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# Clinical evaluation of 222 Iranian patients with halitosis

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**Abstract**
The primary objectives of the study were to investigate the levels of volatile sulfur compounds (VSCs) in Iranian patients and to find the most prevalent class of halitosis among them. The secondary objective was to study the measures employed by the patients to reduce halitosis. 46.4% of the 222 patients were female (average 32.1 years) and 53.6% were male (average 32.1 years). Contrary to other reports, males were dominant in this study. All the subjects were evaluated through oral examination, gas chromatographic analysis, organoleptic assessment and mouth cleaning and rinsing test (MCART). Finally, each patient was classified according to current classification. The patients were also asked about the measures employed by them to reduce halitosis. The data were statistically analysed using SPSS software. Gas chromatographic analysis revealed that the median values for $H_2S$, $CH_3SH$ and $(CH_3)_2S$ levels were 214 ppb, 64 ppb and 2 ppb, respectively. Average values of $H_2S$, $CH_3SH$ and $(CH_3)_2S$ were 358.7 ppb, 143.0 ppb and 19.5 ppb, respectively. A correlation was demonstrated between organoleptic scores and the concentration of only $H_2S$, $CH_3SH$ and the total of three gases. In 62.2% of the subjects, no oral pathologic condition was found, but tongue coating was observed. The patients were in only class I (genuine halitosis) and class II (pseudo-halitosis) halitosis. None of them was diagnosed as halitophobia. The percentages of classes I and II were 98.6% and 1.4%, respectively. The percentages of sub-classes of class I halitosis in total subjects were as follows: 60.8% physiologic halitosis, 37.8% oral pathologic halitosis and 0% extraoral pathologic halitosis. The mean value of organoleptic score for physiologic halitosis was 4.0 and those for oral pathologic halitosis and pseudo-halitosis were 4.3 and 1.6, respectively. MCART was a useful tool to distinguish oral halitosis from extraoral halitosis. Levels of VSCs were not as high as those measured in other countries. Although in most cases VSCs were a contributing factor to halitosis, VSCs levels were not useful diagnostic criteria for the minority of the patients. The most prevalent class and sub-class of halitosis in the patients were genuine halitosis and physiologic halitosis. Measures employed by the patients to reduce halitosis were mostly related to the oral cavity.

M A Persian translation of this abstract is available online

## Introduction

Halitosis is a widespread problem. Putrefactive activity within the oral cavity is the principal cause of halitosis [1]. The bacteria produce various volatile malodours but the main components of oral malodour are volatile sulfur compounds (VSCs) such as hydrogen sulfide ($H_2S$), methyl mercaptan ($CH_3SH$) and dimethyl sulfide ($(CH_3)_2S$). The primary aims of the study were to investigate the levels of VSCs in Iranian patients with halitosis and to classify the patients according to

 

**Table 1.** Summary of gas chromatographic results.

| Gas | Not detected (%) | Below cognitive threshold (%) | Mean ± SEM | Median (ppb) | Correlated with organoleptic score |
|---|---|---|---|---|---|
| $H_2S$ | 2.7 | 29.3 | 358.7 ± 25.6 | 214 | Yes ($r = 0.408$) |
| $CH_3SH$ | 10.3 | 27.5 | 143.0 ± 14.6 | 64 | Yes ($r = 0.299$) |
| $(CH_3)_2S$ | 41.4 | 56.3 | 19.5 ± 2.3 | 2 | No |
| $H_2S + CH_3SH + (CH_3)_2S$ | 1.3 | 14.8 | 521.3 ± 30.0 | 305.5 | Yes ($r = 0.384$) |

current classification [2, 3]. According to the classification, halitosis is classified into categories of genuine halitosis, pseudo-halitosis and halitophobia. Genuine halitosis is subclassified into physiologic halitosis or pathologic halitosis. Pathologic halitosis itself is categorized into oral pathologic halitosis and extraoral pathologic halitosis. If malodour does not exist but the patient believes that he or she has oral malodour, the patient would be diagnosed as having pseudo-halitosis. After treating either genuine halitosis or pseudo-halitosis, should the patient still believe that he or she has halitosis, a rediagnosis of halitophobia is warranted.

The secondary aim was to study the measures employed by the patients to reduce halitosis.

## Subjects and method

### *Subjects*

This study utilized data recorded in a breath odour clinic in Isfahan, Iran. In the clinic, all patients who received halitosis therapy were recorded in a database. From October 2005 to February 2007, a total of 222 patients who complained of halitosis visited the clinic. They were from ten provinces of the country, mainly from Isfahan. They became aware of the clinic through (a) advertisements in local press (88.8%), (b) website visiting (2.2%), (c) referrals from dentists, general practitioners and other medical specialists (8.1%), (d) friends and other family members (0.9%). 95.1% were from urban and 4.9% were from rural areas (with a population of less than 40 000 people). 46.4% of the subjects were female aged from 13 to 64 years (average 32.1 years) and 53.6% were male aged from 8 to 63 years (average 32.1 years). 53.6% of total subjects were married (55.5% female, 44.5% male) and 46.4% were single (37.9% female, 62.1% male) (table 4). Informed consent was not deemed necessary because of the retrospective nature of this study. All the patients were assessed through an identical manner. An appointment was made for each patient and they were asked to abstain from smoking for 12 h before appointment. The patients were instructed to avoid garlic, spicy food and onion for 48 h before appointment. No one took antibiotics during 2 weeks before appointment day. They were instructed to attend at 8 to 9 o'clock in the morning and to refrain from breakfast, brushing, flossing, smoking, perfumes and any mouthwash on the appointment day.

### *The method*

The method of evaluation of the subjects consisted of four steps.

(1) *Gas chromatographic analysis*. A sample of mouth air (5 ml) was taken by a special plastic syringe and injected into a portable gas chromatograph, OralChroma (Abilit Co., Japan). The concentrations of three volatile sulfur compounds (hydrogen sulfide, methyl mercaptan and dimethyl sulfide) were determined in 8 min and a chromatogram was drawn for each subject by the device software (version 3.02). Cognitive thresholds for $H_2S$, $CH_3SH$ and $(CH_3)_2S$ were considered as 1.5 ng/10 ml (=112 ppb), 0.49 ng/10 ml (=26 ppb) and 0.19 ng/10 ml (=8 ppb), respectively. The threshold values for each gas were suggested by the device software. The value for $H_2S$ was the same as that proposed by Tonzetich *et al* [4] and Murata *et al* [5], but the values for $CH_3SH$ and $(CH_3)_2S$ were lower. The values reported by Tonzetich *et al* and Murata *et al* for $CH_3SH$ and $(CH_3)_2S$ were 0.5 ng/10 ml and 0.2 ng/10 ml, respectively.

(2) *Organoleptic assessment*. Oral and nasal malodour were assessed by a trained examiner using a 0–5 scale [2, 3]. The whole mouth malodour and nostrils malodour were separately assessed using a flexible plastic straw. To omit inter-examiner variation, the organoleptic assessment was performed by one examiner.

(3) *Oral cavity examination.* The subjects' periodontium was examined by a dentist to find gum bleeding, deep periodontal pockets and calculus. If purulent discharge was observed in the pharynx, purulent post nasal drip could be confirmed.
To omit inter-examiner variation, the oral cavity examination was performed by a dentist who had a good command of dental practice.

(4) *Mouth cleaning and rinsing test (MCART).* MCART was performed for all patients to reach a proper diagnosis. MCART was performed as follows.
   (a) Tongue coating was removed by a commercial tongue scraper[4] (15 strokes) and the procedure was completed by brushing the tongue (15 strokes) with a child-size extra soft tooth brush wetted with a commercial zinc-containing mouthwash[4] solution.
   (b) Gums, palate and teeth were wetted by a toothbrush that was wetted with the mouthwash solution.
   (c) Then the subject was asked to rinse the mouth with 5 ml of the mouthwash solution for 1 min and again gargle with another 5 ml of the solution for 1 min with the head tilted backwards. Then the patient was asked not to rinse his/her mouth and to avoid any oral activity.

After 1 h, total mouth odour was evaluated through organoleptic assessment. Following the above evaluations, the patients were classified. At the end, the patients were

[4] BreathRX, Discus Dental, Inc., CA, USA.

**Table 2.** Results of patients' classification.

| Class | Per cent | Relevant mean organoleptic score |
|---|---|---|
| (I) Genuine halitosis | 98.6 | |
| (A) Physiologic halitosis | 60.8 | 4 |
| (B) Pathologic halitosis | | |
| (a) Oral pathologic halitosis | 37.8 | 4.3 |
| (b) Extraoral pathologic halitosis | 0 | – |
| (II) Pseudo-halitosis | 1.4 | 1.6 |
| (III) Halitophobia | 0 | – |

**Table 3.** Measures employed by the patients to reduce halitosis.

| Measures | Frequency |
|---|---|
| Chewing gum | 152 |
| Tooth brushing | 91 |
| Mouthwashes (all kinds) | 30 |
| Eating (sweet, chocolate, food, fruits or fruit juice) | 32 |
| Without any measures | 22 |
| Gargling with salty water, toothpaste slurry, baking soda solution, lemon juice, or vinegar | 16 |
| Mints and deodorizing spray | 11 |
| Tongue brushing | 11 |
| Flossing | 7 |
| Antibiotics | 5 |
| Avoiding fruits + vegetables | 2 |
| Drinking excess water | 2 |
| Avoiding spicy and fried foods | 1 |
| Applying perfumes to facial skin | 1 |
| Cigarette smoking | 1 |
| Dental prophylaxis | 1 |
| Hydrotherapy (40 days) | 1 |
| Taking a bath | 1 |

also asked about the measures employed by them to reduce halitosis. The answers were collected and the results are shown in table 3.

### *Statistical evaluation*

The data were statistically analysed using SPSS software. Mean and median values were calculated for the concentrations of three gases ($H$, $M$ and $D$) and the total of the gases ($T$). To determine the relationship between organoleptic scaling ($O$) and the parameters $H$, $M$, $D$ and $T$, Pearson correlation coefficients were used. The concentrations of each gas ($H$, $M$ and $D$) and the total of the gases ($T$) were divided into two groups: group A that was below the cognitive threshold values and group B that was above the cognitive threshold values. Then the percentage of each group was calculated.

## Results

### *Gas chromatographic analysis*

Not all of the readings for $H_2S$ were in the range of device measurement (0 to 1429 ppb). The device shows levels above the upper extreme of measurement as 1429 ppb. In this study 4.9% of readings were beyond the upper extreme and, therefore, were considered as 1429 ppb. In 2.7% of total subjects no hydrogen sulphide (0 ppb) was detected. In 29.3% of total subjects, the concentrations (0–111 ppb) were below cognitive threshold (112 ppb); therefore, only in 70.7% of the subjects was hydrogen sulfide a contributor to halitosis. The mean value and standard error of mean was $358.7 \pm 25.6$ (mean $\pm$ SEM) ppb but the median value was 214 ppb. A correlation was demonstrated between the organoleptic score and the concentration of $H_2S$ ($r = 0.408$, $p < 0.0001$) (table 1).

All of the readings for $CH_3SH$ were in the range of device measurement. The range of readings was 0 to 1513 ppb. In 10.3% of total subjects, no methyl mercaptan (0 ppb) was detected. In 27.5% of total subjects, the concentrations (0–25 ppb) were below the cognitive threshold (26 ppb); therefore, only in 72.5% of the subjects was methyl mercaptan a contributor to halitosis. The mean value and standard error of mean was $143.0 \pm 14.6$ (mean $\pm$ SEM) ppb but the median value was 64 ppb. A correlation was also demonstrated between the organoleptic score and the concentration of $CH_3SH$ ($r = 0.299$, $p < 0.0001$) (table 1).

All of the readings for $(CH_3)_2S$ were in the range of device measurement. The range of readings was 0 to 212 ppb. In 41.4% of total subjects, no dimethyl sulfide was detected. In 56.3% of total subjects, the concentrations (0–7 ppb) were below the cognitive threshold (8 ppb); therefore, only in 43.7% of the subjects was dimethyl sulfide a contributor to halitosis. The mean value and standard error of mean was $19.5 \pm 2.3$ (mean $\pm$ SEM) ppb but the median value was 2 ppb. No correlation was found between the organoleptic score and the concentration of $(CH_3)_2S$ (table 1).

Only in 1.3% of the cases was a zero concentration for three gases recorded. In 0.46%, no hydrogen sulfide and methyl mercaptan were found and also in 6.5% of total subjects no methyl mercaptan and dimethyl sulfide was detected. In 14.8% of total subjects, the concentrations of three gases were below each individual gas cognitive thresholds (table 1). As an apparent oral malodour was obvious in these subjects, the problem was due to odorants other than VSCs. In 81.5% of the cases, $H_2S$ and $CH_3SH$ accounted for 90% or more of the total VSCs content of mouth air.

In some cases hydrogen sulfide and methyl mercaptan individually account for up to 100% of total VSCs content of the mouth but this was not the case for methyl mercaptan. Only in 0.4% of the cases were the concentrations of $H_2S$ and $CH_3SH$ equal, and in 2.7% of the cases they were present in approximately equal amounts. In an attempt to calculate the percentage of both hydrogen sulfide and methyl mercaptan in total VSCs of each subject, the values of the concentrations of two gases were added. This figure was used to calculate the percentage of the gases in the total VSCs content of mouth air. It was proved that in 82.2% of total subjects, the percentages of both gases were 90% or more of the total individual VSCs content of mouth air. The mean value and standard error of mean for three gases was $521.3 \pm 30.0$ (mean $\pm$ SEM) ppb but the median value was 305.5 ppb. A correlation was found between the organoleptic score and the total of the concentrations of three gases ($r = 0.384$, $p < 0.0001$) (table 1).

Comparing the results of chromatographic analysis, it was revealed that the highest correlation between the organoleptic scores and the gases concentrations was related to $H_2S$ ($r = 0.408$) and the lowest was related to $CH_3SH$ ($r = 0.299$). As $H_2S$ was dominant in VSCs, the correlations between the organoleptic scores and the concentrations of $H_2S$ ($r = 0.408$) and the total of three gases ($r = 0.384$) were close to each other. It was concluded that the total of three gases can be considered as reliable as the concentration of $H_2S$.

*Organoleptic assessment*

In total, 33.8% of the subjects had an organoleptic score of 5 and 44.6%, 19.4%, 1.8% and 0.4% of the subjects had an organoleptic score of 4, 3, 2 and 1, respectively. Based on the severity of halitosis, the subjects were divided into two groups. Group 1 had no or slight halitosis (scores 2 and lower), and group 2 had obvious malodour (scores 3–5). The percentage (97.8%) of group 2 was much higher than group 1 (2.2%).

*Oral cavity examination*

In 62.2% of the subjects, neither specific disease nor a pathologic condition was found but tongue coating was observed (physiologic and pseudo-halitosis cases). In 37.8% of the patients, tongue coating along with deep pockets, gum bleeding or calculus was observed (oral pathologic halitosis cases). Tonsils of 9.9% of the patients had been surgically removed due to halitosis or medical indications. None of those patients was the pseudo-halitosis case and apparent halitosis could be detected. Purulent post nasal drip was observed only in 0.4% of the patients.

*Mouth cleaning and rinsing test (MCART)*

In all patients, this test could reduce halitosis to a socially acceptable level (organoleptic score 0–1) for 1 h. Therefore, any underlying medical condition was ruled out.

*Patients' classification*

It was revealed that the patients were in only classes I and II halitosis (table 2). Since after treatment, none of the patients persisted in believing that he or she had halitosis, no one was diagnosed with halitophobia. The mean value of organoleptic score for physiologic halitosis was 4.0 and for oral pathologic halitosis and pseudo-halitosis were 4.3 and 1.6, respectively. The percentages of classes I (genuine halitosis) and II (pseudo-halitosis) halitosis were 98.6% and 1.4%, respectively. The percentages of sub-classes of class I halitosis in total subjects were as follows: 60.8% for physiologic halitosis, 37.8% for oral pathologic halitosis and 0% for extraoral pathologic halitosis. Therefore, the most prevalent class and sub-class of halitosis in the patients were genuine halitosis and physiologic halitosis. Since MCART could reduce halitosis in all patients and it could keep the organoleptic score below 2 for at least 1 h, nobody was diagnosed to have extraoral halitosis. This finding seemed true, because more than 60% of the patients visited various medical specialists before visiting the breath odour clinic and their treatments were not successful.

**Table 4.** Marital status of the patients.

| | Male | Female | Total |
|---|---|---|---|
| Single patients | | | |
| Number | 64 | 39 | 103 |
| Percentage | 62.1% | 37.9% | 100% |
| Married patients | | | |
| Number | 53 | 66 | 119 |
| Percentage | 44.5% | 55.5% | 100% |
| Total | 117 | 105 | 222 |

*Measures for reducing halitosis*

The patients answered the question variously. Some patients used one measure and others used more measures. One patient reported seven measures and 22 persons reported no measures. The others used two to six measures. All measures and their frequencies are arranged in table 3.

## Discussion and conclusion

In most reports [2, 6–11], the majority of the patients who visited the breath odour clinics were female but in this study only 46.4% of the subjects were female. The percentages of females in the group of single patients and married patients were 37.9% and 55.5% respectively (table 4). The result of chi-square analysis showed that the sex and marital status were significantly correlated ($p = 0.009$). Therefore, it seems that the single male patients and the married female patients care more about halitosis treatment.

It was interesting that the mean age of males and females in this study was low and equal to 32.1 years. Although halitosis was considered to be more prevalent among the middle aged or older [10, 13], 49.4% of the males and 48.7% of females were 40 or older. According to the latest census (2006), 73.06% of the population of Isfahan province was 39 years old or younger [14]; therefore, low mean age of the patients in this study may be related to the mean age of the young population of the province.

In this study, an OralChroma device was used to measure VSCs. It is a portable gas chromatograph invented for measuring halitosis through VSCs measurement. In spite of being a conventional gas chromatograph, it does not need specialized staff and does not take much time to measure. It is not heavy and does not take much space; therefore, it is a useful tool for clinical and research usage. Murata *et al* [15] examined the device and found that it might be useful for the diagnosis of halitosis. A drawback to this device is the upper extreme of measurement for $H_2S$. It cannot measure levels above 1429 ppb. Since conventional GC measures high levels of $H_2S$ even up to 2500 ppb [16], it must be expanded up to 3000 ppb. In this study, a correlation between the organoleptic scores and the device measurements was demonstrated except for $(CH_3)_2S$. A correlation was also found between organoleptic scores and the total of three gases. It is proposed to consider the cognitive threshold value of three gases as 146 ppb that is the sum of three gases' concentrations values. This VSC

**Table 5.** Percentages of the patients with various kinds of halitosis in three countries.

| Kind of disease | Iran | Belgium | Japan |
|---|---|---|---|
| Oral related halitosis | 98.6% | 78.4% | 65% |
| (Physiologic + oral pathologic halitosis) | (60.8% + 37.8%) | | (33% + 32%) |
| Extraoral related halitosis | 0% | 3.7% | 1% |
| (Extraoral pathologic halitosis) | | | |
| A combination of ENT/intra-oral halitosis | – | 3% | – |
| Psychologic halitosis | 1.4% | 14.9% | 34% |
| (Pseudo-halitosis + halitophobia) | (1.4% + 0%) | | (32% + 2%) |

threshold value is close to the threshold value (80–140 ppb) proposed by the manufacturer of the Halimeter device[5].

As there was a high difference between lower and higher readings for three gases, the median value is more reliable than the average value. Furthermore, inadequacy of the range of measurement for $H_2S$ makes the average of this gas unreal.

Tonzetich reported that $H_2S$ and $CH_3SH$ accounted for 90% of total VSC content of mouth air [1]. In this study, they accounted for 82.2%. Although this figure was not equivalent to Tonzetich's figure, our figure was close to it.

ADA has recommended that individuals included in clinical trials should have an average organoleptic intensity rating of at least 2.0 on a 0–5 intensity scale [17] but it was shown in this study that 97.8% of total subjects suffered from moderate, strong and severe halitosis (with 3 to 5 organoleptic score); therefore, it is proposed to include individuals with an organoleptic score at least 3.0 on a 0–5 scale.

As the dentist is in a position to assume an important role in early detection of malodour [12], a proper tool is needed to differentiate oral from extraoral malodours. By MCART the dentist can distinguish the halitosis caused by oral bacteria from other types of halitosis. Although this test is time consuming, it is cheap and can be carried out in every dental office. This test has its origin in the technique used by the pioneer researcher Tonzetich [1]. He believed '. . . if the oral cavity is the principal origin of sulphur compounds in mouth air, then their concentrations should be markedly reduced by oral hygiene procedures'. Also he stated, 'Since the oral hygiene measures markedly reduced the sulphur content in the mouth air, the technique affords a convenient means of differentiating the oral from systemic source of volatile sulphur in breath vapour'. The technique was modified and reinforced by adding swirling with a zinc-containing mouthwash because some studies [12, 18, 19] demonstrated that zinc-containing mouthwash reduced mouth air VSCs. As the name of the technique was too long, a contracted form (MCART) was considered. Currently the gold standard for bad breath measurement is still the human odour judge [20]. Therefore, MCART is combined with organoleptic assessment instead of device measurement. Device measurement can be used instead of or besides organoleptic assessment for the patients whose VSCs levels are more than the cognitive threshold. Since objective results are provided by device measurement and the patient can compare the values of device measurements, he or she relies more on the diagnosis and treatment. Device measurement is specially suitable for the patients with halitophobia and pseudo-halitosis.

Patient percentages in various classes of halitosis in this study are different from the results of other countries. The percentage of the patients with oral-related halitosis in this study is 98.6%; meanwhile, it is 78.4% in Belgium and 65% in Japan. In contrast, the percentage of the patients with psychologic halitosis in this study (1.4%) is much less than those in Belgium (14.9%) and Japan (34%). The percentage of extraoral-related halitosis patients in this study is 0%, which is close to the Japanese value (1%) but far from the Belgian percentage (3.7%) (table 5).

Halitosis has a complex nature and is a sociopsychosomatic disease. The diversity of the patient percentages between our results and other reports may be related to cultural, religious, economic, psychologic and lifestyle differences. To find the reasons for the diversities, all factors must be studied comparatively in a distinct multicentre study.

As there are very few commercial advertisements about the halitosis therapeutic agents in Iran, the people are more dependent on their personal knowledge and information. By analysis of the usage frequency of the measures employed by the patients to reduce halitosis, the popularity of the measures and the people's knowledge about the origin of halitosis can be evaluated. This evaluation is applicable to scientific, commercial and governmental fields.

The patients mentioned 25 kinds of measures. The most frequently used ones were chewing gum, tooth brushing and mouth washing. It can be understood that those patients considered the origin of halitosis mostly related to the oral cavity. Ten other measures were also related to the oral cavity. This showed that the patients' estimation about the potential origin of halitosis coincided with our current science. Nine cases were related to the oral cavity to some extent such as eating food and fruits, and three cases were not directly related to the oral cavity such as antibiotic therapy and taking a bath. Twenty two persons reported no measures.

Due to retrospective nature of this study, there are no data about the effectiveness of the measures employed by the patients but as they visited the breath odour clinic, it can be guessed that their measures were not satisfactory.

It is concluded that the levels of volatile sulfur compounds in mouth air are not as high as those measured in other countries. This emphasizes the need for measurement of other malodours. The most prevalent class and sub-class of halitosis in the Iranian patients are genuine halitosis and physiologic halitosis. In spite of the previous reports, no halitophobic

[5] Interscan Corporation. Instruction manual of RH-17 series Halimeter, page 3.

patient is found among the patients. MCART is a useful tool to distinguish oral halitosis from extraoral halitosis. Measures employed by the patients to reduce halitosis are mostly related to the oral cavity. This showed that to some extent the Iranian patients' knowledge about the origin of halitosis coincided with our current scientific findings.

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