Health Survey

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Objective: *To investigate the periodontal health status and associated factors of adolescents aged 12 to 15 years old in China.*

Methods: *A cross-sectional national oral health survey was conducted in 2015-2016. The multi-stage stratified cluster sampling was used to select participants in all 31 provinces, autonomous regions and municipalities in mainland China. Each participant received a clinical assessment including periodontal bleeding and calculus, and 15-year-old adolescents received additional examinations including for periodontal pocket depth and attachment loss, using the latest criteria from the Oral Health Survey Basic Methods, as recommended by the World Health Organization (WHO). A self-answered structured questionnaire was designed to collect the data of background information and associated risk factors.*

Results: *A total of 118,514 adolescents (14.0 ± 1.09 years old) completed all the oral examinations and the questionnaire. The prevalence of periodontal bleeding and calculus was 61.0% and 67.3% respectively. In the group of 15 year olds, 6.5% adolescents had periodontal pocket and 0.5% had attachment loss. Molars were often involved and, furthermore, calculus also occurred on lower incisors. The periodontal status of adolescents became worse as they grew up. The condition of girls was significantly better than boys.*

Conclusion: *This survey illustrated a brief picture of periodontal status of adolescents in China showing that gingival bleeding and calculus were very common and frequent. Further actions on oral health education were necessary, especially for those in lower socio-economic classes.*

Key words: *adolescent, calculus, gingival bleeding, periodontal, the 4th National Oral Health Survey*

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Periodontal disease is one of the most prevalent oral health problems worldwide[1], and is related not only to poor oral hygiene, but also to several systematic chronic diseases, such as diabetes mellitus. In the recent Global Burden of Disease Study, severe periodontitis was listed as the 6th most prevalent disease in the world, affecting about 743 million people, with an overall prevalence of 11.2%. In the past two decades, the global burden of periodontal disease has grown rapidly by 57.3%[1-3].

An accumulation of dental biofilm is the main cause of periodontal disease, and a balance between virulence of biofilm bacteria and immune response of host determines the severity of periodontal disease.

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Periodontal disease is a chronic inflammatory process of periodontal tissue that roughly divides into gingivitis and periodontitis. Gingivitis is a common oral disease in individuals of all age groups, including children and adolescents[4,5]. Despite relating to poor oral hygiene, age, smoking habits and other risk factors are also related to periodontal disease[3,6-8].

The national oral health survey is the most important epidemiological population-based oral health survey in China, and has been repeated every 10 years since 1985[9,10]. This cross-sectional survey covers all provinces, municipalities and autonomous regions in mainland China, reporting on oral health information. The latest national oral health survey was held in 2005, while it was found that gingival bleeding and calculus occurred in more than half of 12-year-old children in China (57.7% and 59.1%). There were significantly differences among individuals in different regions and areas[10].

In the past three national oral health surveys, 12-year-old children were selected as the representative group for adolescents in order to assess periodontal status and dental caries status.

According to the newest methods and criteria recommended by the WHO, 15 years old is a standard age group to evaluate the periodontal status of adolescents[11]. Therefore, a 15-year-olds group was added into the 2015 survey to obtain relevant information. Moreover, the gingival bleeding and calculus status of 12- to 15-year-old children were also included at this time.

The objectives of this survey were:

- To investigate the periodontal status and associated factors of 12- to 15-year-old children and surveillance of the trend of periodontal diseases;
- To investigate the oral health attitude, knowledge and behaviour and utilisation of oral health service, to assess the nation's oral health needs;
- To provide information and evidence to form a public oral health policy.

Materials and methods

To investigate the periodontal status of 12- to 15-year-old adolescents in China, the 4th National Oral Health Survey was conducted in 2015-2016. This study was approved by the Stomatological Ethics Committee of Chinese Stomatological Association (Approval no. 2014-003)

Study design

The sampling design was based on the data of the 2010 population census published by the National Bureau of Statistics of the People's Republic of China. A multi-stage cluster sampling was used to select participants in 31 provinces, autonomous regions and municipalities in mainland China. The probability-proportional-to-size (PPS) with a varied population-sized method was used to choose several cities and countries. Three middle schools in each area were then also randomly selected using the same method. Finally, the quota sampling method was applied to choose participants to be examined.

Clinical examination

Each participant received a clinical assessment with examination criteria that followed the latest WHO recommendations (2013). This periodontal examination included periodontal bleeding, calculus, periodontal pocket depth and attachment loss, with the latter two applied only for the 15-year-olds. Three trained registered dental practitioners conducted examinations in each province, municipality, and autonomous region with three trained assistants as recorders. One on-site coordinator was respondent for quality control.

Questionnaire survey

A self-answered structured questionnaire was designed to collect the data relating to subjects' demographic information, oral health attitude, knowledge and behaviour and smoking habits. Teachers and researchers co-organised and illustrated the content of the questionnaire before students completed all questions independently in the classroom. Every student's questionnaire was fully inspected before he/she left the survey room to avoid mistakes being made and missing data.

Quality control

Before the fieldwork, all examiners received theoretical and clinical examination training by the standard examiner group. Examiners with kappa values higher than 0.6 qualified. In this study, 5% of subjects were randomly selected for duplication to compare the results of two examiners. The inter-examiner reliability of periodontal pocket depth was more than 0.6. All clinical items except full-mouth gingival bleeding were reviewed. Furthermore, the members of the standard examiner group randomly reviewed 10 subjects from each examiner and

Table 1 Demographic characteristics of 12- to 15-year-old Chinese adolescents.

			Male		Female		
	Total	%	N	%	N	%	*P* value
Total	11,8514	100	59,218	50.0	59,296	50.0	0.765
Age group							0.765
12	27,813	23.5	13,835	49.7	13,978	50.3	
13	30,923	26.1	15,497	50.1	15,426	49.9	
14	30,688	25.9	15,376	50.1	15,312	49.9	
15	29,090	24.5	14,510	49.9	14,580	50.1	
Area							0.883
Urban	60,255	50.8	30,095	49.9	30,160	50.1	
Rural	58,259	49.2	29,123	50.0	29,136	50.0	
Region							0.763
East	41,860	35.3	20,871	49.9	20,989	50.1	
Middle	30,476	39.0	15,279	50.1	23,110	49.9	
West	46,178	25.7	23,068	50.0	15,197	50	
Only child							< 0.001
Yes	43,476	36.7	24,655	56.7	18,821	43.3	
No	75,029	63.3	34,561	46.1	40,468	53.9	

the kappa values of periodontal depths for each examiner were more than 0.6. The same type of equipment was used at each location – including a mobile dental chair, light and CPI probe – to ensure the consistency of external conditions.

Results

In total, 118,514 adolescents (14.0 ± 1.09 years old) completed the oral examination and questionnaire. The demographic characteristics of the study population are presented in Table 1. The distribution of male and female subjects was balanced in most groups; however, there were more boys in the families with only one child and more girls in the families of ethnic minority.

Figures 1 and 2 describe the periodontal health conditions according to different teeth. The histogram shows the prevalence of gingival bleeding and calculus in all age groups in Figure 1, and the line chart displays the teeth numbers with a periodontal pocket depth of over 3 mm, and with attachment loss in the 15-year-old group in Figure 2. Unsurprisingly, most of the calculus was found in the first molars and mandibular incisors, especially in the mandibular central incisors, and nearly half of the teeth were involved. Gingival bleeding was mostly found in all four first molars and the difference between maxillary and mandibular molars was not great. Periodontal pockets and attachment loss were concentrated in the mandibular second molar and maxillary first molar.

The periodontal status of Chinese adolescents is shown in Table 2. Gingival bleeding and calculus were used to evaluate the periodontal status of adolescents. In total, the prevalence of gingival bleeding and calculus was 61.0% and 67.3% respectively, and the mean teeth numbers found with gingival bleeding and cal-

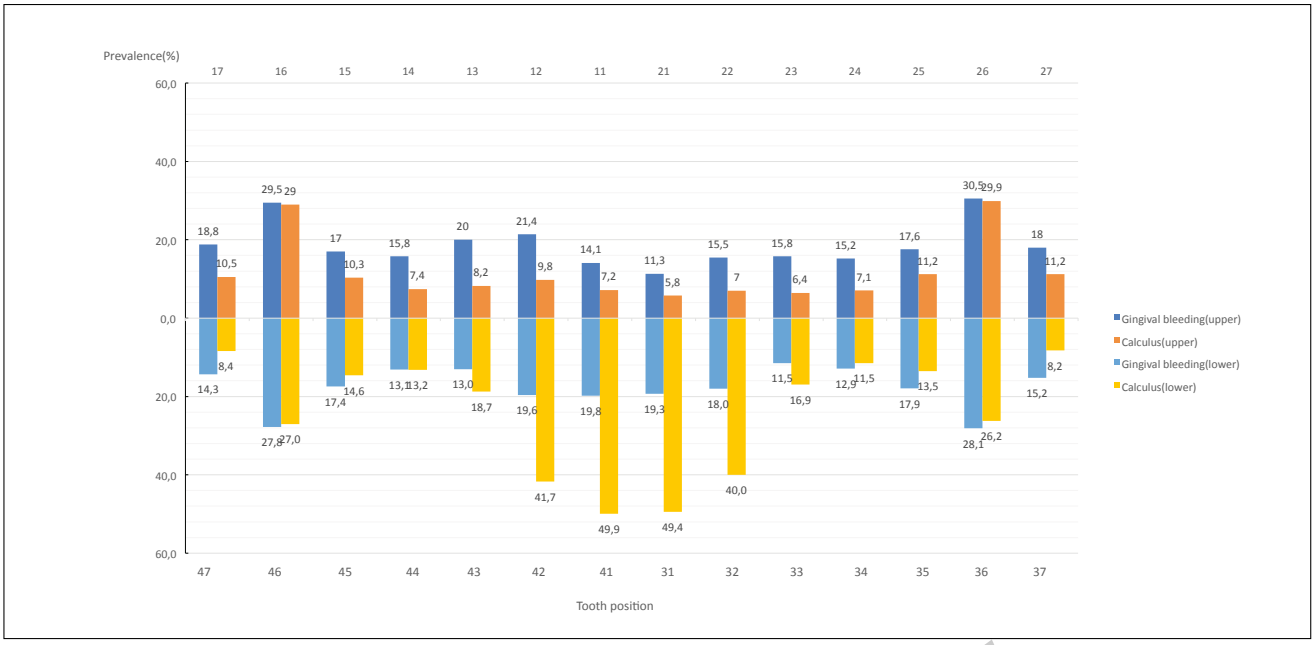

Fig 1 Periodontal status among Chinese adolescents, presented by teeth position.

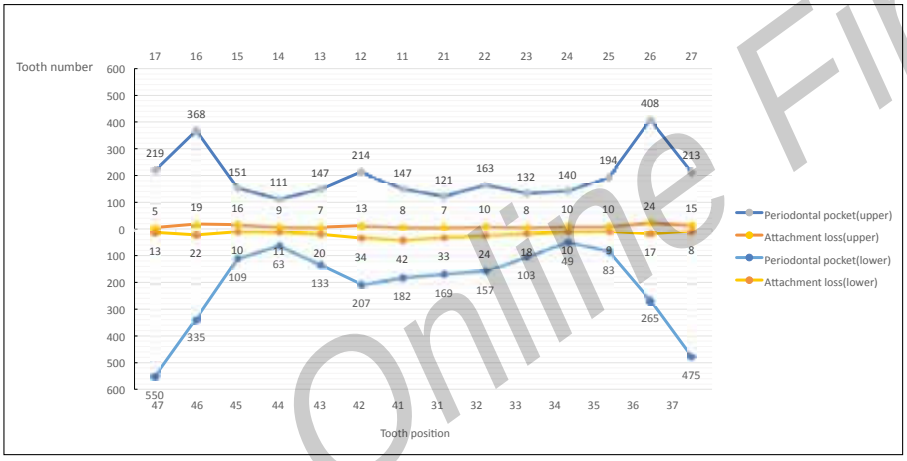

Fig 2 The teeth numbers with periodontal pocket (depth over 3 mm) and attachment loss among Chinese adolescents, presented by teeth position.

culus were 4.94 and 4.90 respectively. In total, 29,090 15-year-olds were also examined for periodontal pocket and attachment loss. The prevalence and mean teeth number of periodontal pocket were 6.5% and 0.19, while for attachment loss it was 0.5% and 0.01.

With a rise in age the periodontal status of subjects worsened, with girls performing better than boys in every age group ($P < 0.001$). The prevalence of gingival bleeding among adolescents aged 12, 13, 14 and 15 years significantly increased from 58.4%, to 60.1%, to 60.8% and 64.7% by the age of 15. The corresponding mean teeth numbers were 4.31, 4.66, 5.01 and 5.78 ($P < 0.001$). This increasing trend was more obvious in the calculus rate of different age groups presented by gender (Figs 3 and 4). The proportion of girls with calculus in the 12- to 15- year-old group increased from 58.5%, to 61.7%, to 66.7% to 71.9%, while for boys rose from 64.1%, to 67.8%, to 72.0%, up to 75.3% as the age increased.

Adolescents living in urban areas had a significantly higher prevalence of gingival bleeding and calculus compared with those living in rural areas ($P < 0.001$). Compared with adolescents who were an only child in their families, the periodontal status of those children who were from families with more than one child was worse. Parents' education levels were also associated

Table 2 Periodontal status of 12- to 15-year-old Chinese adolescents

	N	Gingival bleeding		Calculus		Periodontal pocket		Attachment loss	
		%	Teeth number (mean ± SD)	%	Teeth number (mean ± SD)	%	Teeth number (mean ± SD)	‰	Teeth number (mean ± SD)
Total	11,8514	61.0	4.94 ± 6.50	67.3	4.90 ± 5.82				
Age									
12	27,813	58.4**	4.31 ± 5.92**	61.3**	3.79 ± 4.88				
13	30,923	60.1	4.66 ± 6.25	64.7	4.31 ± 5.29				
14	30,688	60.8	5.01 ± 6.60	69.4	5.21 ± 5.98				
15	29,090	64.7	5.78 ± 7.10	73.6	6.27 ± 6.64	6.5	0.19 ± 1.06	5.0	0.01 ± 0.08
Gender									
Male	59,218	62.4**	5.13 ± 6.64**	69.9**	5.22 ± 5.95**	6.7	0.2 ± 1.07	5.2	0.01 ± 0.22
Female	59,296	59.7	4.75 ± 6.36	64.8	4.58 ± 5.66	6.4	0.19 ± 1.05	4.9	0.02 ± 0.45
Area									
Urban	60,255	61.7**	5.03 ± 6.52**	66.9*	4.91 ± 5.92	6.4	0.19 ± 1.04	4.8	0.01 ± 0.29
Rural	58,259	60.3	4.85 ± 6.48	67.8	4.89 ± 5.71	6.7	0.20 ± 1.08	5.3	0.02 ± 0.42
Only child									
Yes	43,476	56.5**	4.44 ± 6.26**	61.8**	4.38 ± 5.72**	5.6**	0.18 ± 1.05*	4.1	0.01 ± 0.35
No	75,029	63.6	5.23 ± 6.62	70.5	5.21 ± 5.85	7.1	0.20 ± 1.06	5.7	0.02 ± 0.36
Father's education level									
Middle school or below	21,904	65.2**	5.38 ± 6.66**	73.7**	5.70 ± 6.05**	7.6**	6.33 ± 7.23**	9.5**	7.08 ± 6.70**
High school	65,506	61.7	5.05 ± 6.56	67.8	4.93 ± 5.78	6.7	5.86 ± 7.12	4.0	6.24 ± 6.57
University or above	16,639	55.5	4.31 ± 6.18	60.1	4.11 ± 5.59	4.7	5.08 ± 7.12	3.4	5.42 ± 6.65
Mother's education level									
Middle school or below	31,965	65.1**	5.38 ± 6.65**	73.4**	5.66 ± 6.01**	8.1**	6.28 ± 7.24**	8.4**	6.96 ± 6.67**
High school	56,193	60.9	4.99 ± 6.55	66.8	4.80 ± 5.74	6.0	5.77 ± 7.02	3.8	6.15 ± 6.55
University or above	15,781	55.4	4.27 ± 6.14	59.2	4.04 ± 5.56	4.2	4.88 ± 6.77	2.4	5.20 ± 6.58
Toothbrushing									
Yes	107,941	60.1**	4.80 ± 6.40**	66.4**	4.77 ± 5.74**	6.4**	5.62 ± 6.98**	0.5*	6.14 ± 6.56**
No	10,566	70.3	6.43 ± 7.36	76.6	6.23 ± 6.42	8.7	8.21 ± 8.31	0.9	8.29 ± 7.54
Dental floss									
Yes	11,485	56.4**	4.45 ± 6.26**	58.9**	3.91 ± 5.40**	4.3**	5.29 ± 6.94**	0.5	5.08 ± 6.43**
No	107,006	61.5	4.99 ± 6.53	68.2	5.01 ± 5.85	6.7	5.83 ± 7.11	0.5	6.39 ± 6.65

	N	Gingival bleeding		Calculus		Periodontal pocket		Attachment loss	
		%	Teeth number (mean ± SD)	%	Teeth number (mean ± SD)	%	Teeth number (mean ± SD)	‰	Teeth number (mean ± SD)
Smoking									
Yes	8,077	60.7**	5.28 ± 6.62**	66.7**	4.83 ± 5.79**	7.0	5.77 ± 6.95	0.7	6.88 ± 6.59**
No	11,0429	65.0	4.92 ± 6.45	76.1	5.94 ± 6.06	6.5	5.78 ± 7.11	0.5	6.21 ± 6.65

* Difference among groups: $P < 0.05$; ** difference among groups: $P < 0.001$

with adolescents' periodontal condition. Adolescents whose parents had received a higher education had better periodontal health condition than those whose parents had only been educated to middle school level or below.

Adolescents with better oral health behaviour (brushing teeth and using dental floss every day) had a lower prevalence of gingival bleeding and calculus, and less periodontal pocket and attachment loss for the 15-year-old group.

The oral health knowledge score of adolescents without gingival bleeding and calculus was higher than those with gingival bleeding and calculus ($P < 0.001$). And the adolescents whose periodontal status was better had a better positive attitude on oral health ($P < 0.001$).

Data in the questionnaire relating to oral health behaviour and parental education levels is presented in Table 3. It was found that more girls brushed their teeth every day, however more boys used dental floss.

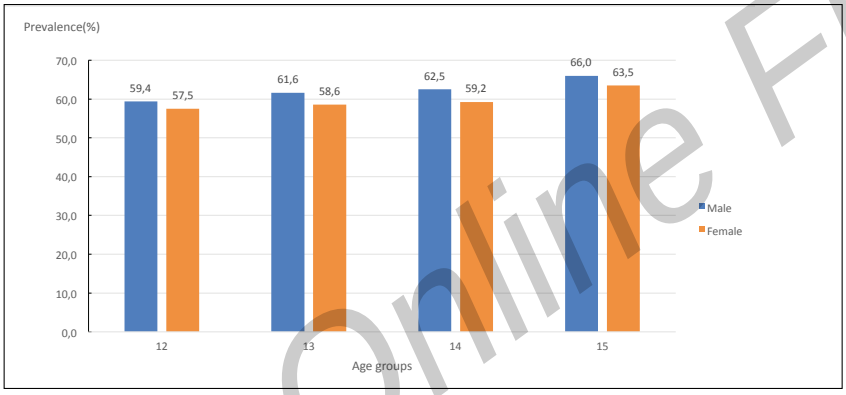

Fig 3 Prevalence of gingival bleeding among Chinese adolescents by gender and age. Difference among 12-to 15-year-old groups in all four groups: $P < 0.001$.

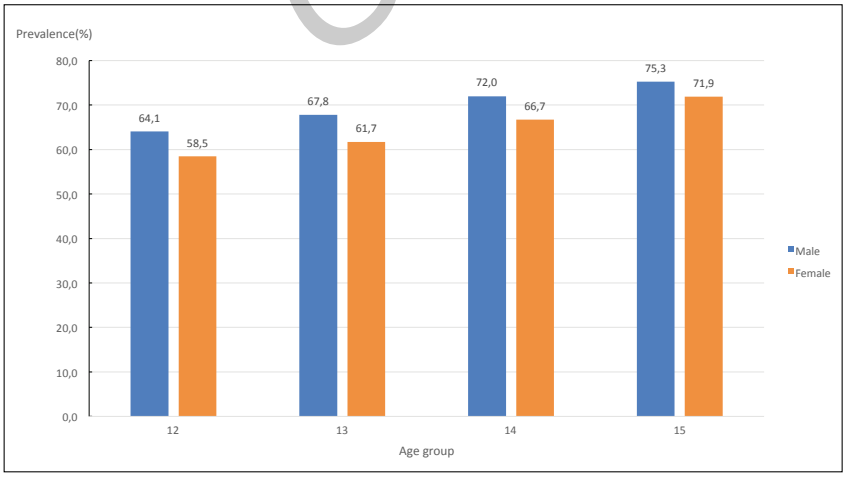

Fig 4 Prevalence of calculus among Chinese adolescents, by gender and age. Difference among 12- to 15-year-olds in all four groups: $P < 0.001$.

Table 3 The difference of oral health behaviour by age, gender and location.

	N	Brush teeth (%)		Dental floss (%)		Smoking (%)		Dental visit (%)	
		Yes	No	Yes	No	Yes	No	Yes	No
Total	118,514	91.1	8.9	9.7	90.3	6.8	93.2	49.4	50.6
Age									
12	27,813	88.1**	11.9	9.6**	90.4	4.1**	95.9	53.1**	46.9
13	30,923	90.0	10.0	10.3	89.7	5.9	94.1	51.3	48.7
14	30,688	92.1	7.9	9.7	90.3	7.9	92.1	47.7	52.3
15	29,090	94.0	6.0	9.1	90.9	9.3	90.7	45.6	54.4
Gender									
Male	59,218	86.6**	13.4	10.5**	89.5	12.1**	87.9	49.1	50.9
Female	59,296	95.6	4.4	8.9	91.1	1.5	98.5	49.7	50.3
Area									
Urban	60,255	92.0**	8.0	11.7**	88.3	5.9**	94.1	53.8**	46.2
Rural	58,259	90.1	9.9	7.6	92.4	7.8	92.2	44.9	55.1

** Difference among groups: $P < 0.001$

Adolescents in urban areas and the east region had healthier oral health behaviour and a higher proportion had well-educated parents.

Discussion

This study is part of the 4th National Oral Health Survey in China and illustrated the periodontal status of 12 to 15 years old Chinese adolescents. The prevalence of gingival bleeding and calculus in adolescents aged 12 to 15 years old was relatively high. More than 60% of adolescents did not have a satisfied periodontal condition and their periodontal health became worse when they grew up. Adolescents living in rural areas of eastern China had better periodontal health than those living in urban areas of the western region – except for the group of 15 year olds. The periodontal health condition of adolescents from higher-educated families was better than those from less-educated families.

It was found that the periodontal health of 12-year-old children was no better than the results from 10 years ago. The prevalence of gingival bleeding had increased from 59.1% to 61.3%, and calculus had risen from 57.7% to 58.3%[10]. The periodontal status of both boys and girls had became worse, especially in boys (gingival bleeding: 60.6% in 2005 vs 64.1% in 2015, calculus: 57.9% in 2005 vs 59.4% in 2015). Calculus is calcified biofilm and its association with the initiation and progression of periodontal disease has been clearly demonstrated[12]. It is regarded as an outcome of poor daily oral hygiene maintenance and also plays an important role in the development of periodontal disease. This high prevalence of gingival bleeding and calculus indicated the need for improvements in oral hygiene instruction and more routine periodontal examinations and scaling.

Compared with the result from surveys in other countries, the prevalence of gingival bleeding and calculus was considerably high. According to the latest data from the WHO Oral Health Country/Area Profile Programme (CAPP), in Japan the prevalence of gingival bleeding and calculus in subjects aged 15 to 19 years old was 30.6% and 26.5%[13], much lower than the results in this survey. An epidemiological study in Jordan found 22.9% and 31.7% of 12 year olds had periodontal bleeding and calculus[14]. In Namibia, 44.1% of adolescents aged 15 had calculus[15]. Botero et al extracted data from various studies from Latin American countries; it was found that 34.7% of children and adolescents were affected by gingivitis[5]. Although the study age groups were not exactly same, the wide difference revealed a

lack of awareness of prevention on periodontal disease for adolescents in China and more oral health instruction and motivation is quite urgent.

As a chronic oral disease, effective preventive measurement requires long-term focus on personal oral health care. A comprehensive system involved the cooperation of policy makers, oral health professionals and general populations[16]. The WHO asked for priority action for the improvement of oral health in youth through Health Promotion Schools worldwide[17].

Adolescence is a transitional and crucial stage from mixed dentition to permanent dentition, which will determine the foundation of oral health status in adulthood. Specific actions to strengthen awareness and change the behaviours of oral health should be taken into consideration as part of future public oral health education. In the latest long-term plan for chronic diseases prevention and treatment in China (2017–2035)[18], it was noted that oral health education for adolescents in schools should be enhanced.

The proportion of adolescents with gingival bleeding or calculus in older age groups was much higher than that in the younger age groups, which was in accordance with results found in other studies. In Mexican, the rate of adolescents with healthy gums fell from 83.3% in the 10 to 14 years age bracket, to 64.1% in the 15 to 19 group[5]. This trend is more obvious in adults; the prevalence and severity of periodontal disease becomes higher as subjects age[19,20]. Periodontal disease is a chronic and progressive disease, thus prevention should start from the beginning of the permanent dentition.

The periodontal status of adolescents was greatly associated with gender. This significant difference between genders was also observed in other surveys[20-22], due to girls having a higher awareness and better knowledge of oral health[23,24]. In this study, girls' better toothbrushing habits might explain the difference between genders. Although the proportion of boys using dental floss was higher than girls, the total number of subjects using dental floss was only small.

The periodontal status of adolescents living in urban areas was worse than those who living in rural areas, although those young people in urban areas had better oral health habits and their parents' level of education was higher.

Family socioeconomic status (SES) was an important factor in predicting children's periodontal conditions. Children from lower SES families had a worse gingival bleeding status[25]. In this survey, parents' educational levels in the questionnaire were collected to imply the family's SES. Adolescents whose parents had attended university were less likely to have gingival bleeding, compared with those whose parents received only a middle and high school education. In the Brazilian survey it was agreed that children whose father had less education experienced a higher level of gingival bleeding[26]. This socioeconomic disadvantage in childhood significantly related to a higher prevalence of periodontitis in adulthood[27]. Therefore, more oral health education programmes would be concentrated on those adolescents from lower SES families, to benefit them from childhood and throughout their adult lives.

Conclusions

The periodontal status of Chinese adolescents was unsatisfactory. The high prevalence of periodontal bleeding and calculus requires further action on oral health education for teenagers, especially for adolescents from lower SES families. To reduce the future periodontal burden, professionals should collaborate with schools to carry out effective oral health promotion.

Conflict of interest

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

Author contribution

Drs Xi CHEN, Wei YE, and Jing Yu ZHAN contributed to the literature review, study concept and design, data analysis, and drafted 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; Dr Xi Ping FENG contributed to study concept and design, data acquisition, organisation and supervision of study, and critically revised the manuscript. All of the authors have read and approved the final manuscript.

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