Influence of Lifestyle Factors on Risk of Dental Caries among Children Living in Urban China

Taeko Kanemoto¹, Hiroki Imai¹, Atsuo Sakurai¹, Hongwei Dong², Sizhen Shi², Masashi Yakushiji¹ and Seikou Shintani¹

¹ Department of Pediatric Dentistry, Tokyo Dental College, 2-9-18 Misaki-cho, Chiyoda-ku, Tokyo 101-0061, Japan
² Research Institute of Pediatric Dentistry, Tongji University, 2, Lane 158, DaMuQiao Rd., Ste. 402 Shanghai, 200032, PR China

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Abstract

The prevalence of dental caries has been decreasing among kindergarten children in Shanghai, China, over recent years, although it still remains at an unacceptably high level. The purpose of this study was to identify which factors were important in providing oral health guidance and achieving further improvement in the oral health status of kindergarten children in urban China. A survey was conducted on dental caries in 128 Japanese and 368 Chinese kindergarten children and a questionnaire given to their parents/guardians on each child’s lifestyle and dietary habits from birth to the present. Correlations between responses to each questionnaire item and the status of dental caries were statistically analyzed. The dft index score (p=0.0016), prevalence of dental caries (p=0.0002), and percentages of children with decayed (untreated caries-affected) teeth (p<0.0001) were significantly higher in the Chinese than in the Japanese children. Many differences were observed in lifestyle factors between the two groups. The percentage of parents failing to control the child’s snacking habits between meals was higher in China, and weaning was significantly delayed in China compared with in Japan. These lifestyle factors were considered to be associated closely with the high risk of dental caries in Chinese kindergarten children. These findings indicate that oral health guidance for kindergarten children in Shanghai, China, should focus on control of dietary habits, including control of inter-meal snacking, and breastfeeding practices. The results of this study may help improve the status of dental caries among Chinese children.

Key words: Deciduous tooth caries — Oral health — Questionnaire — Chinese children — Shanghai

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Introduction

In the People’s Republic of China (herein-after simply called “China”), remarkable economic growth has been accompanied by major change in dietary habits. Such change, however, has been predicted to have a negative impact on oral health in children, with a concomitant elevation in risk of caries. Against this background, in 1988, the Chinese Government commissioned a committee of experts to look at ways of improving preventive dentistry and promoting oral health. The effects of these measures, however, remain virtually unknown.

Since 1994, this group has been periodically investigating the status of dental caries and oral health guidance for kindergarten children and their guardians in Shanghai. Although some similar studies have noted a decrease in the prevalence of dental caries among kindergarten children, the results have still been poor in comparison with those observed in Japan during the same period.

Shanghai is a coastal city. Economically powerful, it sees large inflows and outflows of people and is home to a population of wide ethnic diversity. An understanding of the importance of maintaining and improving oral health from childhood onward would improve the quality of life for many of its citizens. Moreover, this would serve as a model for disseminating such knowledge throughout the rest of the country. However, the promotion of oral health guidance in Japan is tailored to the lifestyle there, and there is no guarantee that the same approach would work in China too. Therefore, before such methods can be adopted for the Chinese population, it is necessary to determine how lifestyle factors will affect how this should be done.

The purpose of this study was to identify which factors were responsible for the high risk of dental caries observed in Chinese children. A survey was conducted on dental caries among kindergarten children in Shanghai and a questionnaire given on their diets and lifestyles. The results were then compared with those of another survey on such factors in Japanese kindergarten children.

Materials and Methods

1. Participants

The participants comprised 128 children attending a kindergarten in Funabashi City, Chiba Prefecture, Japan and 368 children attending 2 kindergartens in Shanghai, China (Table 1). All the children were aged between 3 and 6 years. Kindergarten education lasts for 3 years in China, beginning at the age of 3, identical to the kindergarten system adopted in Japan. The socioeconomic status of the Chinese children and their families was deemed to be relatively high compared with the national average. Therefore, a Japanese kindergarten in the city of Funabashi, close to the Tokyo metropolitan area, was chosen as a suitable control group. Oral health guidance has been provided for approximately 20 years in all the kindergartens surveyed, but no fluoride was used for prevention of dental caries. A survey on dental caries and a questionnaire for parents/guardians were implemented in both groups, in November 2012 for the Chinese children and in June 2013 for the Japanese children. The school year begins in September in China, whereas it begins in April in Japan. The study protocol was approved by the Tokyo Dental College Ethics Committee (Approval No. 286).

2. Survey of dental caries

In China, the status of dental caries was surveyed by a single Chinese dentist in the presence of a Japanese dentist. In Japan, the same examination was carried out by another single Japanese dentist, a specialist in pediatric dentistry. The examination given was the same as that used for dental health checkups in schools throughout Japan, employing a health checkup illumination system and dental mirror. In China, both dentists checked the oral cavities of several children in advance, and adjustments were made on the basis of the results of this preliminary checkup to
avoid discrepancies between the two countries in the method employed for the main examination. The diagnosis of dental caries was based on the WHO criteria, with records taken of the status of caries of the deciduous teeth and the dft index.

3. Questionnaire

A questionnaire, in Japanese or Chinese as appropriate (Table 2), was given to the par-

Table 1  Kindergarten children surveyed in Japan and China

|                | Japan                      | China                     |
|----------------|----------------------------|---------------------------|
|                | All children | Boys | Girls | All children | Boys | Girls |
| Minor (aged 3 or 4 yr) | 35           | 18   | 17    | 119          | 76   | 43    |
| Middle (aged 4 or 5 yr)| 47           | 22   | 25    | 139          | 90   | 49    |
| Elder (aged 5 or 6 yr)  | 46           | 17   | 29    | 110          | 67   | 43    |
| Total           | 128          | 57   | 71    | 368          | 233  | 135   |

Table 2  Items contained in questionnaire on lifestyle and dietary habits of children

1. When does the child brush their teeth?
2. How often does the child brush his/her teeth every day?
3. How often does the parent/guardian perform final brushing?
4. Is toothpaste used?
   4-1. If toothpaste is used, does the paste contain fluoride?
5. Has the child received guidance on tooth brushing?
6. How often does the child ingest snacks per day?
7. When does the child ingest snacks?
8. Who selects the foods taken as snacks?
9. When did the child begin taking snacks?
10. Does the child eat 3 meals at regular times of the day?
11. Does the child eat his/her meals with other family members?
12. Do you feel that the child eats too fast or too slowly?
13. Do you feel the child eats large amounts or small amounts of food?
14. Do any of the following hold true for your child during meals?
   Watches TV
   Is picky about food
   Ingests food with water or tea without sufficient chewing
   Keeps the food in the mouth for a long time
   Talks excessively
   Dislikes hard foods
   Makes loud sounds while eating
   Does not eat sufficiently because of untimely ingestion of snacks
15. How often does the family eat outdoors?
16. Did the child receive breastfeeding only, bottle-feeding only, or both?
17. Did the child receive milk feeds at bedtime?
   17-1. If yes, until what age did the child receive feeds at bedtime?
18. At what age was weaning achieved?
19. Did the child receive dental care?
   19-1. If yes, why did the child visit the dental clinic?
20. Have you ever looked up any information on oral health?
21. Do you know about the effects of fluoride in preventing dental caries?
   21-1. If yes, are you using fluorides for preventing dental caries?
22. Who are the members constituting your family?
23. When does the child get up in the morning and when does he/she go to bed at night?
24. Has the child developed any illness requiring hospitalization?
   24-1. If yes, what was the diagnosis?
25. Does the child suffer from allergy to any food or drug?
ents/guardians on each child’s dietary habits and lifestyle from birth to the present. It consisted of items on factors reported to be associated with the onset of dental caries in the literature. In addition, the parent/guardian was asked to list all the foods/drinks ingested, the time of ingestion, tooth brushing habits and whether final brushing was conducted by the adult each day over a 4-day period.

4. Statistical analysis

The results for each country were compared and correlations between lifestyle factors or dietary habits with the risk of dental caries in the Chinese children statistically analyzed. Responses to individual items served as independent variables and experience of dental caries and presence/absence of decayed teeth as dependent variables. The statistical analysis was performed using the JMP® software (version 10.0.2; SAS Institute Inc., NC, USA). The Student’s t-test was used to compare the number of teeth with caries. The chi-square test was used to compare lifestyles, prevalence of dental caries, and percentages of children with decayed teeth between Japan and China. If any cells in the contingency table were less than 5, the Fisher’s exact test was applied instead of the chi-square test. A p value of <0.05 was regarded as statistically significant. To predict risk of dental caries in Chinese children, a multiple logistic regression analysis using the stepwise method was employed and the odds ratios for factors possibly involved in the development of dental caries calculated. The model thus created was evaluated by the goodness-of-fit test. A p value of <0.05 by the goodness-of-fit test implied that the model was adequate.

Results

1. Status of dental caries in Japan and China

Table 3 shows the dft score, prevalence of dental caries, and percentages of children with decayed teeth in Japan and China. The number of caries-affected teeth, dft score, prevalence of dental caries, and percentages of children with decayed teeth were significantly higher in Chinese than in Japanese children. On the other hand, the number of treated teeth was significantly higher in Japanese children. In both Japan and China, the dft score, prevalence of dental caries, and percentage of children with decayed teeth tended to be higher in girls than in boys, although the difference was not statistically significant. When analyzed by the school year, children from both the minor and middle grades in China had a significantly higher dft score, prevalence of dental caries, and percentages of decayed teeth than children in Japan (Table 4).
2. Differences in lifestyle factors between Japan and China based on questionnaire

Responses to the questionnaire were collected from 104 participants in Japan (response rate: 81.3%) and 172 in China (46.7%). A comparison of the responses to the questions (including the information collected from the meal record form) between Japan and China is shown in Table 5.

The questionnaire revealed many differences in lifestyle between Japan and China. The following were characteristics of the lifestyle in China: i) tooth brushing was often performed before breakfast, but few children brushed their teeth after each of their 3 meals; ii) the parent/guardian only performed final brushing infrequently; iii) few parents/guardians provided fluoride in toothpaste or in any other form; iv) many children ingested snacks three times or more daily, although there were some children who did not have the habit of snacking at all; v) a high frequency of snack ingestion after supper; vi) snacks were selected not only by the mother, but also sometimes by the father; vii) regular meals were taken, but without the attendance of any family members in many cases; viii) eating outdoors was frequent; ix) the breastfeeding period was prolonged, with breastfeeding at night continued for particularly long periods of time.

3. Correlation between responses to questionnaire and prevalence of caries in deciduous teeth

The prevalence of dental caries and percentages of children with decayed teeth among Chinese children were calculated after they had been grouped according to responses to the questionnaire. The data collected were analyzed with the chi-square test to identify which lifestyle factors influenced the prevalence of dental caries or percentages of children with decayed teeth (Table 6). The following factors were found to be associated with an increase in the prevalence of dental caries and/or the percentages of children with decayed teeth: i) failure of the parent/guardian to perform final tooth brushing every day; ii) ingestion of snacks once or more frequently per day; iii) ingestion of snacks before breakfast; iv) ingestion of snacks between supper and bedtime; v) snacks selected by the children themselves; vi) absence of regular intake of three meals; vii) insufficient amount of food at mealtimes; viii) watching TV during intake of meals; ix) pickiness about food; x) talking excessively during intake of meals; and xi) weaning at the age of 25 months or later. Unexpectedly, the risk for dental caries was found to be lower in the group not using toothpaste for tooth brushing (xii). When the children were grouped according to timing of ingestion of snacks,
Table 5 Comparison of responses to questionnaire between Japan and China

| Number answering “Yes”/subjects | Japan (%) | China (%) | p value |
|----------------------------------|-----------|-----------|---------|
| **Timing of brushing teeth (multiple answers permitted)** | | | |
| Before breakfast | 2/104 | 1.9 | 118/167 | 70.7 | <0.0001 |
| After breakfast | 75/104 | 72.1 | 21/167 | 12.6 | <0.0001 |
| After lunch | 74/104 | 71.2 | 0/167 | 0 | <0.0001 |
| After supper | 34/104 | 32.7 | 6/167 | 3.6 | <0.0001 |
| At bedtime | 69/104 | 66.4 | 125/167 | 74.9 | N.S. |
| No brushing | 0/104 | 0 | 3/167 | 1.8 | N.S. |
| **Frequency of brushing teeth** | | | |
| Once daily or more | 71/72 | 98.6 | 137/143 | 95.8 | N.S. |
| Twice daily or more | 52/72 | 72.2 | 72/143 | 50.4 | 0.0019 |
| Thrice daily or more | 16/72 | 22.2 | 1/143 | 0.7 | <0.0001 |
| **Final brushing** | | | |
| Done every day | 79/103 | 76.7 | 41/159 | 25.8 | <0.0001 |
| Done every day or occasionally | 102/103 | 99.0 | 107/159 | 67.3 | <0.0001 |
| **Use of toothpaste** | | | |
| Present | 89/104 | 85.6 | 134/144 | 93.1 | N.S. |
| **Fluoride-containing toothpaste** | | | |
| Selected product used | 75/104 | 72.1 | 48/144 | 33.3 | <0.0001 |
| **History of receiving guidance on brushing method** | | | |
| Present | 98/103 | 95.2 | 102/160 | 63.8 | <0.0001 |
| **Frequency of snack ingestion** | | | |
| Once daily or more | 102/104 | 98.1 | 117/158 | 74.1 | <0.0001 |
| Twice daily or more | 23/104 | 22.1 | 47/158 | 29.8 | N.S. |
| Thrice daily or more | 6/104 | 5.8 | 16/158 | 10.1 | N.S. |
| **Time of snack ingestion (multiple answers permitted)** | | | |
| Before breakfast | 2/102 | 2.0 | 3/147 | 2.0 | N.S. |
| Between breakfast and lunch | 20/102 | 19.6 | 26/147 | 17.7 | N.S. |
| Between lunch and supper | 102/102 | 100.0 | 98/147 | 66.7 | <0.0001 |
| Between supper and bedtime | 4/102 | 3.9 | 46/147 | 31.3 | <0.0001 |
| Times other than interval between lunch and supper | 23/102 | 22.6 | 76/147 | 51.7 | <0.0001 |
| **Who selects the snacks for the child (multiple answers permitted)** | | | |
| Child himself/herself | 60/104 | 57.7 | 98/166 | 59.0 | N.S. |
| Mother | 92/104 | 88.5 | 76/166 | 45.8 | <0.0001 |
| Father | 4/104 | 3.9 | 35/166 | 21.1 | <0.0001 |
| Grandparent | 21/104 | 20.2 | 41/166 | 24.7 | N.S. |
| **Age at start of snack ingestion** | | | |
| Before 1 year of age | 7/66 | 10.6 | 10/106 | 9.4 | N.S. |
| Before age of 2 years | 52/66 | 78.8 | 49/106 | 46.2 | <0.0001 |
| Before age of 3 years | 65/66 | 98.5 | 77/106 | 72.6 | <0.0001 |
### Lifestyle and Dental Caries in China

#### Table 5, continued

| Dietary style                                      | Number answering “Yes”/subjects | p value |
|---------------------------------------------------|---------------------------------|---------|
| Taking 3 meals regularly                          | 91/103 (88.4) 162/170 (95.3)    | 0.0362  |
| Breakfast & supper taken with all family members  | 80/103 (77.7) 104/170 (61.2)    | 0.0042  |
| Breakfast & supper taken alone                    | 0/103 0 15/170 (8.8)            | 0.0001  |
| Eating rapidly                                    | 8/104 (7.7) 58/170 (34.1)       | <0.0001 |
| Eating slowly                                     | 39/104 (37.5) 12/170 (7.1)      | <0.0001 |
| Eating large amounts                              | 4/104 (3.9) 15/156 (9.6)        | N.S.    |
| Eating small amounts                              | 30/104 (28.9) 29/156 (18.6)     | N.S.    |

### Scenes while eating (multiple answers permitted)

| Activity                                      | Number answering “Yes”/subjects | p value |
|-----------------------------------------------|---------------------------------|---------|
| Watches TV                                    | 55/104 (52.9) 67/157 (42.7)     | N.S.    |
| Picky about food                              | 43/104 (41.4) 48/157 (30.6)     | N.S.    |
| Eats without chewing sufficiently             | 1/104 1.0 48/157 (30.6)         | <0.0001 |
| Keeps food pooled in mouth                    | 11/104 (10.6) 29/157 (18.5)     | N.S.    |
| Talks excessively                              | 43/104 (41.4) 77/157 (49.0)     | N.S.    |
| Dislikes hard foods                            | 1/104 1.0 37/157 (23.6)         | <0.0001 |
| Makes loud sounds while eating                | 6/104 (5.8) 8/157 (5.1)         | N.S.    |
| Does not each much because of frequent/untimely snacking | 6/104 (5.8) 9/157 (5.7) | N.S.    |

### Frequency of eating outdoors

| Frequency | Number answering “Yes”/subjects | p value |
|-----------|---------------------------------|---------|
| Once a week or more                          | 21/103 (20.4) 58/144 (40.3)    | 0.0008  |
| Twice a week or more                         | 3/103 2.9 18/144 (12.5)        | 0.0046  |
| Three times a week or more                   | 0/103 0 6/144 (4.2)            | 0.0103  |

### Milk feeding

| Feeding method                        | Number answering “Yes”/subjects | p value |
|---------------------------------------|---------------------------------|---------|
| Breastfeeding only                    | 34/103 (33.0) 30/160 (18.8)     | 0.0091  |
| Bottle-feeding only                   | 23/103 (22.3) 32/160 (20.0)     | N.S.    |
| Weaning at 13 months or more          | 75/99 (75.8) 57/84 (67.9)       | N.S.    |
| Weaning at 19 months or more          | 36/99 (36.4) 51/84 (60.7)       | 0.0010  |
| Weaning at 25 months or more          | 13/99 (13.1) 38/84 (45.2)       | <0.0001 |
| Feeding at night continued until 13 months or more | 31/63 (49.2) 84/104 (80.8) | <0.0001 |
| Feeding at night continued until 19 months or more | 14/63 (22.2) 75/104 (72.1) | <0.0001 |

### History of receiving dental care

| History | Number answering “Yes”/subjects | p value |
|---------|---------------------------------|---------|
| Present | 70/103 (68.0) 55/160 (34.4)     | <0.0001 |

### Oral health

| Oral health                                   | Number answering “Yes”/subjects | p value |
|------------------------------------------------|---------------------------------|---------|
| History of searching for information on oral health | 33/100 (33.0) 14/69 (20.3)     | N.S.    |

### History of use of fluorides other than in toothpaste

| History | Number answering “Yes”/subjects | p value |
|---------|---------------------------------|---------|
| Having used | 32/99 (32.3) 3/50 (6.0)        | <0.0001 |

### Family composition (multiple answers permitted)

| Family composition | Number answering “Yes”/subjects | p value |
|--------------------|---------------------------------|---------|
| Living with both parents | 100/104 (96.2) 143/158 (90.5) | N.S.    |
| Living with grandparent(s) | 33/104 (31.7) 110/158 (69.6)  | <0.0001 |
| Having sibling/s | 83/104 (79.8) 18/158 (11.4)     | <0.0001 |
significant differences were found in the prevalence of dental caries and percentages of children with decayed teeth, depending on multiple categories related to timing of snack ingestion. In the logistic regression analysis described below, a new variable, “snack ingestion at times other than the interval between lunch and supper (xiii)” was entered, but “ingestion of snacks before breakfast (iii)” and “ingestion of snacks between supper and bedtime (iv)” were omitted. Thus, 11 factors were used as independent variables in further analysis. The children were grouped again according to the status of this additional category and prevalence of dental caries and percentages of children with decayed teeth recalculated (Table 5, 6).

The multiple logistic regression analysis was conducted to identify which factors possibly exerted a marked impact on the risk of dental caries among Chinese children. The analysis revealed that the risk of dental caries was higher when the children selected their own snacks, when snacking occurred at some time other than between lunch and supper, when they talked excessively during meals, and/or when they were weaned only at the age of ≥25 months (Table 7). Furthermore, the timing of snack ingestion and prolonged breastfeeding were also revealed as lifestyle factors showing a significant difference between Japan and China.

Discussion

Periodic surveys of children in kindergarten in Shanghai by this group have revealed a decrease in the prevalence of dental caries. However, in the present study, all the scores for caries-affected teeth, prevalence of dental caries, percentages of children with decayed teeth, and the dft index were significantly higher in the Chinese than in the Japanese children, suggesting the need for further effort towards improvement (Table 3). Furthermore, the mean number of decayed teeth was also significantly higher among children in China. These results are similar to those of earlier studies on dental caries by this group in 1994 and 2004 and those of other groups also11,30. This indicates the need for more education on the importance of treating caries in deciduous teeth in China. The mean number of treated teeth per child was significantly higher in Japanese children. It is not clear whether this was due to the greater proportion of dentists to the total population in Japan or differences in the level of awareness of oral health, however. The response rate to the questionnaire and adherence to keeping a record of meals was lower in China, even though the socioeconomic status of the families involved was relatively high, indicating that work still needs to be done on raising awareness of oral health.
Table 6  Status of caries of the deciduous teeth in Chinese children as analyzed from the responses to the questionnaire

| Response to questionnaire | Prevalence of dental caries (%) | Persons with decayed teeth (%) |
|---------------------------|---------------------------------|-------------------------------|
|                           | Yes    | No    | p value | Yes    | No    | p value |
| **Timing of brushing teeth (multiple answers permitted)** |       |       |         |       |       |         |
| Before breakfast           | 40.5   | 50.9  | N.S.    | 39.7   | 47.3  | N.S.    |
| After breakfast            | 47.2   | 43.0  | N.S.    | 42.9   | 41.8  | N.S.    |
| After lunch                | —      | 43.6  | N.D.    | —      | 41.9  | N.D.    |
| After supper               | 57.1   | 43.0  | N.S.    | 57.1   | 41.3  | N.S.    |
| At bedtime                 | 43.0   | 39.2  | N.S.    | 41.4   | 39.6  | N.S.    |
| No brushing                | 75.0   | 42.9  | N.S.    | 75.0   | 41.2  | N.S.    |
| **Frequency of brushing teeth** |       |       |         |       |       |         |
| Once daily or more         | 41.6   | 66.7  | N.S.    | 40.9   | 50.0  | N.S.    |
| Twice daily or more        | 41.7   | 43.7  | N.S.    | 41.7   | 40.9  | N.S.    |
| Thrice daily or more       | 0      | 43.0  | N.S.    | 0.0    | 41.6  | N.S.    |
| **Final brushing**         |       |       |         |       |       |         |
| Done every day             | 31.6   | 77.8  | 0.0097  | 31.6   | 49.6  | 0.0225  |
| Done every day or occasionally | 41.3  | 55.8  | N.S.    | 39.7   | 53.9  | N.S.    |
| **Use of toothpaste**      |       |       |         |       |       |         |
| Present                    | 44.4   | 19.1  | 0.0211  | 42.4   | 19.1  | 0.0328  |
| **Fluoride-containing toothpaste** |        |         |           |        |         |           |
| Selected product used      | 56.3   | 41.7  | N.S.    | 54.2   | 39.6  | N.S.    |
| **History of receiving guidance on brushing method** |       |       |         |       |       |         |
| Present                    | 42.2   | 43.1  | N.S.    | 41.3   | 41.7  | N.S.    |
| **Frequency of snack ingestion** |       |       |         |       |       |         |
| Once daily or more         | 49.2   | 31.8  | 0.0419  | 48.5   | 27.3  | 0.0123  |
| Twice daily or more        | 49.1   | 43.0  | N.S.    | 49.1   | 40.5  | N.S.    |
| Thrice daily or more       | 61.1   | 43.0  | N.S.    | 61.1   | 41.1  | N.S.    |
| **Time of snack ingestion (multiple answers permitted)** |       |       |         |       |       |         |
| Before breakfast           | 100.0  | 45.1  | 0.0299  | 100.0  | 43.2  | 0.0259  |
| Between breakfast and lunch| 55.2   | 44.1  | N.S.    | 55.2   | 41.9  | N.S.    |
| Between lunch and supper   | 39.1   | 60.0  | 0.0110  | 39.1   | 54.6  | N.S.    |
| Between supper and bedtime | 59.6   | 39.8  | 0.0177  | 57.7   | 38.1  | 0.0184  |
| Times other than interval between lunch and supper | 55.8 | 35.4  | 0.0085  | 53.5   | 34.2  | 0.0122  |
| **Who selects snacks for child (multiple answers permitted)** |       |       |         |       |       |         |
| Child himself/herself      | 48.6   | 36.6  | N.S.    | 48.6   | 32.9  | 0.0305  |
| Mother                     | 44.4   | 42.3  | N.S.    | 41.1   | 42.3  | N.S.    |
| Father                     | 41.5   | 42.8  | N.S.    | 41.5   | 41.8  | N.S.    |
| Grandparent                | 34.6   | 46.7  | N.S.    | 34.6   | 44.4  | N.S.    |
| Response to questionnaire | Prevalence of dental caries (%) | Persons with decayed teeth (%) |
|---------------------------|-------------------------------|-------------------------------|
|                           | Yes  | No   | p value | Yes  | No   | p value |
| **Age at start of snack ingestion** |      |      |         |      |      |         |
| Before 1 year              | 30.0 | 43.8 | N.S.    | 30.0 | 41.7 | N.S.    |
| Before 2 years             | 44.9 | 40.4 | N.S.    | 42.9 | 38.6 | N.S.    |
| Before 3 years             | 44.2 | 37.9 | N.S.    | 42.9 | 34.5 | N.S.    |
| **Dietary habits**         |      |      |         |      |      |         |
| Taking 3 meals regularly   | 41.5 | 100.0| 0.0002  | 39.0 | 100.0| 0.0002  |
| Breakfast & supper taken with all family members | 44.7 | 41.7 | N.S.    | 43.9 | 39.0 | N.S.    |
| Breakfast & supper taken alone | 27.8 | 45.1 | N.S.    | 27.8 | 43.4 | N.S.    |
| Eating rapidly             | 37.9 | 47.2 | N.S.    | 37.9 | 44.8 | N.S.    |
| Eating slowly              | 58.3 | 43.0 | N.S.    | 58.3 | 41.3 | N.S.    |
| Eating large amounts       | 26.3 | 46.5 | N.S.    | 26.3 | 44.6 | N.S.    |
| Eating small amounts       | 69.0 | 39.5 | 0.0034  | 69.0 | 37.4 | 0.0017  |
| **Scenes while eating (multiple answers permitted)** |      |      |         |      |      |         |
| Watches TV                 | 53.3 | 38.2 | 0.0458  | 52.0 | 36.3 | 0.0367  |
| Picky about food           | 58.0 | 39.4 | 0.0250  | 58.0 | 37.0 | 0.0113  |
| Eats without chewing sufficiently | 40.4 | 46.4 | N.S.    | 40.4 | 44.0 | N.S.    |
| Keeps food pooled in mouth | 58.1 | 41.8 | N.S.    | 58.1 | 59.7 | N.S.    |
| Talks excessively          | 52.9 | 37.0 | 0.0323  | 50.6 | 35.9 | 0.0478  |
| Dislikes hard foods        | 51.2 | 42.7 | N.S.    | 51.2 | 40.4 | N.S.    |
| Makes loud sounds while eating | 44.4 | 44.4 | N.S.    | 44.4 | 42.6 | N.S.    |
| Does not eat much because of frequent/untimely snacking | 55.6 | 44.1 | N.S. | 55.6 | 42.3 | N.S. |
| **Frequency of eating outdoors** |      |      |         |      |      |         |
| Once a week or more        | 36.9 | 47.9 | N.S.    | 35.4 | 45.8 | N.S.    |
| Twice a week or more       | 45.0 | 43.3 | N.S.    | 45.0 | 41.1 | N.S.    |
| Three times a week or more | 66.7 | 42.6 | N.S.    | 66.7 | 40.7 | N.S.    |
| **Milk feeding**           |      |      |         |      |      |         |
| Breastfeeding only         | 45.7 | 45.8 | N.S.    | 45.7 | 41.8 | N.S.    |
| Bottle-feeding only        | 41.7 | 44.8 | N.S.    | 38.9 | 43.5 | N.S.    |
| Weaning at 13 months or more | 57.9 | 39.4 | N.S.    | 56.1 | 36.4 | N.S.    |
| Weaning at 19 months or more | 56.9 | 43.6 | N.S.    | 54.9 | 41.0 | N.S.    |
| Weaning at 25 months or more | 63.2 | 42.3 | 0.0496  | 60.5 | 40.4 | N.S.    |
| **History of receiving dental care** |      |      |         |      |      |         |
| Present                    | 65.5 | 34.1 | <0.0001 | 60.0 | 34.1 | 0.0012 |
The purpose of the present study was to identify which factors were important in providing oral health guidance and improving dental health among Chinese children. Towards this end, two methods were employed. First, a questionnaire was designed to compare lifestyle factors between Japan and China (Table 5). If any of the precautions urged in Japan in relation to lifestyle elements were not sufficiently practiced in China, they were to be considered as candidate topics of focus in improving oral health guidance. However, since the cultures differ between Japan and China, it may be difficult to apply the type of oral health guidance provided in Japan, which is tailored to the Japanese lifestyle, directly to the Chinese population. Second, the Chinese children were grouped according to responses to the questionnaire, and prevalence of dental caries and percentages of children with decayed teeth in each group calculated. Our goal was to identify which lifestyle factors were associated with an increase in the risk of dental caries among Chinese children by comparing data between these groups (Table 6). It was anticipated that each factor identified by both the first and second methods would deserve attention as a point of importance in providing oral health guidance.

Chinese children often brushed their teeth before breakfast, but only infrequently after each meal, possibly because many people are in the habit of eating outdoors in China, even breakfast. Awareness that brushing immediately after each meal is the most effective way of maintaining oral health appears to be low, suggesting that education on the importance of brushing soon after lunch in kindergarten should be part of any guidance given on oral health guidance.

### Table 6, continued

| Response to questionnaire | Prevalence of dental caries (%) | Persons with decayed teeth (%) |
|---------------------------|---------------------------------|--------------------------------|
|                           | Yes    | No   | p value | Yes    | No   | p value |
| Oral health               |        |      |         |        |      |         |
| History of searching for information on oral health | 57.1 50.9 | N.S. | 53.3 47.0 | N.S. |
| History of use of fluorides other than in toothpaste |        |      |         |        |      |         |
| Having used               | 100.0 50.0 | N.S. | 66.7 44.4 | N.S. |
| Family composition (multiple answers permitted) |        |      |         |        |      |         |
| Living with both parents  | 41.7 60.0 | N.S. | 39.9 60.0 | N.S. |
| Living with grandparent(s) | 41.9 46.3 | N.S. | 40.3 44.4 | N.S. |
| Having sibling/s          | 50.0 42.4 | N.S. | 45.0 41.1 | N.S. |
| Duration of sleep         |        |      |         |        |      |         |
| 10 hours or more          | 44.4 48.8 | N.S. | 48.8 42.2 | N.S. |
| History of hospitalization |        |      |         |        |      |         |
| Present                   | 50.0 52.5 | N.S. | 50.0 50.8 | N.S. |
| History of food/drug allergy |        |      |         |        |      |         |
| Present                   | 42.9 53.5 | N.S. | 42.9 51.7 | N.S. |

Prevalence of dental caries and percentages of children with decayed teeth among Chinese children at time of check up were calculated from responses (Yes/No). p values refer to comparison among groups with different responses. Tested with chi-square test or Fisher’s exact test. N.D.: Not determined because of absence of corresponding Chinese child. N.S.: Not significant.
health. The percentage of parents/guardians performing final brushing every day was significantly lower in China, and the prevalence of dental caries and percentages of children with decayed teeth were high in the Chinese. Moreover, these figures were also higher in the group in which final brushing was only occasionally performed by the parent/guardian in comparison with in the group in which it was performed every day (data not shown), indicating that the effect of tooth brushing in preventing dental caries was low unless final brushing was practiced on a daily basis.

The prevalence of dental caries was found to be significantly higher among children using toothpaste. Toothpaste often contains fluoride, which should prevent dental caries. This suggests that the contents of toothpaste products sold in China should be investigated. However, the percentage of responders answering that they did not know whether they were using fluoride-containing toothpaste was significantly higher in China than in Japan (data not shown). Moreover, the response rate was particularly low to questions on experience of fluoride utilization through products other than toothpaste. This result was consistent with those of earlier studies suggesting that knowledge of the effects of fluoride in preventing dental caries is not yet widespread in China. In the present study, fluoride use was not identified as a point of focus for providing oral health guidance, maybe due to the low response rate. If knowledge of the usefulness of fluoride in preventing caries was disseminated more widely, it might gain in importance. In addition, utilization of toothpaste by children might shorten brushing time. Therefore, a more detailed investigation is needed on the status of tooth brushing by children in China.

The prevalence of dental caries and percentages of children with decayed teeth were significantly higher in children not taking 3 meals regularly, although the number of such children was small. Taking meals at regular times is also reported to be associated with the daily habits of individual children and seems to be effective in preventing dental caries.

The prevalence of dental caries and percentages of children with decayed teeth were significantly higher in Chinese children who, according to their parents/guardians, ate insufficient quantities of food, watched TV while eating meals, were picky about food, or were in the habit of talking too much during meals. Because the responses to these questions relied on the subjective views of the individual parent/guardian, a reliable statistical analysis may be difficult. However, watching TV or talking too much while eating might extend mealtimes, thus increasing the

| Table 7 Factors influencing risk of dental caries in Chinese children as identified by logistic regression analysis |
|--------------------------------------------------|
| Factors strongly affecting presence/absence of history of dental caries | Factors strongly affecting presence/absence of decayed teeth |
| Odds ratio | 95%CI | p value | Odds ratio | 95%CI | p value |
| Snacks selected by children themselves | 4.00 | 1.32-13.70 | 0.0136 | 6.01 | 1.88-22.81 | 0.0019 |
| Snack ingestion at time other than between lunch and supper | 3.11 | 1.07-9.61 | 0.0367 | 3.24 | 1.09-10.36 | 0.0341 |
| Talking excessively while eating | 3.71 | 1.25-12.06 | 0.0178 | 4.29 | 1.39-15.04 | 0.0108 |
| Weaning at 25 months or later | 3.68 | 1.24-12.04 | 0.0182 | 3.95 | 1.29-13.58 | 0.0151 |

p value of goodness-of-fit test; 0.6238 (dental caries), 0.6567 (decayed teeth)

Records of 74 children were used in logistic regression analysis. Odds ratio indicates magnitude of increase in risk of dental caries associated with each factor listed above. Factors more often seen in Chinese children than in Japanese children are shown in bold-faced type (Table 5).
risk of dental caries. Small quantities of food ingested at mealtimes may be attributable to snacking between meals. Chinese children received dental care less frequently than Japanese children. The percentages of children who had visited dental clinics for prevention of dental caries or periodic dental checkups were especially low in China. Raising awareness of the need to visit dental clinics for prevention and early detection of dental caries may be an issue requiring special effort. However, differences in the insurance system in how it affects rural and urban populations can make it particularly difficult for a rural migrant to the city to obtain dental care. The present study revealed that while most of the Chinese children had visited dental clinics for treatment of dental caries, few had done so for preventive treatment, probably due to such difficulties. This then would explain why the prevalence of dental caries and percentages of children with decayed teeth were high. Therefore, the presence or absence of experience of dental care was excluded from the logistic regression analysis.

The percentage of children living with grandparent(s) was higher in China than in Japan, but the percentage of children with siblings was lower in China due to the “one family, one child policy” in the country. In Japan, living with grandparent(s) has been reported to increase risk of dental caries, but no such tendency was revealed in the present study. According to our data, not only the grandparents of Chinese children, but also the parents were likely to have insufficient knowledge about dental caries. Thus, living with grandparent(s) might not have been a factor in the present results as regards dental caries. Duration of sleep was significantly shorter in Chinese children as bedtime was approximately 0.4 hr (25 min) later there (data not shown). Although going to bed later can affect a child’s lifestyle, increasing the rate of post-supper snacking, for example, no effect was observed on risk for dental caries here.

Multiple logistic regression analysis revealed which factors had the strongest influence on the risk of dental caries in children aged 3–5 years in Shanghai, China (Table 7). These factors were in accordance with those identified in previous studies. However, “snacking at other times than the interval between lunch and supper” and “weaning at 24 months of age or later” are habits on which less attention has been paid in China than in Japan. Therefore, these factors require close attention.

The time of snack ingestion was between lunch and supper in most cases in Japan, whereas it varied greatly in China. In Japan, avoidance of snacking after supper is often advised, and this was reflected in the answers to the questionnaire. Children selecting their own snack was also identified as a factor closely associated with the risk of dental caries. Snack ingestion in China appears to involve many factors possibly associated with the risk of dental caries, as is the case in Japan. In terms of frequency of snack ingestion, the percentages of children with decayed teeth was significantly higher in Chinese children with the habit of snacking, even among those who snacked only once a day. This result may be explained by the fact that the percentages of children indicating that they did not ingest snacks was higher in China than in Japan. However, as snacking may also serve to supplement the 3 daily meals, advising avoiding snacking altogether cannot be recommended. Moreover, the contents of foods and drinks commonly used as snacks, including the amount of sugar, varies greatly between China and Japan, indicating the need to investigate their effects in more detail.

The number of children who had not yet achieved weaning by the age of 1 year 6 months was higher in China than in Japan. Milk feeding at night was also more frequent and more prolonged in China. In this survey, no correlation was noted between milk feeding at night and the status of dental caries. However, failure to achieve weaning by the age of 2 years can increase the risk of development of dental caries. Long-term and nocturnal breastfeeding is considered to have the
potential to increase the risk of development of dental caries \(^{10,22}\). The percentage of infants receiving 100% breastfeeding is low in China, and even when nocturnal feeding is done, it is unlikely to involve breast milk exclusively. In addition, the contents of artificial milk in China, such as sugar and fluoride, should be investigated. The response rate to questions pertaining to feeding was lower than that to the other questions, indicating the need to investigate this aspect in a larger number of subjects.

Identifying which factors are important in providing guidance on oral health may be useful in decreasing risk of dental caries among children living in urban areas of China. Moreover, such factors are likely to change with time. Therefore, our group will continue to monitor such trends in the future.

The results of this study indicate that primary emphasis should be placed on limiting inter-meal snack ingestion and greater vigilance where children are still being breast- or bottle-fed at over 2 years in improving oral health in kindergarten children in Shanghai, China. However, parental selection of snacks and avoidance of too much talking during meals both had higher odds ratios than the other factors described above, urging careful attention here also. These findings will be utilized in providing oral health guidance to Chinese children in the future.

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Correspondence:
Dr. Atsuo Sakurai
Department of Pediatric Dentistry,
Tokyo Dental College,
2-9-18 Misaki-cho, Chiyoda-ku,
Tokyo 101-0061, Japan
E-mail: sakuraia@tdc.ac.jp