

Original Article

Prevalence of Self-Perceived Oral Malodor in a Group of Thai Dental Patients

P. Youngnak-Piboonratanakit¹, T. Vachirarojpisan²

¹ Assistant Professor, Department of Oral Medicine, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

² Lecturer, Department of Community Dentistry, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

Abstract:

Objective: To determine the prevalence and correlated factors of self-reported oral malodor in Thai dental patients from Chulalongkorn Dental Hospital.

Materials and Methods: A self-administered questionnaire was developed to assess the self-reported perception of oral malodor in 839 patients. Significant associations between self-perceived oral malodor and sociodemographics, oral problems and oral hygiene practice variables were determined by Chi-square test.

Results: The prevalence of currently self-perceived oral malodor was 61.1%. A higher prevalence of self-perceived oral malodor was significantly correlated with a number of factors including being 30 years of age or older, having a high school or lower educational level, tongue coating, xerostomia, bleeding when brushing teeth, never receiving professional tooth cleaning and a lower toothbrushing frequency. However, multivariable analysis showed that tongue coating was the factor most strongly associated with self-perceived oral malodor (OR=3.53; CI=2.05-6.08), followed by bleeding when brushing teeth (OR=2.96) and being 30 years of age or older (OR=2.46). Subjects with oral malodor perceived by themselves and others had a higher level of self-perceived oral malodor, a higher prevalence of bad odor when talking, in the morning and throughout the whole day, and a higher prevalence of consulting with other people in comparison with those with perception by themselves alone.

Conclusion: Tongue coating, bleeding when brushing teeth and being 30 years of age or older were significantly associated with self-perceived oral malodor. The level of self-perceived oral malodor and consulting with other people was more prevalent in subjects with oral malodor perceived by themselves and others.

Key Words: Epidemiology; Halitosis; Oral Hygiene; Prevalence; Self Concept

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✉ Corresponding author:
P. Youngnak-Piboonratanakit,
Department of Oral Medicine,
Faculty of Dentistry,
Chulalongkorn University
Henri Dunant Road, Patumwan,
Bangkok 10330, Thailand.
pompan.p@chula.ac.th

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INTRODUCTION

Oral malodor or halitosis is an unpleasant or foul odor emerging from the oral cavity, which is a common problem in the general population throughout the world [1]. Based on different methodologies, the prevalence of oral malodor is unclear. There are few community-based studies evaluating the prevalence of oral malodor with reported rates ranging from 2-50% [2-10]. A questionnaire-based study of

1551 subjects in Kuwait [3] and 254 healthy elder subjects [4] reported that 23% and 28.3% of the samples complained of oral malodor, respectively. Similarly, the rate of self-reported oral malodor in a study of 1052 subjects in Italy was 19.36% [5]. In a group of 626 young male adults in Switzerland, the questionnaire revealed that 17% of all subjects had never experienced oral malodor [6], whereas in 419 subjects of the city of Bern,

Switzerland revealed the prevalence of self-reported oral malodor of 32% [7]. In a Japanese study of 2762 subjects assessed by volatile sulphur-containing compounds (VSC) monitoring, the prevalence of oral malodor was present in 23% [8]. Similarly, a study of 2000 subjects in China revealed a prevalence of oral malodor of 27.5% evaluated by the organoleptic scores [9]. In contrast, according to the American Dental Association, approximately 50% of the adult population had at least an occasional complaint of oral malodor [10].

Oral malodor is classified into three groups of genuine halitosis, pseudohalitosis and halitophobia which has a multifactorial etiology involving extrinsic and intrinsic causes [10,11]. The extrinsic causes consist of tobacco, alcohol and some volatile odoriferous foods and sociodemographic factors, which lead to transient oral malodor [3,4,12]. The intrinsic causes consist of intra-oral causes and extra-oral or systemic causes [13]. Intra-oral causes result from tongue coating, periodontal disease, extensive dental caries with exposed tooth pulps, pericoronitis, impacted food, unclean denture, mucosal ulcers and diseases, xerostomia and habitual mouth breathing, the latter involving children particularly [1,14-16], in which the microbial degradation of organic substrates mainly produces VSCs [2,17]. Extra-oral causes include disturbances of the respiratory tract, gastrointestinal disorders, diabetic ketoacidosis, renal disease, hepatic cirrhosis and certain medications which reduce the salivary flow [1,14,18]. One population-based study in Germany showed a strong positive association between gastroesophageal reflux disease (GERD)-related symptoms and oral malodor in denture wearing subjects and a moderate positive association in dentate subjects [19].

Oral conditions have been considered to be the major causes of oral malodor in nearly 90% of all cases [10,20]. Delanghe et al [20] reported that 87% of a total of 260 patients diagnosed

as having oral malodor had oral problems, followed by 8% originating from ENT problems and 5% with unknown causes. Despite multi-disciplinary approaches in the treatment of oral malodor, significant attention has been given to emphasizing the importance of eliminating the microbial load by professional and personal oral care instructions [11,21,22]. The purposes of this study were to investigate the prevalence of self-perceived oral malodor and its correlation with sociodemographic factors, smoking and alcohol consumption history, oral problems and oral hygiene habits in Thai dental patients.

MATERIALS AND METHODS

This was a cross-sectional study of randomly selected Thai patients using an anonymously constructed questionnaire. The protocol was approved by the Ethical Committee of the Faculty of Dentistry, Chulalongkorn University. The population consisted of 901 patients who attended the Oral Diagnosis Clinic at Chulalongkorn University Dental Hospital, Bangkok, Thailand between October 2007 and February 2009, and the valid cases for data analysis were numbered as 839 (93.1%).

A self-administered questionnaire was constructed comprised of four parts. The first part of the questionnaire contained general patient information including gender, age, occupation, marital status and educational level. The second part inquired about those elements of medical history that have been reviewed in the literature as having a relation with oral malodor, including respiratory disease, chronic sinusitis, diabetes mellitus, gastrointestinal disease, renal disease and medication use, smoking status, alcohol consumption and eating odoriferous food. The third part covered the oral health status and oral hygiene practices assessed by questions of the presence or absence of oral health problems, including bleeding gums, tooth pain, food impaction, tooth sensitivity, tooth decay, xerostomia, coated

tongue, frequency of appointments with a dentist, frequency of tooth brushing, dental floss use, tongue cleaning, mouth rinsing and toothpick use.

In the fourth part, patients were asked if they thought they had oral malodor, how they knew they had oral malodor (through self-perception

or being told by a family member, or a friend), the degree of oral malodor (mild, moderate, strong or very strong), timing of oral malodor (after waking up, when hungry or thirsty, when tired, during work, when having stress, while talking with other people, morning, afternoon or all day), whether they had sought

Table 1. Association of sociodemographic characteristics, smoking history, alcohol drinking history and oral hygiene variables with self-perceived oral malodor.

Variable		Subjects with self-perceived oral malodor n (%)	Total*	P value**
Sex	Male	168 (77.1)	218	0.067
	Female	345 (70.4)	490	
Age (years)	< 30	226 (65.3)	346	0.000
	≥ 30	287 (79.3)	362	
Educational level	High school or lower	258 (77.7)	332	0.001
	University education	215 (66.2)	325	
Smoking status	Yes	113 (77.9)	145	0.106
	No	388 (71.2)	545	
Alcohol drinking status	Yes	238 (74.1)	321	0.307
	No	260 (70.7)	368	
Tongue coating	Yes	199 (84.3)	236	0.000
	No	104 (52.5)	198	
Xerostomia	Yes	259 (80.9)	320	0.000
	No	243 (64.6)	376	
Bleeding when brushing teeth	Yes	366 (81.0)	452	0.000
	No	143 (56.7)	256	
Professional tooth cleaning	Yes	301 (68.7)	438	0.025
	No	174 (77.0)	226	
Tooth brushing frequency	Everyday	477 (70.8)	631	0.008
	Someday	64 (85.3)	75	
Dental floss use	Yes	167 (69.6)	240	0.211
	No	342 (74.0)	462	
Mouth rinse use	Yes	292 (76.2)	383	0.011
	No	213 (67.6)	315	
Toothpick use	Yes	380 (76.8)	495	0.000
	No	113 (59.2)	191	

* Numbers may not add up to the total number (839) due to missing cases; ** By Chi-square test.

treatment for the problem before and whether they had received the treatment for the problem from the dentist or physician before.

Data were statistically analyzed by the SPSS program version 16. The data were analyzed for means and frequency distributions. The chi-square test was used to examine the associations of the categorical background variables with self-perceived oral malodor. Multivariate analysis using logistic regression was used to examine which factors were found significant with univariate analyses after adjusting for confounding effects between the variables. Adjusted odds ratios and corresponding 95% confidence intervals (95% CI) were generated for all significant variables. A P value less than 0.05 was considered to be significant.

RESULTS

Out of a total 839 subjects (256 male and 583 female), the mean age of all subjects was 33.5 years (SD=13.7, range: 13-75 years). The majority of the subjects were single (59.7%), followed by married (32.4%) and separated (4.9%). The distribution of high school or lower and university education was almost equal (47.3% and 45.3%, respectively). Most subjects did not have any systemic diseases (54.8%), while 41.1% had systemic diseases. The prevalence of self-perception of oral malodor in the past 6 months and at present was 65.0% and 61.1% (N=545 and 513, respective-

ly). A subjective assessment by putting the palm in front of the mouth and exhaling (hand-on-mouth technique) and by report by other people revealed comparable prevalence of self-perceived bad odor (42.8% and 41.4%, respectively). The majority of subjects with currently self-perceived oral malodor experienced bad breath after waking up (84.0%), followed by when thirsty (32.7%), talking (18.7%), stress (15.2%), when hungry (11.7%) and morning (10.1%).

Table 1 presents the various factors associated with self-perceived oral malodor. Oral malodor was reported higher in the age range of older than 30 years compared with younger patients (P=0.000). Subjects with lower educational levels reported a significantly higher prevalence of self-perceived oral malodor than those with a university education (P=0.001). In contrast, there was no statistically significant difference in self-reported oral malodor with or without smoking or alcohol consumption (P=0.106 and P=0.307, respectively). Patients with tongue coating, xerostomia and bleeding when brushing teeth reported a higher prevalence of oral malodor than patients without these problems (P=0.000). Subjects receiving professional tooth cleaning and subjects brushing their teeth everyday had a lower prevalence of self-perceived oral malodor (P=0.025 and P=0.008, respectively). However, subjects using either a mouth rinse or toothpick showed a higher prevalence of self-perceived oral mal-

Table 2. Logistic regression analysis of factors associated with self-perceived oral malodor.

Variable	B	SE	OR (95% CI)	P value
Age ≥ 30	0.90	0.28	2.46 (1.43-4.23)	0.001
≤ High school education	-0.42	0.28	0.66 (0.39-1.12)	0.122
Tongue coating	1.26	0.28	3.53 (2.05-6.08)	0.000
Xerostomia	0.44	0.28	1.56 (0.89-2.71)	0.120
Bleeding when brushing teeth	1.08	0.27	2.96 (1.76-4.97)	0.000
Never professional tooth cleaning	-0.42	0.30	0.66 (0.36-1.19)	0.166
Tooth brushing someday	-0.81	0.48	0.45 (0.17-1.16)	0.096
Mouth rinse use	0.24	0.27	1.27 (0.76-2.14)	0.364
Toothpick use	0.31	0.27	1.36 (0.80-2.32)	0.262

B: regression coefficient; SE: standard error; OR: adjusted odds ratio; CI: confidence interval

odor than those who never used either a mouth rinse or toothpick ($P=0.011$ and $P=0.000$, respectively).

Results of logistic regression analysis are presented in Table 2. Tongue coating was the factor most strongly associated with self-perceived oral malodor ($OR=3.53$; 95% $CI=2.05-6.08$; $P=0.000$) followed by bleeding when brushing teeth ($OR=2.96$; 95% $CI=1.76-4.97$; $P=0.000$) and being 30 years of age or older ($OR=2.46$; 95% $CI=1.43-4.23$; $P=0.001$). We next classified 513 subjects with currently self-perceived oral malodor into two groups based on perception through reporting by other people; 209 subjects with self-perception alone and 301 subjects with perception through themselves and other people (three cases failed to answer the question whether other people had ever told them about oral malodor). From Table 3, we found self-perceived oral malodor subjects with perception through themselves and others reported a higher level of oral malodor than those with perception by themselves alone ($P=0.000$).

Regarding the timing of self-perceived bad breath during the day, the prevalence of self-perceived bad odor was significantly higher in subjects with oral malodor perceived by themselves and others in comparison with subjects with oral malodor perceived by themselves alone when talking (26.1% and 9.8%; $P=0.000$), in the morning (13.4% and 6.4%; $P=0.012$) and during the whole day (11.3% and 0.5%; $P=0.000$).

Among the 513 cases with currently self-perceived oral malodor, only 9.2% and 3.1% had experienced consultation with dentists and

physicians, respectively; while 22.2% had ever consulted with other people. Only 4% of subjects had received treatment from their dental practitioners. Furthermore, consultation with other people was more prevalent in subjects with oral malodor perceived by themselves and others (33.5%) than those with perception by themselves alone (18.2%; $P=0.002$). There were no significant differences between subjects with oral malodor perceived by themselves and others and those with perception by themselves alone in experiences of consultation with dentists (11.9% and 8.2%; $P=0.216$) or physicians (4.8% and 3.0%; $P=0.374$) and receiving treatment from dental practitioners (4.8% and 1.5%; $P=0.051$).

DISCUSSION

There is no data available from Thailand on the prevalence of oral malodor among the general population. In the present study, we found a 65% prevalence of self-perceived oral malodor which is higher than usually reported [2-10,23] and may result from the difference of measurement methods ranging from self-reported oral malodor to objective measurements such as VSC monitoring or organoleptic scores and the sampling design. Although most subjective reports of oral malodor usually cannot be correlated with objective findings [6-8,24], Iwanicka-Grzegorek et al [23] showed that subjective patients' opinion correlated well with objective evaluation of oral malodor. Furthermore, self-estimation of oral malodor has been found to be reliable and has correlated with the objective assessment of the general population who were non-worriers

Table 3. Level of self-perceived oral malodor between subjects with and without perception through other people.

Group	Level of self-perceived oral malodor, n* (%)			P value**
	Mild	Moderate	Strong and very strong	
Perception by themselves alone (N=209)	115 (59.3)	73 (37.6)	6 (3.1)	0.000
Perception by themselves and others (N=301)	81 (28.0)	151 (52.2)	57 (19.7)	

* Numbers may not add up to the total number due to missing cases; ** By Chi-square test

[25]. The previous data suggest that patients who had a complaint of oral malodor are more sensitive to their own odor than an objective odor judge and objective odor evaluations are positively correlated with the patient's periodontal status [26]. A recent study showed the correlation of anxiety and the rate of self-reported oral malodor [5]. In the present study, we used a number of questions to address the perception of oral malodor including self-perception in the past six months, self-perception at present, being informed by others and subjective assessment by the hand-on-mouth technique. Iwakura et al [27] showed that most of the patients with primary complaints of oral malodor were self-conscious or became conscious of oral malodor because of the indication of others. Interestingly, the prevalence of self-reported oral malodor assessed by the hand-on-mouth technique was comparable with that perceived by others, which indicates that information about oral malodor obtained from other people might suggest that the subjects may have a real condition of oral malodor.

We found that males and females were not significantly different in the prevalence of self-perceived oral malodor. This finding is similar to the studies in Kuwait [3] and Turkey patients [4], but different with the previous studies of university students in Brazil [28], Poland [29] and dental students in Saudi Arabia [30], which showed that males suffered from oral malodor more often than females. However, a previous study showed the association of female gender and self-reported oral malodor [5]. Consistent with previous studies [3-5,8,28], self-perceived oral malodor in those over 30 years of age was significantly higher than those under 30, which may show an association between increased VSC with age [8]. Furthermore, there are some factors which may correlate with the increased prevalence of oral malodor with age including tongue coating, periodontal disease, changes in dietary

habits, decreased salivary flow, change in the quality of saliva, an inability to physically cope with oral hygiene techniques and overnight denture wear [15]. Similar to the study of self-reported prevalence in Kuwait [3] and Turkey [4], a lower educational level may be related with self-perceived oral malodor, because subjects with a university education may have better oral health and be more concerned about professional oral health care and oral hygiene practice.

Smoking and alcohol ingestion may result in transient oral malodor because some substances can cause xerostomia and alcoholic beverages are known to produce volatile compounds, acetaldehyde and other odorous by-products by oxidation of alcohol in the mouth and liver [1,18]. In contrast to the previous study [3,5,31], we did not find any significant differences in self-perceived oral malodor in subjects with or without smoking or alcohol consumption. The difference in results may be a consequence of culture, smoking habits including the type of cigarette, number and frequency of cigarettes smoked.

Some oral health problems including periodontal disease, tongue coating and xerostomia influence the degree of oral malodor [4,5,7,15,32-35]. We found that tongue coating, xerostomia and bleeding when brushing teeth had an effect on self-perceived oral malodor. Many studies have shown that periodontal disease and tongue coating are the major source of VSCs and oral malodor [2,8,9,13,32,35]. In the present study, we found that self-perceived oral malodor was most closely associated with the tongue coating. This is attributed to the large surface area of the tongue which allows the accumulation of food debris, the presence of dead leukocytes and desquamated epithelial cells and the presence of many organisms, which provide an ideal environment for the production of offensive odor [1,2,13]. The level of VSC has been reported to increase with tongue coating and to

reduce after the removal of the coating [6-8,21,33]. Xerostomia or dry mouth is generally regarded as another contributing factor of oral malodor. A reduction of salivary flow rate influenced the generation of VSC, which may result from depletion of the normal cleaning mechanism of the mouth and predisposition of the oral flora toward the gram-negative bacteria responsible for the oral malodor.

It is known that adequate oral hygiene measures may reduce, treat or protect people from oral malodor [13,22,36]. Consistent with the previous studies [3,29], we found that a lower frequency of tooth brushing and a greater frequency of using a mouth rinse or toothpick increased the frequency of subjective oral malodor. It is possible that using a mouth rinse and toothpick may be a consequence of a person's own self-perception of oral malodor in our study. Regarding the perception of oral malodor by other people in subjects with self-perceived oral malodor, we found that the majority of subjects with perception through themselves and others felt moderate and strong levels of self-reported oral malodor; whereas, most subjects with perception through themselves alone felt mild oral malodor. A recent study reported that 22.7% of subjects experiencing oral malodor were initially told by their relatives and friends and 0.9% was told by their dentists [7]. It suggests that other people could provide assistance in confirming whether the patient had real oral malodor [37].

Similar to the previous study of dental students in Saudi Arabia [30], most of the self-perceived oral malodor subjects complained of their own bad breath especially after waking up, which is the result of reduced salivary flow during sleep. This condition promotes anaerobic bacterial putrefaction, producing a transient oral malodor [38,39]. The second order of timing of self-perceived oral malodor was when thirst, which may cause a transient dry mouth, led to subjective oral malodor. Interestingly, there was a significantly higher severity

and prevalence of bad breath when talking and for the whole day in subjects with oral malodor perceived by themselves and others. This evidence reflects the fact that oral malodor when perceived through the subjects and others may interfere with social communication and may make them lack confidence when relating to other people.

Patients with self-perceived oral malodor chose to share this problem with friends, relatives and others more frequently than with health professionals. Similarly, approximately 6% of dental students received treatment from their medical and dental practitioners, while self-treatment was sought by 17% of dental students [30]. Subjects with oral malodor perceived by themselves and others had a significantly higher prevalence of consultation with others than those with perception by themselves alone. It is possible that since oral malodor is an embarrassing condition, these patients who were concerned about their own oral malodor did not desire to have consultation and examination by professionals. Furthermore, because of its complex issue, the health professionals generally lack adequate training and systematic guidelines for patient management.

In the present study, although the lack of objective assessment of malodor by the health professionals, self-assessment through the self-administered questionnaire and the hand-on-mouth technique may be useful in helping the assessment of risk factors and the detection of their own oral malodor in real life, it is important to enhance the knowledge of self-perception of oral and general health among common people, to encourage the health professionals to be concerned about this problem, as well as, to seek collaboration between oral health care professionals including dentists, ENT specialists, gastroenterologists, nutritionists and psychologists, which will enable an appropriate multidisciplinary approach for management of this condition.

CONCLUSION

There was a high prevalence of self-perceived oral malodor but a low prevalence of seeking of treatment in Thailand. Older age, tongue coating and bleeding when brushing teeth were the factors most strongly associated with self-perceived oral malodor. Perception of oral malodor by other people correlated with a higher level of self-reported oral malodor, the timing of self-perceived oral malodor and a higher prevalence of consulting with other people.

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REFERENCES

- 1-Hughes FJ, McNab R. Oral malodour--a review. *Arch Oral Biol* 2008 Apr;53 Suppl 1:S1-7.
- 2-Loesche WJ, Kazor C. Microbiology and treatment of halitosis. *Periodontol* 2000 2002;28:256-79.
- 3-Al-Ansari JM, Boodai H, Al-Sumait N, Al-Khabbaz AK, Al-Shammari KF, Salako N. Factors associated with self-reported halitosis in Kuwaiti patients. *J Dent* 2006 Aug;34(7):444-9.
- 4-Nalcaci R, Baran I. Factors associated with self-reported halitosis (SRH) and perceived taste disturbance (PTD) in elderly. *Arch Gerontol Geriatr* 2008 May-Jun;46(3):307-16.
- 5-Settineri S, Mento C, Gugliotta SC, Saitta A, Terranova A, Trimarchi G, et al. Self-reported halitosis and emotional state: impact on oral conditions and treatments. *Health Qual Life Outcomes* 2010 Mar 26;8:34.
- 6-Bornstein MM, Stocker BL, Seemann R, Burgin WB, Lussi A. Prevalence of halitosis in young male adults: a study in Swiss army recruits comparing self-reported and clinical data. *J Periodontol* 2009 Jan;80(1):24-31.
- 7-Bornstein MM, Kislig K, Hoti BB, Seemann R, Lussi A. Prevalence of halitosis in the population of the city of Bern, Switzerland: A study comparing self-reported and clinical data. *Eur J Oral Sci* 2009 Jun;117(3):261-7.
- 8-Miyazaki H, Sakao S, Katoh Y, Takehara T. Correlation between volatile sulphur compounds and certain oral health measurements in the general population. *J Periodontol* 1995 Aug;66(8):679-84.
- 9-Liu XN, Shinada K, Chen XC, Zhang BX, Yaegaki K, Kawaguchi Y. Oral malodor-related parameters in the Chinese general population. *J Clin Periodontol* 2006 Jan;33(1):31-6.
- 10-ADA Council on Scientific Affairs. Oral malodor. *J Am Dent Assoc* 2003 Feb;134(2):209-14.
- 11-Yaegaki K, Coil JM. Examination, classification, and treatment of halitosis; clinical perspectives. *J Can Dent Assoc* 2000 May;66(5):257-61.
- 12-Porter SR, Scully C. Oral malodour (halitosis). *BMJ* 2006 Sep 23;333(7569):632-5.
- 13-Sanz M, Roldan S, Herrera D. Fundamentals of breath malodour. *J Contemp Dent Pract* 2001 Nov 15;2(4):1-17.
- 14-van den Broek AM, Feenstra L, de Baat C. A review of the current literature on aetiology and measurement methods of halitosis. *J Dent* 2007 Aug;35(8):627-35.
- 15-Nalcaci R, Baran I. Oral malodor and removable complete dentures in the elderly. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008 Jun;105(6):e5-9.
- 16-Kanehira T, Takehara J, Takahashi D, Honda O, Morita M. Prevalence of oral malodor and the relationship with habitual mouth breathing in children. *J Clin Pediatr Dent* 2004;28(4):285-8.
- 17-Krespi YP, Shrimme MG, Kacker A. The relationship between oral malodor and volatile sulfur compound-producing bacteria. *Otolaryngol Head Neck Surg* 2006 Nov;135(5):671-6.
- 18-Dal Rio AC, Nicola EM, Teixeira AR. Halitosis--an assessment protocol proposal. *Braz J Otorhinolaryngol* 2007 Nov-Dec;73(6):835-42.

- 19-Struch F, Schwahn C, Wallaschofski H, Grabe HJ, Volzke H, Lerch MM, et al. Self-reported halitosis and gastro-esophageal reflux disease in the general population. *J Gen Intern Med* 2008 Mar; 23(3):260-6.
- 20-Delanghe G, Ghyselen J, van Steenberghe D, Feenstra L. Multidisciplinary breath-odour clinic. *Lancet* 1997 Jul;19;350(9072):187.
- 21-Farrell S, Baker RA, Somogyi-Mann M, Witt JJ, Gerlach RW. Oral malodor reduction by a combination of chemotherapeutical and mechanical treatments. *Clin Oral Investig* 2006 Jun;10(2):157-63.
- 22-van den Broek AM, Feenstra L, de Baat C. A review of the current literature on management of halitosis. *Oral Dis* 2008 Jan;14(1):30-9.
- 23-Iwanicka-Grzegorek E, Michalik J, Kepa J, Wierzbicka M, Aleksinski M, Pierzynowska E. Subjective patients' opinion and evaluation of halitosis using halimeter and organoleptic scores. *Oral Dis* 2005;11 Suppl 1:86-8.
- 24-Rosenberg M, Kozlovsky A, Gelernter I, Cherniak O, Gabbay J, Baht R, et al. Self-estimation of oral malodor. *J Dent Res* 1995 Sep;74(9):1577-82.
- 25-Rosenberg M, Kozlovsky A, Wind Y, Mindel E. Self-assessment of oral malodor 1 year following initial consultation. *Quintessence Int* 1999 May;30(5):324-7.
- 26-Eli I, Baht R, Kozlovsky A, Rosenberg M. The complaint of oral malodor: possible psychopathological aspects. *Psychosom Med* 1996 Mar-Apr;58(2):156-9.
- 27-Iwakura M, Yasuno Y, Shimura M, Sakamoto S. Clinical characteristics of halitosis: Differences in two patient groups with primary and secondary complaints of halitosis. *J Dent Res* 1994 Sep;73(9):1568-74.
- 28-Nadanovsky P, Carvalho LB, Ponce de Leon A. Oral malodour and its association with age and sex in a general population in Brazil. *Oral Dis* 2007 Jan;13(1):105-9.
- 29-Paradowska A, Marczewski B, Pawlowska-Cierniak E. Self-perception of halitosis among students of Wroclaw Medical University. *Adv Clin Exp Med* 2007;16:543-8.
- 30-Almas K, Al-Hawish A, Al-Khamis W. Oral hygiene practices, smoking habit, and self-perceived oral malodor among dental students. *J Contemp Dent Pract* 2003 Nov 15;4(4):77-90.
- 31-Rosenberg M, Knaan T, Cohen D. Association among bad breath, body mass index, and alcohol intake. *J Dent Res* 2007 Oct;86(10):997-1000.
- 32-Figueiredo LC, Rosetti EP, Marcantonio E Jr., Marcantonio RA, Salvador SL. The relationship of oral malodor in patients with or without periodontal disease. *J Periodontol* 2002 Nov;73(11):1338-42.
- 33-Cicek Y, Orbak R, Tezel A, Orbak Z, Erciyas K. Effect of tongue brushing on oral malodor in adolescents. *Pediatr Int* 2003 Dec;45(6):719-23.
- 34-Kleinberg I, Wolff MS, Codipilly DM. Role of saliva in oral dryness, oral feel and oral malodour. *Int Dent J* 2002 Jun;52 Suppl 3:236-40.
- 35-Koshimune S, Awano S, Gohara K, Kurihara E, Ansai T, Takehara T. Low salivary flow and volatile sulfur compounds in mouth air. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003 Jul;96(1):38-41.
- 36-Roldan S, Herrera D, O'Connor A, Gonzalez I, Sanz M. A combined therapeutic approach to manage oral halitosis: a 3-month prospective case series. *J Periodontol* 2005 Jun;76(6):1025-33.
- 37-Eli I, Baht R, Koriati H, Rosenberg M. Self-perception of breath odor. *J Am Dent Assoc* 2001 May;132(5):621-6.
- 38-Tangerman A. Halitosis in medicine: a review. *Int Dent J* 2002 Jun;52 Suppl 3:201-6.
- 39-Suarez FL, Furne JK, Springfield J, Levitt MD. Morning breath odor: influence of treatments on sulfur gases. *J Dent Res* 2000 Oct;79(10):1773-7.