Prevalence of oral malodor and the relationship with habitual mouth breathing in children

Takashi Kanehira* / Junji Takehara** / Dairo Takahashi*** / Okahito Honda**** / Manabu Morita*****

The prevalence of oral malodor and association of habitual mouth breathing with oral malodor were investigated in children residing in rural areas. One hundred and nineteen children participated in this study. A sulfide monitor and organoleptic method were used to evaluate oral malodor. About 8% of children had a sulfide level in mouth air above the socially acceptable limit (75 ppb). Habitual mouth breathing was a factor contributing to oral malodor. Oral malodor was not significantly correlated with plaque index, history of caries or frequency of toothbrushing.
J Clin Pediatr Dent 28(4): 285-288, 2004

INTRODUCTION

Oral malodor affects a large proportion of the population and may be the cause of a significant social or psychological handicap.[1] Miyazaki *et al.*[2] conducted an epidemiological survey on oral malodor in a general population of Japan and found that 24% of the individuals examined exhibited clinically-detectable oral malodor. The subjects of their study were adults aged 18 to 64 years old. Yoshida *et al.*[3] reported that 45.7% of parents complained of oral malodor in their children. However, the information presented in the report was obtained only from parents who visited a university dental hospital, and the prevalence of oral malodor in children was estimated on the basis of questionnaire results, which depend on subjective evaluation by the parents. Therefore, data on oral malodor in children in a general population are limited.

Various compounds produce unpleasant odors in the human oral environment. These include hydrogen sulfide, methyl mercaptan, dimethylsulfide, n-dodecanol, n-tetradecanol, phenol, indole, diphenylamine and pyridine.[4,5] Volatile sulfur compounds (VSCs; hydrogen sulfide, methyl mercaptan and dimethyl sulfide), which are formed from bacterial metabolism of amino acids, mainly contribute to oral malodor.[6] The intensity of clinical oral malodor is significantly associated with intra-oral VSC level.[7] Methods for measuring intensity of oral malodor and related parameters include organoleptic examination by odor judges, gas chromatographic analysis and sulfide monitoring.[7]

Habitual mouth breathing is a widespread clinical problem and is a concern for all child healthcare specialists.[8] The effects of mouth breathing on tissues of the nose and paranasal sinuses have been studied.[9] The effect of the habit on the gingival health have been observed by the periodontists[10], while orthodontists and pedodontists have studied the effects of mouth breathing on occlusion of the teeth[11] and development of the facial skeleton[12]. Amir *et al.*[13] studied the effect of mouth breathing on oral malodor in children aged 5 to 14 years and found a significant association between mouth breathing habit and oral malodor. Since the subjects in the study were only children whose parents complained about the oral malodor, we designed the present study to investigate the effect of mouth breathing on oral malodor in a general population.

The aims of this study were 1) to determine the prevalence of oral malodor and 2) to determine the relationship between oral malodor and habitual mouth breathing in children of a general population.

* Takashi Kanehira, Professor, Department of Oral Health Science, Hokkaido University Graduate School of Dental Medicine, Sapporo, Japan.
** Junji Takehara, Department of Oral Health Science, Hokkaido University Graduate School of Dental Medicine, Sapporo, Japan.
*** Dairo Takahashi, Department of Oral Functional Science, Hokkaido University Graduate School of Dental Medicine, Sapporo, Japan.
**** Okahito Honda, Department of Oral Functional Science, Hokkaido University Graduate School of Dental Medicine, Sapporo, Japan.
***** Manabu Morita, Department of Oral Functional Science, Hokkaido University Graduate School of Dental Medicine, Sapporo, Japan.

Send all correspondence to Dr. Manabu Morita, Department of Oral Functional Science, Hokkaido University Graduate School of Dental Medicine, North 13, West 7, Kita-ku, Sapporo, 060-8586, Japan.

Voice: 81-11-706-4254
Fax: 81-11-706-4918
E-mail: mmorita@den.hokudai.ac.jp

MATERIALS AND METHODS

Study population

After the Institutional Review Board of Hokkaido University Graduate School of Dental Medicine had approved the protocol of this study, all of the pre-school children (137 children aged 3-5 years) living in Kikonai Town were asked to participate in the study. Kikonai Town, a farming and fishing town, has a population of 6,676 and land area of 221.88 km^2. About 30% of the residents are over 65 years of age. The parents of the children were fully informed of the nature of the study, and verbal consent for participation of the children in the study was obtained from all parents during the survey. The parents were interviewed about medical history, frequency of tooth brushing, and awareness of oral malodor in their children.

Oral malodor assessment

Subjects were asked to refrain from oral activities (e.g., eating, drinking, chewing, brushing, and mouth rinsing) for 2 hours prior to data collection. Two investigators (TK and JT) assessed malodor levels of the children by VSC level measurements in mouth air (TK) and by organoleptic evaluation (JT).[13] The VSC level in mouth air (VSC) was measured by using a portable sulfide monitor (Halimeter®, Interscan Corp., Chatsworth, CA) zeroed on ambient air prior to each measurement. Each subject sat quietly without talking for 30 seconds prior to VSC measurement. A disposable plastic straw was attached to the air inlet of the monitor. The subject was instructed to bring his/her mouth slightly opened over the straw so that it extended approximately 4 cm into the oral cavity. The sulfide monitor contains a pump that draws air through the plastic straw. As the sample of mouth air passes through an electrolytic sensor, the concentration of VSC is measured. Peak VSC level was determined in parts per billion (ppb) sulfur equivalents by direct reading from the digital scale of the monitor.

In the organoleptic measurement, each subject was instructed to remain quiet with lips closed for a period of 30 seconds. Each subject was then asked to exhale through the mouth briefly with moderate force at a distance of approximately 10cm from the principal investigator (JT). Organoleptic malodor rating (OR) was estimated on a scale of 0 to 5 as follows: 0, no odor; 1, barely noticeable odor; 2, slight, but clearly noticeable odor; 3, moderate odor; 4, strong odor; and 5, extremely strong odor.[13]

Clinical examination

One investigator (DT), who was blind to the malodor measurements, collected clinical data under an artificial light of a special bulb lamp. The items examined were number of teeth with history of caries (including number of decayed deciduous teeth [*d*], number of decayed deciduous teeth indicated for extraction [*i*], and number of filled deciduous teeth [*f*]) and plaque index according to Silness and Löe.[14]

Diagnosis of mouth breathing

Mouth breathers were diagnosed by one investigator (OH) using the following criteria: (1) predominant mouth breathing confirmed by the investigator noting that the lips were apart when in a relaxed position and corroborated by the parents as being the predominant mode of breathing and (2) medical history of perennial allergic or chronic rhinitis.[12] There were no children with a history of facial trauma.

Examiner calibration

Pearson's correlation tests showed that the intra-examiner agreement for VSC measurements and that for organoleptic measurements were 0.95 and 0.93, respectively. The validity of Pearson's correlation test was checked preliminarily: tests were done on two separate occasions on 30 randomly selected subjects.

Data analysis

The mean values of OR and VSC in the subgroups with different demographic factors were compared using analysis of variance (ANOVA) and Scheffe's multiple comparison test. Pearson's correlation coefficients were calculated to determine the association of each clinical variable to OR and VSC. Ordinal stepwise multiple regression analysis was done to detect the degree of association of OR and VSC levels with potential explanatory variables using age, gender, frequency of toothbrushing, total number of *dif* teeth, total number of *d* teeth, plaque index, and the presence of habitual mouth breathing as independent variables. Calculations were undertaken using a statistical software package (SPSS Inc., Tokyo, Japan).

RESULTS

A total of 119 children (62 boys and 57 girls), 87% of the total population of children aged 3 – 5 years living in Kikonai Town, participated in the study. Forty-four percent of the parents had noticed oral malodor of the children. Means ± standard deviations of the variables tested are listed in Table 1. The mean OR and VSC level in mouth air for all subjects was 0.44 ± 0.61 and 49.0 ± 23.0, respectively. A significantly positive correlation ($r=0.65$, $p<0.001$) was found between OR and VSC level. If we take 75 ppb as the socially acceptable VSC level as suggested by Yaegaki and Sanada,[15] 7.6% of children in this study had clinically oral malodor.

Table 1. Means ± standard deviations (SDs) and ranges of oral malodor measurements and clinical parameters (n=119)

	Mean ± SD	Range
Oral malodor measurements		
Organoleptic rating	0.44 ± 0.61	0 - 2
VSC concentration	49.0 ± 23.0	6 - 165
Number of *dif* teeth	4.43 ± 4.87	0 - 17
Number of *d* teeth	2.87 ± 3.79	0 - 14
Plaque index	0.29 ± 0.51	0 - 2.0

Table 2. Relationships of oral malodor with gender, age, frequency of toothbrushing, and habitual mouth breathing (Mean ± standard deviation).

		n	Organoleptic rating	VSC in mouth air
Gender	Male	62	0.48 ± 0.62	52.9 ± 28.8
	Female	57	0.41 ± 0.59	44.8 ± 13.4
Age	3	35	0.31 ± 0.63	47.9 ± 27.6
	4	43	0.28 ± 0.45	42.6 ± 8.9
	5	41	0.73 ± 0.63	56.7 ± 26.9*
Frequency of toothbrushing	≤ Once per day	81	0.43 ± 0.61	48.4 ± 22.3
	≥ Twice per day	38	0.47 ± 0.60	50.3 ± 24.7
Mouth breathing	Positive	25	0.64 ± 0.64	59.7 ± 22.7†
	Negative	94	0.39 ± 0.59	46.0 ± 22.3

* Significantly higher than the 3- and 4-year-old groups by one-way ANOVA and Scheffe's multiple comparison test ($P<0.05$)
† Significantly higher than the negative group by one-way ANOVA ($P<0.01$)

Table 2 shows the relationships of oral malodor with sex, age, frequency of toothbrushing, and presence of habitual mouth breathing. The mean VSC of 5-year-old children was significantly higher than those in the other age groups by ANOVA and Scheffe's multiple comparison test ($p<0.05$). The mean VSC of children with habitual mouth breathing was significantly higher than that of children without habitual mouth breathing. However, there was no significant association of VSC with gender or frequency of toothbrushing. There was also no significant association of mean OR with gender, age, toothbrushing frequency, or presence of habitual mouth breathing. Pearson's correlation coefficients (r) between oral malodor level and dental parameters are listed in Table 3. There were no significant correlation coefficients between these parameters.

Table 3. Pearson's correlation coefficients (r) between oral malodor measurements and clinical parameters (n=119).

	Correlation coefficients (r) with	
	Organoleptic rating	**VSC in mouth air**
Number of *dif* teeth	0.088	0.035
Number of *d* teeth	0.012	-0.037
Plaque index	0.051	0.078

The degrees of association between oral malodor and potential explanatory variables were examined using stepwise multiple regression analysis with OR and VSC as dependent variables (Table 4). The presence of mouth breathing was the strongest factor for both OR ($p=0.001$) and VSC ($p<0.001$). For example, mean VSC in mouth air was 18.8 ppb higher in habitual mouth breathers than in the non-mouth breathers. Age was significantly associated with OR ($p=0.007$).

DISCUSSION

This study was conducted in an area in which about 30% of the residents were over 65 years of age, the percentage being higher than that for all of Japan (19%). The ratios of caries-free children in the 3-, 4- and 5-year-old groups were 46%, 44% and 17%, respectively (data not shown). These percentages were lower than those for corresponding age groups obtained from the Japanese National Survey[16] (63% for 3-year-old children, 58% for 4-year-old children, and 36% for 5-year-old children). Therefore, the results of this study might be considered as being representative results for a rural area of Japan.

In the present study, 7.6% of the children had oral malodor above the socially acceptable limit (VSC level >75 ppb[15]). In an epidemiological study done in Japan[2], up to 23% of adults showed VSC values > 75 ppb. Thus, the prevalence of oral malodor in children might be lower than that in adults. Since VSC-producing bacteria

Table 4. Stepwise multiple regression analysis of oral malodor measurements.

		Non-standardized		Standardized	
Dependent variables	**Independent variables**	β	**SE**	β	**p**
Organoleptic rating	Mouth breathing*	0.369	0.108	0.301	0.001
Age		0.209	0.075	0.276	0.007
VSC in mouth air	Mouth breathing	18.806	3.982	0.404	<0.001

*: Negative (1), Positive (2)

are related to periodontal disease[17], the apparently lower prevalence of oral malodor in children is not surprising.

Based on the information obtained by questionnaires, 44% of the parents had noticed oral malodor in their children. This percentage is similar to that reported by Yoshida *et al.*[3], who randomly selected parents visiting a pediatric dental clinic at a university hospital and reported that 45.7% of parents complained of oral malodor in the children. These two values are much higher than the prevalence (7.6%) based on VSC level in mouth air. However, this discrepancy is reasonable, since the prevalence obtained from interviews is "period prevalence", whereas the prevalence obtained from VSC measurement is "point prevalence". In addition, the parents were concerned about their children having even slight oral malodor.[13]

The mean value of organoleptic rating (OR) was 0.44 ± 0.61. According to a study by Amir *et al.*[13], the mean OR of children was 1.9 ± 0.8, which is much greater than that in our study. However, they selected children whose parents complained of oral malodor, and the children in their study were 5 to 14 years old. For organoleptic measurements in the present study, subjects were asked to exhale through the mouths briefly with moderate force at a distance of approximately 10 cm from an investigator. It is possible that some children aged 3 to 5 years can not exhale mouth air correctly. Therefore, the results of our study might be underestimated.

Mouth breathing was the factor that contributes most significantly to both OR and VSC. This is supported by the result of a previous study showing that the mean value of tongue dorsum posterior malodor was significantly higher for children with mouth breathing than those without the habit.[13] Allergic or chronic rhinitis causes mouth breathing. In such a condition, oral malodor related to tongue odor might occur as a result of putrefaction of postnasal drip that accumulates on the back of the tongue.[18] In addition, mouth breathing leads to tongue and palate moisture loss, thus possibly enabling escape of malodor volatiles into mouth air.[19]

Dental parameters such as total number of *dif* teeth and *d* teeth and plaque index were not correlated with OR or VSC in mouth air. These results are not consistent with those of a study by Amir *et al.*[13] In the study, a significant correlation was found between OR and plaque index. The reason for this discrepancy between the results of the study and our results is not clear. On the other hand, the results of our study are supported by results obtained by Paryavi-Gholami *et al.*[20] In the study, total viable counts in saliva from children with and without oral malodor were not significantly different. However, children with oral malodor harbored significantly higher levels of VSC-producing species than did children without oral malodor. More detailed microbiological data in needed for the study of oral malodor.

REFERENCES

1. Hine MK. Halitosis. J Am Dent Assoc 55: 37-46, 1957.
2. Miyazaki H, Sakao S. Katoh Y, Takehara T. Correlation between volatile sulphur compounds and certain oral health measurements in the general population. J Periodontol 66: 679-684, 1995.
3. Yoshida M, Takamori K, Ono Y, Takeda T, Suse K, Suzuki A, Murakami Y, Tanaka S, Fujisawa S, Tokiyasu Y, Watanabe S. Study on halitosis children: Questionnaire and halitosis test. Pediatr Dent J 39: 694-703, 2001.
4. Kostelc JG, Preti G, Zelson PR, Stoller NH, Tonzetich J. Salivary volatiles as indicators of periodontitis. J Periodont Res 15: 185-192, 1980.
5. Kostelc JG, Preti G, Zelson PR, Brauner L, Baehni P. Oral odors in early experimental gingivitis. J Periodont Res 19: 303-312, 1984.
6. Tonzetich J. Direct gas chromatographic analysis of sulphur compounds in mouth air in man. Arch Oral Biol 16: 587-597, 1971.
7. Rosenberg M, Kulkarni GV, Bosy A, McCulloch CAG. Reproducibility and sensitivity of oral malodor measurements with a portable sulfide monitor. J Dent Res 70: 1436-1440, 1991.
8. Massler A, Zwemer JD. Mouth breathing. II. Diagnosis and treatment. J Am Dent Assoc 46: 658-671, 1953.
9. Emslie RD, Massler A, Zwemer JD. Mouth breathing: I. Etiology and effects (a review). J Am Dent Assoc 44: 506-521, 1952.
10. Jacobson L. Mouthbreathing and gingivitis 1. Gingival conditions in children with epipharyngeal adenoids. J Periodont Res 8: 269-277, 1973.
11. Venetikidou A. Incidence of malocclusion in asthmatic children. J Clin Pediatr Dent 17: 89-94, 1993.
12. Bresolin D, Shapiro PA, Shapiro GG, Chapko MK, Dassel S. Mouth breathing in allergic children: Its relationship to dentofacial development. Am J Orthod 83: 334-339, 1983.
13. Amir E, Shimonov R, Rosenberg M. Halitosis in children. J Pediatr 134: 338-343, 1999.
14. Silness J, Löe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odont Scand 22: 121-135, 1964.
15. Yaegaki K, Sanada K. Effects of a two-phase oil-water mouthwash on halitosis. Clin Prevent Dent 14: 5-9, 1992.
16. Dental Health Division of Health Policy Bureau Ministry of Health and Welfare: Report on the survey of dental diseases (in Japanese). Tokyo, Oral Health Association, pp 41, 1999.
17. Persson S, Edlund MB, Claesson R, Carlsson J. The formation of hydrogen sulfide and methyl mercaptan by oral bacteria. Oral Microbiol Immunol 5: 195-201, 1990.
18. Rosenberg M. Clinical assessment of bad breath: current concepts. J Am Dent Assoc 127: 475-482, 1996.
19. Kleinberg I, Wolff MS, Codipilly DM. Role of saliva in oral dryness, oral feel and oral malodour. Int Dent J 52: 236-240, 2002.
20. Paryavi-Gholami F, Minah GE, Turng BF. Oral malodor in children and volatile sulfur compound-producing bacteria in saliva: preliminary microbiological investigation. Pediatr Dent 21: 320-324, 1999.