Atatürk Üniv. Diş Hek. Fak. Derg.
J Dent Fac Atatürk Uni
Cilt:26, Sayı:2, Yıl: 2016, Sayfa: 203-211

**Araştırma/ Research Article**

# PREVALENCE OF HALITOSIS AND EVALUATION OF ETIOLOGICAL FACTORS IN A TURKISH SUBPOPULATION

# BİR GRUP TÜRK POPULASYONUNDA HALİTOZİSİN GÖRÜLME SIKLIĞI VE ETYOLOJİK FAKTÖRLERİN İNCELENMESİ

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***Makale Kodu/Article code:*** 2596
***Makale Gönderilme tarihi:*** 08.02.2016
***Kabul Tarihi:*** 11.05.2016

## ABSTRACT

**Aim:** The purpose of this study was to estimate the prevalence of halitosis in an adult Turkish subpopulation and to assess the relationship between halitosis and sociodemographics, self reported halitosis, etiological factors, by employing standardized procedures for measurement of halitosis.

**Methods:** The study included 459 subjects who referred to oral diagnosis clinic of Gazi University Faculty Of Dentistry. The questionnaire including the questions of sociodemographic data, halitosis complaints, oral hygiene practices, extrinsic causes and extra-oral causes. In the clinical examination, dentition and soft tissues were evaluated. Tongue coating status, periodontal index, gingival index and plaque index were recorded. Values for halitosis were assessed by measurement of volatile sulfur compounds (VSC) using portable sulphide monitor.

**Results:** The questionnaire revealed that 46.6% of the subjects suffered from halitosis and females sufferred from halitosis more frequently than males. The prevalence of halitosis was 50.7% . A significant correlation was found between halitosis and tongue coating, periodontitis, gingivitis though PI did not affect halitosis. There were not significant correlations between halitosis and oral hygiene practices, extrinsic causes and extra-oral causes.

**Conclusion:** This study showed that there was a high prevalence of halitosis in the Turkish population and the most important factors that influence halitosis were intra-oral causes.

Keywords: Epidemiology, halitosis, VSCs

## ÖZ

**Amaç:** Bu çalışmanın amacı erişkin bir grup Türk populasyonunda halitozisin görülme sıklığını, sosyo-kültürel faktörleri, halitozis şikayeti ve etiyolojik faktörlerin araştırılmasıdır.

**Gereç ve yöntem:** Çalışmaya, Gazi üniversitesi Oral Diagnoz Kliniğine başvuran 18 yaşından büyük 459 erişkin hasta dahil edildi. Hastaların sosyo-kültürel durumları, halitozis şikayeti, oral hijyen alışkanlıkları, ekstrensek faktörleri ve ağız dışı nedenleri sorgulayan anemnez formları dolduruldu. Klinik muayenede dentisyon ve yumuşak dokular değerlendirildi ve dil yüzeyindeki birikintiler, periodontal durum indeksi, gingival indeks ve plak indeksleri kaydedildi. Halitozis portatif sülfür monitörü kullanılarak volatil sülfür bileşikleri (VSB) seviyesi ölçülerek değerlendirildi.

**Bulgular:** Ankete göre, hastaların %46.6' sı halitozisden şikayetçidir. Hastaların % 50.7'sinde halitozis vardır. Halitozis ile periodontal durum, dil yüzeyi birikinti miktarı, gingival durum arasında istatistiksel olarak anlamlı bir ilişki bulunmuştur. Plak indeks değerleri, oral hijyen alışkanlıkları, ekstrensek faktörler ve ağız dışı nedenler ile halitozis arasında istatistiksel olarak anlamlı bir ilişki bulunmamıştır.

**Sonuç:** Çalışmamızın sonuçlarına göre halitozis Türk populasyonunda yaygındır ve halitozisi etkileyen en önemli nedenler ağız-içi faktörlerdir.

**Anahtar kelimeler:** Epidemiyoloji, halitozis, VSB

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## INTRODUCTION

Halitosis or oral malodor is an unlikeable or bad odor arising from the oral cavity, which is a common problem that effects social relationships. Other terms include bad or foul breath, breath odor, foul smells, foetor ex ore, breath malodor, oral malodor, and offensive breath. The term of oral malodour is used the describe the halitosis caused by intra-oral factors[1].

The etiological factors of halitosis include extrinsic and intrinsic causes[2,3]. The extrinsic causes are using tobacco, alcohol and some foods[4-6]. The intrinsic causes contain intra-oral and extra-oral causes[7]. Intra-oral causes are related with oral hygiene problems and oral diseases such as tongue coating, periodontal disease, extensive dental caries, pericoronitis, impacted food, unclean denture, stomatitis, xerostomia and habitual mouth breathing[1,8-10]. Extra-oral causes are systemic diseases and some medications that effects the oral odor[1,8,11]. Oral conditions are responsible for halitosis in nearly 90% of all cases[2,12].

The three main methods for measuring and assessing the halitosis are organoleptic measurement, gas chromatography (GC), and sulfide monitoring[13]. Methyl mercaptan, hydrogen sulfide, butyric acid, proprionic acid and valeric acid are called as volatile sulphur components (VSCs) and these components are major cause of halitosis[14]. These components are formed as a result of the anaerobic bacteria in the mouth to degrade the sulfur-containing amino acids proteolytically[14,15]. Portable sulphur monitors (Halimeters) measure the total concentration of sulphur compounds.

The prevalence of halitosis varies because different measurement methods were used. The prevalence of halitosis found to be 19-61% in studies that by using subjective criteria[16,17] (patients with halitosis complaint) and found to be 28-42 %. by using objective criteria[18,19] (organoleptic method or the VSC-levels measuring).

The purpose of this study was to estimate the prevalence of halitosis in an adult Turkish subpopulation and to assess the relationship between halitosis and comprehensive survey of sociodemographics, self reported halitosis, etiological factors, by employing standardized procedures for measurement of halitosis.

## MATERIAL METHOD

Ethical approval for this study was obtained from the Ethical Committee of the Faculty of Dentistry, University of Ankara. The study population was composed of 459 adult patients (222 M,237 F) between the ages 18-72 who referred to Oral Diagnosis and Radiology clinic of Gazi University, Faculty of Dentistry. All patients were informed and their consent was given prior to entering the study. The subjects were instructed to refrain from eating (especially garlic and onion), drinking coffee, eating mints, using minted chewing gum or scented oral hygiene products, and rinsing their mouths for 2 hours before the examination. All measurements were recorded between 8:30 and 11:30 hours (before lunch).

### Questionnaire

The subjects were asked to fill in a questionnaire that included 32 questions. The first part of the questionnaire inquired about sociodemographic data, including age, gender, education level, etc. The subjects' oral hygiene practices were assessed through questions on the frequency of toothbrush, dental floss, miswak (chewing stick), mouthrinse use, tongue cleaning, frequency of dental visits. In the last part of the questionnaire, subjects were asked how often they have halitosis (never/ rarely/sometimes/frequently)?

For evaluation of extrinsic causes, patients were also asked about their habits (smoking, drinking and diet).

The medical conditions were recorded for each patient carefully that including diabetes mellitus, renal disease, gastrointestinal tract disorders, respiratory disease, chronic sinusitis, neglected foreign bodies in the nose, pregnancy and medication use. A single positive statement to any of these questions classified a subject as having extra-oral causes.

### Clinical examination (intra-oral causes)

Oral examinations were carried out by 2 experienced dentists from the department of Oral Diagnosis And Radiology Clinic (E.YK. and K.G.) . Oral health status was examined using a dental mirror and explorer under artificial light. Any of oral health problem that affecting the halitosis, such as extensive dental caries, pericoronitis, impacted food, unclean removable and fixed dentures, incompatible proximal

surface of the dental restorations,oral mucosal lesions and xerostomia were recorded. A single positive statement to any of these data was recorded as other intra-oral causes except oral hygiene indices during statistical analysis.

Clinically to assess oral hygiene and periodontal status, the tonque coating index[20] (TCI), periodontal screening index[21,22] (PSI), plaque index[23] (PI) and gingival index[23] (GI) records were obtained. All measurements were recorded at 6 aspects on each of the 6 Ramfjord teeth (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual) by using a standard periodontal probe (PCP 15; Hu-Friedy, Chicago, IL).

**Halitosis measurements**

For determininig halitosis and the level of detection, measurements were done according to organoleptic assessment and using portable sulphur monitor (Halimeters, Interscan corporation, Chatsworth, CA, USA).

VSC concentrations were measured using a Halimeter (Model No. RH17R; Chatsworth, CA). The subject was asked to close his or her mouth and to breathe through the nose for 3 minutes before the Halimeter reading was taken. It was used according to the manufacturer's instructions with a newly calibrated detector. The subject was asked not to exhale or inhale while the Halimeter reading was collected. The highest score was recorded, and the procedure was repeated twice at 3-minute intervals, resulting in 3 Halimeter readings, from which a mean odor score was calculated. The mean value was calculated in parts per billion (ppb) for each patient. According to the manufacturer, halitosis is present at a VSC value >110 ppb.

**Statistical Analysis**

The data obtained in this study was evaluated with the help of SPSS 12 software version (SPSS Inc., Chicago, IL, USA). First, all data were analyzed using descriptive methods. Dependence between the variables, the chi-square test and Fisher's exact, test for comparison of group comparisons, Mann-Whitney U test for two groups, Kruskal-Wallis test for 3 groups and more were used for comparisons. P value was set at 0.05.

## RESULTS

The study participants were composed of 459 adult patients (222 M,237 F) between the ages 18-72.

**Questionnaire**

The results according to questionnaire are provided in Tables 1 through 2.

Table 1. Distribution of sociodemographic data, oral hygiene practices, suffering from halitosis according to questionnaire.

| | | n | % |
|---|---|---|---|
| **Gender** | Male | 222 | 48.4 |
| | Female | 237 | 51.6 |
| | Toplam | 459 | 100.0 |
| **Education level** | Primary School | 110 | 24.8 |
| | Junior high school | 42 | 9.5 |
| | High School | 103 | 23.3 |
| | University | 181 | 40.9 |
| | Master degree | 7 | 1.6 |
| | Total | 443 | 100.0 |
| **Frequency of dental visit per year** | Never | 217 | 47.3 |
| | 1 | 109 | 23.7 |
| | 2 | 75 | 16.3 |
| | 3 | 24 | 5.2 |
| | >3 | 34 | 7.4 |
| | Total | 459 | 100.0 |
| **Frequency of toothbrush per day** | Never | 67 | 14.6 |
| | 1 | 166 | 36.2 |
| | 2 | 196 | 42.7 |
| | 3 | 27 | 5.9 |
| | >3 | 3 | 0.7 |
| | Total | 459 | 100.0 |
| **Flossing** | No | 341 | 74.3 |
| | Yes | 118 | 25.7 |
| | Total | 459 | 100.0 |
| **Mouthrinse use** | No | 308 | 67.1 |
| | Yes | 151 | 32.9 |
| | Total | 459 | 100.0 |
| **Tongue cleaning** | No | 303 | 66.0 |
| | Yes | 156 | 34.0 |
| | Total | 459 | 100.0 |
| **Suffering from halitosis** | Never/rarely | 245 | 53.4 |
| | Sometimes | 109 | 23.7 |
| | Frequently | 105 | 22.9 |
| | Total | 459 | 100.0 |

Distribution of sociodemographic data according to questionnaire was given in Table 1. Most of the subjects reported brushing their teeth twice a day (42.7%; 196 of 459). This was followed by 36.2% of the subjects (n = 166) brushing once per day, 14.6% (n = 67) brushing any time, 5.9% (n=27) brushing three times per day. A higher frequency of toothbrushing was reported by three paticipants. Most of our patients (85.4%) reported that brushing their teeth at least once a day. Flossing was performed by 45 subjects (9.8%), tongue cleaning was reported by 156 subjects (34%), and 151 subjects (32.9%) were

using a mouthrinse (table 1). Most of the study subjects reported that they suffered rarely/never from halitosis (53.4%; n = 245), 46.6% of the subjects suffered from bad breath. 109 subjects (23.7%) suffered sometimes from bad breath, and 105 subjects (22.9%) reported they experienced halitosis frequently (Table1).

Extrinsic and extra-oral causes were showed in table 2. Cigarette smoking was reported by 74 participants (16.1%). Almost 96.9% of the patients reported that they did not consume alcohol. Extra-oral causes were reported by 245 subjects (53.4% of the study population).

Table 2: Extrinsic and extra-oral causes according to questionnaire.

| | | n | % |
|---|---|---|---|
| **Cigarette smoking** | No | 385 | 83.9 |
| | Yes | 74 | 16.1 |
| | Total | 459 | 100.0 |
| **Consuming alcohol** | No | 444 | 96.9 |
| | Yes | 14 | 3.1 |
| | Total | 458 | 100.0 |
| **How often do you consume sugar-containing food?** | Rarely | 130 | 28.3 |
| | Once a week | 87 | 19.0 |
| | 2-3 times per week | 100 | 21.8 |
| | Daily | 142 | 30.9 |
| | Total | 459 | 100.0 |
| **How often do you eat meat?** | Rarely | 90 | 19.6 |
| | Once a week | 44 | 9.6 |
| | 2-3 times per week | 282 | 61.4 |
| | Daily | 43 | 9.4 |
| | Total | 459 | 100.0 |
| **Extra-oral causes** | No | 214 | 46.6 |
| | Yes | 245 | 53.4 |
| | Total | 459 | 100.0 |

### Clinical examination (intra-oral causes)

Clinical findings were given in table 3. Other intra-oral causes except oral hygiene indices were found 299 (65.4%) of the persons examined.

Tongue coating grade 1 was present mostly and found in 47.2% of the persons examined (n=458, missing data=1). Only 4.6% of the study subjects were recorded as grade 3. Majority of the patiens (n=337, 73.6%) had tongue coating.

Grade 1 of PSI was found highest and was present in 40.7% of the patients (n=457, missing data=2) . Over 50% of the study participants examined had a PSI of grade 1 or grade 0. Only two subjects (0.4%) exhibited severe periodontitis, with pocket probing depths of >5.5 mm. 43 of the patiens were diagnosed as periodontitis.

Grade 1 of the plaque index was found mostly and present with 44.6 % of the patients ( n=457, 2 missing data). Majority of the patiens (73.5%) revealed plaque index scores of grade 0 and 1. According to GI, grade 2 an higher (gingivitis) was present in 100 of the subjects ( n=456, 3 missing data), most of the patients (n=356, 78%) revealed scores of grade 0 and 1.

Table 3. Clinical findings

| | | n | % |
|---|---|---|---|
| **Other intra-oral causes** | Absent | 158 | 34.6 |
| | Present | 299 | 65.4 |
| | Total | 457 | 100.0 |
| **TCI** | Grade 0 = no tongue coating present. | 121 | 26.4 |
| | Grade 1 = light coating of the tongue present/;10% of the surface. | 216 | 47.2 |
| | Grade 2 = moderate coating of the tongue present/ 10% to 50% of the surface. | 100 | 21.8 |
| | Grade 3 = severe coating of the tongue present/ >50% of the surface. | 21 | 4.6 |
| | Total | 458 | 100.0 |
| **PSI** | Grade 0 = no bleeding on probing, no pathologic pocket, no calculus | 186 | 40.7 |
| | Grade 1 = bleeding on probing | 57 | 12.5 |
| | Grade 2 = calculus and no pathologic pocket | 171 | 37.4 |
| | Grade 3 = probing depth 3.5–5.5 mm | 41 | 9.0 |
| | Grade 4 = probing depth > 5.5 mm | 2 | 0.4 |
| | Total | 457 | 100.0 |
| **PI** | Grade 0 = No plaque | 132 | 28.9 |
| | Grade 1 = A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by using the probe on the tooth surface. | 204 | 44.6 |
| | Grade 2 = Moderate accumulation of soft deposits within the gingival pocket, or the tooth and gingival margin which can be seen with the naked eye. | 97 | 21.2 |
| | Grade 3 = Abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin. | 24 | 5.3 |
| | Total | 457 | 100.0 |
| **GI** | Grade 0 = Normal gingiva | 178 | 39.0 |
| | Grade 1 = Mild inflammation – slight change in color and slight edema but no bleeding on probing | 178 | 39.0 |
| | Grade 2 = Moderate inflammation – redness, edema and glazing, bleeding on probing | 86 | 18.9 |
| | Grade 3 = Severe inflammation – marked redness and edema, ulceration with tendency to spontaneous bleeding. | 14 | 3.1 |
| | Total | 456 | 100.0 |

### Halitosis measurements

The mean value of the VSC measurements for the 458 (1 missing data) persons included in the study was 164.3 ppb (SD ±163.1 ). 232 (50.7%) subjects had a VSC value of >110 ppb and 226 (49.3%)

subjects had a VSC value of ≤110 ppb. The Halimeters values of >110 ppb accepted as having halitosis.

**Correlations**

**Correlations between suffering from halitosis and sociodemographic data, objective halitosis values:**

A significant correlation was found between suffering from halitosis and gender and education levels ($p<0.05$). Females sufferred from halitosis more frequently than males. 48.7% of the subjects who were suffering from halitosis never/rarely were graduated from Universty. 34.7% of the subjects who were suffering from halitosis sometimes were graduated from high school. A significant correlation was found between suffering from halitosis and objective halitosis measurements ($p<0.05$). 59.3% of the patients who had a VSC value of ≤110 ppb were reported that they never/rarely suffered from halitosis. The correlations were showed in table 4, we can say that there were compatible correlations between degree of suffering from halitosis and objective presence of halitosis. In addition, 9.3% (43 of 459) of the patients who had not halitosis according to halimeter measurements were suffered from halitosis frequently (halitophobia) (table 4).

Table 4: Correlations between suffering from halitosis and sociodemographic data, objective halitosis values:

| | | Suffering from halitosis | | | | | | Chi-square Test | |
|---|---|---|---|---|---|---|---|---|---|
| | | Never/Rarely | | Sometimes | | Frequently | | | |
| | | n | % | n | % | n | % | chi-square | p |
| Gender | Male | 127 | 51.8 | 40 | 36.7 | 55 | 52.4 | 7.802 | **0.020** |
| | Female | 118 | 48.2 | 69 | 63.3 | 50 | 47.6 | | |
| | Total | 245 | 100.0 | 109 | 100.0 | 105 | 100.0 | | |
| Education level | Primary school | 51 | 21.4 | 29 | 27.9 | 30 | 29.7 | 22.375 | **0.004** |
| | Junior high school | 23 | 9.7 | 13 | 12.5 | 6 | 5.9 | | |
| | High school | 43 | 18.1 | 25 | 24.0 | 35 | **34.7** | | |
| | University | 116 | **48.7** | 36 | 34.6 | 29 | 28.7 | | |
| | Master degree | 5 | 2.1 | 1 | 1.0 | 1 | 1.0 | | |
| | Total | 238 | 100.0 | 104 | 100.0 | 101 | 100.0 | | |
| Halitosis | Absent | 134 | **59.3** | 49 | 21.7 | 43 | 19.0 | 6.446 | **0.040** |
| | Present | 111 | **47.8** | 59 | 25.4 | 62 | 26.7 | tabloda sadece biri verilmeli | **0.040** |

**Correlation among questionnaire data and halitosis measurements:**

There were not significant correlations between halitosis and oral hygiene practices, extrinsic causes and extra-oral causes ($p>0.05$)

**Correlations between halitosis and intra-oral causes:**

A positive significant correlation was found between halitosis and tongue coating, periodontitis, gingivitis ($p<0.05$). There was no significant correlation found between halitosis and PI ($p>0.05$). Number of patients with objective presence of halitosis had significantly higher levels of tongue coating and periodontal scores than patients with objective absence of halitosis. Number of patients with objective absence of halitosis had significantly higher level of healthy gingiva than patients with objective presence of halitosis.

## DISCUSSION

There are limited epidemiological studies of halitosis about Turkish population and comparison of the result is rather difficult as the researchers use different criteria. Our 459 patients represent the general population because all patients came spontaneously, had been having several dental complaints. Among the patients, there were slightly more women than men in this present study. It had already been observed that women seek treatment more often than men do[20]. In addition, according to our results, females sufferred from halitosis more frequently than males. It has been reported that women seem to be more willing to consult dentists about their halitosis problems[24]. Most of the study subjects (53.4%) reported that they suffered rarely/never from halitosis, 46.6% of the subjects suffered from bad breath. Rosenberg et al[25] reported that in the USA about 50% of the population suffers from halitosis. A previous study[20] in Japan, among 232 respondents about 47% were sure they had oral malodour. The results of these previous studies were slightly higher than our results. It may be related to the different statistical analysis. We did not diveded the answer of rarely and never suffering from halitosis because halitosis complaints would be related to the temporary conditions such as respiratory disease, sinusitis, pregnancy, habits, oral hygiene.

Our findings revealed that there were compatible significant correlations between degree of suffering from halitosis and objective presence of halitosis. The results of this present study are

incompatible with the previous studies that suggest that there was no relationship between the degree of self-reported halitosis and the objective presence of halitosis. In a study carried out in Berlin, Germany, almost 30% of patients complaining that they suffered from halitosis showed no objective detectable signs of oral malodor[26]. On the other hand, the data of the study by Bornstein et al[18] revealed a negligible degree of correlation between self-reported halitosis and organoleptic measurements and no correlation between self-reported halitosis and halimeter measurements. These different results may be related to characteristics of the study population and statistical analyses.

The term pseudo-halitosis is used when no breath malodour can be perceived, and yet the patient is convinced that he suffers from it. If after a diagnosis of pseudo-halitosis the patient still believes that there is bad breath, one can speak about halitophobia[3]. We found that 9.3% (43 of 459) of the subjects were designated as revealing pseudo halitosis/halitophobia. Similarly, Vandekerckhove et al[27] stated that the pseudo halitosis/halitophobia rate was 7.6% and Quirynen et al[28] defined in their study that pseudo-halitosis rate was 15.7% for the 2000-patient series.

It was declared that inadequate oral hygiene habits were the most important factors associated with self-reported halitosis and interdental cleaning methods, including dental floss, have been shown important in the treatment of oral malodor[29]. In this study there were not significant correlations between halitosis and oral hygiene practices, though most of our patients (85.4%) reported that brushing their teeth at least once a day but flossing rate (9.8%) was low. Subjects with lower education levels reported a significantly higher prevalence of self-perceived halitosis because subjects with a university education may have better oral health and be more concerned about professional oral health care and oral hygiene practice[29]. Oral hygiene education should be improved in populations.

Smoking has been defined as an extrinsic cause of halitosis[30]. Cigarette smoke contains a volatile sulfur compound that can be detected using a halimeter[31,32]. Myazaki and coworkers[20] demonstrated a statistically significant correlation between smoking and higher VSC values. However, the concentration of detectable VSC strongly depends on the amount of time since the last cigarette[20]. In the present study, however, according to our results, there were not significant correlations between halitosis and extrinsic causes ($p>0.05$)and the prevalence of smokers was clearly lower (16.1%) a than in previous study mentioned. Although study participants were advised not to smoke for at least 1 h before their examination, smoking could represent an important confounding factor[19]. Alcoholic beverages are also known to produce volatile compounds, acetaldehyde and other odorous byproducts by oxidation of alcohol in the mouth and liver[11,33]. In contrast to the previous studies[4,17,25], we did not find any significant correlation between presence of objective halitosis and alcohol consumption. The difference in results may be a consequence of culture.

Extra-oral causes were reported 53.4% of this study population however there were not significant correlations between objective presence of halitosis and extra-oral causes. Even though multidisciplinary approach plays an important role for halitosis treatment, the results of this study noticed the main role of dentists in both diagnosis and treatment of halitosis.

Many studies have shown that periodontal disease and tongue coating are the major source of VSCs and oral malodor[5,7,14,34,35]. In the present study, a significant correlation was found between halitosis and tongue coating, periodontitis and gingivitis ($p<0.05$). Number of patients with objective presence of halitosis had significantly higher levels of tongue coating and periodontal scores than patients with objective absence of halitosis. 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[7,33,36]. The level of VSC has been reported to increase with tongue coating and to reduce after the removal of the coating[18,20,35]. As most of the oral bacteria that produce malodorous compounds (e.g. Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsynthensis, etc) are periodontal pathogens, it was logical to assume a positive correlation between VSC levels in the mouth air and the extent of periodontal pocket depths and the gingival bleeding tendency[37].

PI as an indicator of objective oral hygiene was chosen as a potential influencing factor for oral malodor. Grade 1 of the plaque index was found mostly and present with 44.6 % of the patients (n=457, 2 missing data). Majority of the patiens (73.5%) revealed plaque index scores of grade 0 and 1 altough there was no significant correlation found between halitosis and PI ((p>0.05)). It has been reported in the literature that the biofilm present at the time of examination seems not to significantly influence VSC values and organoleptic scores[34,38]. With regard to the findings in our study, there is a need for further research to more clearly understand the roles of dental plaque and their relationship to oral malodor[18].

The amount of VSCs (ppb) in the breath for the diagnosis of halitosis was measured by the Halimeter. The Halimeter is preferred because it provides an objective measurement, is portable, does not require experienced personnel, has low probability of crossinfection, and has 1- to 2-minute intervals between measurements[39]. Organoleptic measurements were not preferred due to being subjective and having crossinfection risks[40]. The gas chromatography device was also not preferred because it is expensive and complex and requires an experienced physician[41]. However, it has been reported that measuring only the VSCs would not be sufficient in determining halitosis and that the organoleptic method related to other gases would give more definitive data[40]. However, recent studies have shown that data obtained with the Halimeter are consistent with data found with organoleptic measurements[39-41].

Of the 459 subjects included in the present study, 232 (50.7%) subjects revealed objective presence of halitosis and 226 (49.3%) subjects had not halitosis related to the VSC values. In the present study, the prevalence of halitosis was higher than that reported by previous epidemiological studies in China[42], with VSC values >110 ppb for 20.3% of the subjects. A study from Japan[20] found that only 23% of the population had scores >75 ppb; however, the distribution of VSC values >75 ppb was not specified by the investigators. Other threshold measurements for manifest halitosis reported in the literature vary. Reported values include 125[43], ≥150[44], ≥170[45], and ≥200[46] ppb. The manufacturer of Halimeters had not stated a definite value of ppb for normal reading for many years. Yaegaki et al[47] recommended 75 ppb as a perceived level of malodor in mouth air. Miyazaki et al[20] also utilized the same standard in their survey of the general population for halitosis in Japanese. Recently, the manufacturer suggested 110 ppb or below as a normal reading in their instructions (http://www.halimeter.com/halcal.htm) and we accepted the manufacturer's levels. This wide variation and optional fixing of threshold values makes comparisons of studies difficult. Furthermore, the lack of a universally accepted VSC level for detection of halitosis could change the results with regard to self-reported oral malodor and VSC measurements[19].

**Conclusions**

This study showed that there was a high prevalence of halitosis in the Turkish population. Females sufferred from halitosis more frequently than males. Subjects with lower education levels reported a significantly higher prevalence of self-perceived halitosis. We found that there were not significant correlations between halitosis and oral hygiene practices, extrinsic causes and extra-oral causes. The most important factors that influence VSCs levels were intra-oral causes. A significant correlation was found between halitosis and tongue coating, periodontitis, gingivitis though PI did not affect halitosis.

**REFERENCES**

1- Tangerman A. Halitosis in medicine: a Review. Int Dent J 2002;52:201-6.
2- ADA Council on Scientific Affairs. Oral malodor. J Am Dent Assoc 2003;134:209-14.
3- Yaegaki K, Coil JM. Examination, classification, and treatment of halitosis; clinical perspectives. J Can Dent Assoc 2000;66:257-61.
4- 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;34:444-9.
5- Nalcaci R, Baran I. Factors associated with selfreported halitosis (SRH) and perceived taste disturbance (PTD) in elderly. Arch Gerontol Geriatr 2008;46:307-16.
6- Porter SR, Scully C. Oral malodour (halitosis). BMJ 2006:23;333:632-5.
7- Sanz M, Roldan S, Herrera D. Fundamentals of

breath malodour. J Contemp Dent Pract 2001;2:1-17.

8- 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;35:627-35.

9- Nalcaci R, Baran I. Oral malodor and removable complete dentures in the elderly. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:5-9.

10- 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;28:285-8.

11- Dal Rio AC, Nicola EM, Teixeira AR. Halitosis an assessment protocol proposal. Braz J Otorhinolaryngol 2007;73:835-42.

12- Delanghe G, Ghyselen J, van Steenberghe D, Feenstra L. Multidisciplinary breath-odour clinic. Lancet 1997;19;350:187.

13- Shimura M, Yasuno Y, Iwakura M, Shimada Y, Sakai S, Suzuki K, et al. A new monitor with a zinc-oxide thin film semiconductor sensor for the measurement of volatile sulfur compounds in mouth air. J Periodontol 1996;67:396-402.

14- Grover HS, Blaggana A, Jain Y, Saini N. Detection and measurement of oral malodor in chronic periodontitis patients and its correlation with levels of select oral anaerobes in subgingival plaque. Contemp Clin Dent 2015;6:181-7.

15- Moriyama T. Clinical study of the correlation between bad breath and subgingival microflora. Shikwa Gakuho 1989;89:1425-39.

16- Eldarrat A, Alkhabuli J, Malik A. The Prevalence of Self-Reported Halitosis and Oral Hygiene Practices among Libyan Students and Office Workers. Libyan J Med 2008;3:170-6.

17- 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;8:34.

18- 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;117:261-7

19- Bornstein MM, Stocker B, Seemann R, Walter B , Lussi A Prevalence of Halitosis in Young Male Adults: A Study in Swiss Army Recruits Comparing Self-Reported and Clinical Data. J Periodontol 2009;80:24-31

20- Miyazaki H, Sakao S, Katoh Y, Takehara T. Correlation between volatile sulphur compounds and certain oral health measurement in the general population. J Periodontol 1995;66:679-84.

21- Ainamo J, Barmes D, Beagrie G, Cutress TW. Sardo- Infirri J. Development of the World Health Organization (WHO) Community Periodontal Index of Treatment Needs (CPITN) Int Dent J 1982;32: 281–91

22- Diamanti-Kipioti A, Papapanou TN, Moraitaki-Zamitsai A, Lindhe J, Mitsis F. Comparative estimation of periodontal conditions by means of different index systems. J Clin Periodontol 1993; 20:656–61.

23- Löe H. The gingival index, the plaque index and the retention index systems. J Periodontol. 1967;38:610–16.

24- 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;73: 1568–74.

25- Rosenberg M. The science of bad breath. Sci Am 2002;4:72–5.

26- Seemann R, Bizhang M, Djamchidi C, Nachnani S, Kage A. The proportion of pseudo-halitosis patients in a multidisciplinary breath malodor consultation. Int Dent J 2006;56:77-81.

27- Vandekerckhove, B., Quirynen, M. & van Steenberghe, D. An inventory study on a randomized group of 1000 patients visiting a multidisciplinary breath odor clinic at a university hospital. Oral Dis 2005;11;98–9.

28- Quirynen M, Dadamio J, Van den Velde S, De Smit M, Dekeyser C, Van Tornout M, Vandekerckhove B. Characteristics of 2000 patients who visited a halitosis clinic. J Clin Periodontol 2009;36:970–5.

29- 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;34:444-9.

30- Morita M, Wang HL. Relationship between sulcular sulfide level and oral malodor in subjects with periodontal disease. J Periodontol 2001;72:79–84.

31- Rosenberg M. Clinical assessment of bad breath:

current concepts. J Am Dent Assoc 1996;127: 475–82.
32- Christen AG. The impact of tobacco use and cessation on oral and dental diseases and conditions. Am J Med 1992;93:25–31.
33- Hughes FJ, McNab R. Oral malodour a review. Arch Oral Biol 2008;53:1-7.
34- 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;73:1338-42.
35- Cicek Y, Orbak R, Tezel A, Orbak Z, Erciyas K. Effect of tongue brushing on oral malodor in adolescents. Pediatr Int 2003;45:719-23.
36- Loesche WJ, Kazor C. Microbiology and treatment of halitosis. Periodontol 2002;28:256-79.
37- Coli JM, Tonzetich J. Characterization of volatile sulphur compounds production at individual gingival crevicular sites in humans. J Clin Dent 1992;3:97–103.
38- De Boever EH, De Uzeda M, Loesche WJ. Relationship between volatile sulfur compounds. BANA-hydrolizing bacteria and gingival health in patients with and without complaints of oral malodor. J Clin Dent 1994;4:114-9.
39- Rosenberg M, Kulkarni GV, Bosy A, McCulloch CA. Reproducibility and sensitivity of oral malodor measurements with a portable sulphide monitor. J Dent Res 1991;70:1436–40.
40- Murata T, Yamaga T, Iida T, Miyazaki H, Yaegaki K. Classification and examination of halitosis. Int Dent J 2002;52:181–6.
41- Nalcaci R, Sonmez IS. Evaluation of oral malodor in children. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:384–8.
42- Liu XN, Shinada K, Chen XC, Zhang GX, Yaegaki K, Kawaguchi Y. Oral malodor-related parameters in the Chinese general population. J Clin Periodontol 2006;33:31-6.
43- Iwanicka-Grzegorek E, Michalik J, Kepa J, Wierzbicka M, Aleksinski M, Peirzynowska E. Subjective patients' opinion and evaluation of halitosis using halimeter and organoleptic scores. Oral Dis 2005;11:86-8.
44- Richter JL. Diagnosis and treatment of halitosis. Compend Contin Educ Dent 1996;17:370-2.
45- 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;76:1025-33.
46- Kazor CE, Mitchell PM, Lee AM, et al. Diversity of bacterial populations on the tongue dorsa of patients with halitosis and healthy patients. J Clin Microbiol 2003;41:558-63.
47- Yaegaki K. & Sanada K. Effects of a two-phase oil-water mouthwash on halitosis. Clin Prev Dent 1992;14: 5–9.

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