Descriptive Statistical Analysis Report on the Results of Questionnaire and Observations on Patients With Physiological Halitosis Who Visited the KUMC Halitosis Clinic- A Retrospective Study

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Research Article

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Abstract

**Background:** We initiated to prepare the basic data that could help us to understand the characteristics of patients with physiological halitosis symptoms in Korea and aid in explaining the causes of these symptoms.

**Methods:** We collected questionnaire and dietary analysis results from the data of 246 adult patients diagnosed with physiological halitosis symptoms, collected the data from the patients’ salivary measurements and the analysis data of patients’ tongue and throat management status. Using the SPSS (IBM SPSS™, Ver. 22.0) program, we performed a frequency analysis, calculating the correlation coefficient Phi with an independence test.

**Results:** The mean age and one standard deviation of 246 patients with physiological halitosis was 41.85±11.63 years. The proportion of women, the proportion of patients who replaced breakfast with fast food or skipped breakfast, with beverage drinking habits such as coffee, tea, or carbonated drink, with irregular or insufficient consumption of water, who recognized their own oral malodor, suffering anxiety or stress over oral malodor, with an introverted personality, with insufficient unstimulated salivation volume, with incorrect tongue management, and with PND (Postnasal drip) or PTC (Posterior Tongue Coating) were all statistically analyzed to be significant ($p < 0.05$). As a result of the correlation analysis, the Phi values of the seven pairs of the bivariate variables were from 0.137 to 0.196, and the Phi values of the five pairs of the bivariate variables - the Phi value between the breakfast pattern variable and the regular diet variable, the Phi value between the stimulating menu variable and the drinking variable, the Phi value between the unstimulated saliva variable and the stimulated saliva variable, the Phi value between the unstimulated saliva variable and the sedimentation ratio of saliva variable, and the Phi value between the stimulated saliva variable and the sedimentation ratio of saliva variable - were from 0.203 to 0.394 ($p < 0.05$).

**Conclusion:** We could suggest the 10 potential common risk factors related to physiological halitosis symptom, and the five pairs of variables with Phi values ranging from 0.20 to 0.40 could be judged to have a moderate correlation.

**Background**

Oral malodor refers to exhaled breath that a person or a third party finds to be unpleasant. Oral malodor patient is a patient who has anxiety about oral malodor caused by physiological, physical and mental causes [1]. In the past, depending upon the person perceiving themselves as having oral malodor, this problem could be classified as either self-reported halitosis (subjective halitosis) or objective halitosis, as recognized by other people. These more usually have been classified as genuine halitosis, pseudo halitosis, and halitophobia. In the past, many scholars had adopted this classification around the world [2]. But instead, the authors of the present study have adopted the classification of physiological and pathological halitosis as proposed by the Japanese Academy of Malodor Syndrome (JAMS) and the
Korean Academy of Halitosis Control under the Korean Academy of Preventive Dentistry and Oral Health (KAPDOH) [3]. Accordingly, we can classify pathological halitosis as being oral malodors resulting from diseases of the oral region, the otorhinolaryngological system, neurological disorders, mental disorders, or from systemic medical diseases. We can also classify physiological halitosis as oral malodor occurring when a person wakes up in the morning, gets hungry, becomes tense, is tired, during a woman's menstrual fluctuations, when pregnant or in puberty, during menopause, or after the ingestion of favorite foods, ordinary foods, or certain drugs [1, 3].

Looking at the trend of recent published papers related to halitosis, Bigler and Filippi conducted a survey on the perception of oral malodor among adolescents and young people [4], and Jongh et al. analyzed the effect of oral malodor on social activities [5]. They reported on the social discomfort caused by oral malodor. In addition, Alquatami et al. suggested mouth breathing as one cause of oral malodor [6], and Milanesi et al. reported that gender, dry mouth, and education levels to be contributing factors to oral malodor [7]. Wang and He analyzed patients' mental and psychological factors and suggested these as being some causes of oral malodor [8]. Du et al. and M. Van Tornout et al. insisted that a coated tongue had the closest relationship to oral malodor [9, 10]. Chen et al. argued that the depth of the periodontal pockets, along with coated tongue, could be related to oral malodor [11]. Suzuki et al. pointed out that coated tongue, periodontitis, and reduced salivary flow at rest could affect the occurrence of oral malodor [12]. Suzuki et al. also argued that habitual drinking and oral malodor were especially related in periodontal disease patients [13]. M. Rad et al. argued that there was a relationship between habitual smoking habit and oral malodor [14]. Troger B et al. surveyed and reported that lower educational and income levels were associated with a greater occurrence of oral malodor, and such patients could find their own oral malodor more distressing than other people [15]. In addition, M. Torsten et al. reported the possibility of oral malodor caused by some drugs [16]. A. Wälti et al. suggested the need for a breakfast containing normal dietary fiber to suppress oral malodor [17]. M. Ueno et al. argued that saliva turbidity could be associated with oral malodor and that the risk of halitosis would become greater with an increase in salivary viscosity [18, 19]. M. Fukui et al. also suggested that an increase in the salivary cortisol concentration due to chronic stress could cause physiological oral malodor [20], and Patel et al. argued that social anxiety, poor oral hygiene, and coated tongue were associated with subjective halitosis [21].

But the above scholars did not comprehensively explain the causes and treatment methods for physiological halitosis [22]. Therefore, we performed a descriptive statistical analysis of a questionnaire to determine patients' dietary habits, their own perceptions of oral malodor, and lifestyle habits that could induce oral malodor. We also analyzed the results of salivary measurements and photographic data of the tongue and throat of 246 patients with physiological halitosis symptoms who had visited the KUMC (Korea University Medical Center) Oral Malodor Clinic from 2009 to 2020. We then were able to prepare the basic data that could help us to understand the characteristics of patients with physiological halitosis symptoms in Korea and also aid in explaining the causes of these symptoms.
Materials And Methods

Study participants

The study population consisted of 246 adult patients diagnosed with physiological halitosis symptoms, excluding minors under the age of 18, who had visited the KUMC Halitosis Clinic from 2009 to 2020. All data was obtained from the patients' surveys and examination records at the time of physiological halitosis diagnosis, but we excluded the patients’ name, dental diagnosis & treatment record number, resident registration number, and contact information.

Data collection from questionnaires and dietary records

From the contents of questionnaires and dietary records, we collected the patients’ data including age, sex, breakfast patterns, three-meal-a-day dietary habits, soft drink beverage habits, snack consumption patterns, stimulating menu choices, daily water intake frequency, oral malodor self-awareness or self-consciousness, anxiety or stress over halitosis, toothbrushing frequency, mouth breathing or smoking habits, drinking patterns, and their character, using the data collection form shown in Table 1.

Table 1. Data gathering form used in this study for the physiological malodor symptom patients
| Variable               | Value determination standard                                                                 | Patient’s data |
|------------------------|---------------------------------------------------------------------------------------------|----------------|
| AGE                    | Patient’s age in the 1st visit                                                              |                |
| SEX                    | 0=Male, 1=Female                                                                            |                |
| Breakfast Pattern      | 0=Korean meal menu, 1=Fast food or Skip                                                     |                |
| Regular Diet           | 0= Regular diet as 3-times meal a day                                                        |                |
|                        | 1= Irregular diet                                                                           |                |
| Soft Drink             | 0=Do not sip any cup of coffee or tea, carbonated drink                                      |                |
|                        | 1=Often sip some coffee or tea, carbonated drink                                            |                |
| Snack                  | 0=Do not eat any snack which is staying behind on tongue                                     |                |
|                        | 1=Preference for snack which is staying behind on tongue                                     |                |
| Stimulating Menu       | 0=Do not eat salty or hot food                                                              |                |
|                        | 1=Often eat salty or hot food                                                               |                |
| Water Intake           | 0=Regular and sufficient water intake                                                       |                |
|                        | 1=Irregular or insufficient water intake                                                    |                |
| Self-awareness         | 0=Not aware of one’s own halitosis                                                           |                |
|                        | 1=Aware of one’s own halitosis                                                              |                |
| Anxiety or Stress<sup>a</sup> | 0=No, 1=Yes                                         |                |
| TB frequency<sup>b</sup> | 0=Three times or less a day                                                                 |                |
|                        | 1=More than 4 times a day                                                                    |                |
| Mouth Br. or Smoking<sup>c</sup> | 0=Have not a habit of mouth breathing and do not smoke                                        |                |
|                        | 1=Have a habit of mouth breathing or have a habit of smoking                                 |                |
| Drinking               | 0=Drinking once or none in a week                                                            |                |
|                        | 1=Drinking more than twice in a week                                                         |                |
| Character              | 0=Extroverted, 1=Introverted                                                                 |                |
| Unstimulated Saliva<sup>d</sup> | 0=Above or equal to the level of 3.0mL / 3.0min<sup>*</sup>                                   |                |
|                        | 1=Below the level of 3.0mL / 3.0min                                                         |                |
| Stimulated Saliva<sup>d</sup> | 0=Above or equal to the level of 3.0mL / 3.0min<sup>*</sup>                                   |                |
|                        | 1=Below the level of 3.0mL / 3.0min                                                         |                |
| Sedimentation ratio<sup>e</sup> | 0=Below the level of 10%<sup>a</sup> |
|-------------------------------|---------------------------------|
|                               | 1=Equal to or above the level of 10% |

| Red or Coated Tongue<sup>f</sup> | 0=No, 1=Yes |
|---------------------------------|-------------|

| PND or PTC<sup>g</sup> | 0=No, 1=Yes |
|------------------------|-------------|

**a**: Anxiety or Stress for one’s own halitosis, **b**: Toothbrushing frequency a day, **c**: Mouth Breathing or Smoking habit, **d**: Based on the standards suggested by JAMS and the Korean Academy of Halitosis Control under the KAPDOH, **e**: Sedimentation ratio of Saliva, **f**: Red Tongue or Coated Tongue, **g**: Postnasal Drip or Posterior Tongue Coating

**Data from clinical observations and measurements**

We also collected the data from the patients’ salivary measurements and the analysis data of the patients’ tongue and throat photographs obtained by use of an intraoral camera (Spirit II™, Dentall, Korea), as being the amount of unstimulated saliva, the amount of stimulated saliva, the sedimentation ratio of saliva, the patients’ tongue care status such as red tongue or coated tongue or healthy tongue, and whether they had PND (postnasal drip) or PTC (posterior tongue coating), using the data collection form shown in Table 1.

**Statistical analysis**

Using the SPSS (IBM SPSS™, Ver. 22.0) program, we performed a frequency analysis for each of 19 variables in data collected from 246 physiological halitosis patients. For the statistically significant ($p < 0.05$) variables among these, we calculated the correlation coefficient Phi with an independence test and investigated the correlation among the variables. All $p$-values were two-sided and if below 0.05 the results were considered statistically significant.

**Ethical approval**

This research protocol was approved by the Institutional Review Board of Korea University Guro Hospital. (IRB No. 2021GR0246)

**Results**

Using the standards in Table 1, we obtained descriptive statistical analysis results of the 246 patients, who had been diagnosed with physiological halitosis, as summarized in Table 2 and Table 3. In addition, for the 17 bivariate variables that were statistically significant ($p < 0.05$) as shown in Table 3, we performed an independence test. We could then summarize the statistically significant ($p < 0.05$) correlation results of 12 combinations as shown in Table 4.
Table 2. Age analysis result for the 246 patients with physiological halitosis symptoms.

| Variable | N  | Mean | Standard Deviation |
|----------|----|------|--------------------|
| AGE      | 246| 41.85| 11.63              |

The mean age and one standard deviation of 246 patients with physiological halitosis was $41.85 \pm 11.63$ years, and the proportion of women was statistically significantly high ($p=0.022$). We analyzed the proportion of patients who replaced breakfast with fast food or skipped breakfast ($p<0.001$), the proportion of patients with beverage drinking habits such as coffee, tea, or carbonated drink ($p<0.001$), the proportion of patients with irregular or insufficient consumption of water ($p<0.001$), the proportion of patients who recognized their own oral malodor ($p<0.001$), the proportion of patients suffering anxiety or stress over oral malodor ($p<0.001$), and the proportion of patients with an introverted personality ($p<0.001$) to be statistically significantly high. And the proportion of the patients with insufficient unstimulated salivation volume (less than 3.0mL / 3.0 min) ($p<0.001$), the proportion of the patients with incorrect tongue management ($p<0.001$), and the proportion of patients with PND in the throat or PTC on the posterior surface of tongue ($p<0.001$) were all statistically analyzed to be significantly high.

Table 3. Frequency analysis results for the 246 patients with physiologic halitosis symptoms
| Variable                      | Frequency/Percent (%) | $\chi^2$ value | $p$-value |
|-------------------------------|-----------------------|----------------|-----------|
| SEX                          | 0. Male               | 105/42.7       | 5.268     | 0.022     |
|                               | 1. Female             | 141/57.3       |           |           |
| Breakfast Pattern             | 0. Korean meal menu   | 89/36.2        | 18.797    | $<$ 0.001 |
|                               | 1. Fast Food or Skip  | 157/63.8       |           |           |
| Regular Diet                  | 0. Regular Diet as 3 meals | 170/69.1 | 35.919 | $<$ 0.001 |
|                               | 1. Irregular Diet     | 76/30.9        |           |           |
| Soft Drink                    | 0. Do not sip any cup of coffee or tea, carbonated drink | 52/21.1 | 81.967 | $<$ 0.001 |
|                               | 1. Often sip some coffee or tea, carbonated drink | 194/78.9 |       |           |
| Snack                         | 0. Do not eat any snack which is staying behind on tongue | 114/46.3 | 1.317  | 0.251     |
|                               | 1. Preference for snack which is staying behind on tongue | 132/53.7 |       |           |
| Stimulating Menu              | 0. Do not eat salty or hot food | 145/58.9 | 7.870 | 0.005     |
|                               | 1. Often eat salty or hot food | 101/41.1 |       |           |
| Water Intake                  | 0. Regular & Sufficient Water Intake | 53/21.5 | 79.675 | $<$ 0.001 |
|                               | 1. Irregular & Insufficient Water Intake | 193/78.5 |       |           |
| Self-awareness                | 0. Not aware of one's own halitosis | 27/11.0 | 149.854 | $<$ 0.001 |
|                               | 1. Aware of one's own halitosis | 219/89.0 |       |           |
| Anxiety or Stress             | 0. No                 | 6/2.4          | 222.585   | $<$ 0.001 |
|                               | 1. Yes                | 240/97.6       |           |           |
| TB frequency                  | 0. Three times or less a day | 160/65.0 | 22.260 | $<$ 0.001 |
|                               | 1. More than 4 times a day | 86/35.0 |       |           |
| Mouth Br. or Smoking          | 0. Have not a habit of mouth breathing and do not smoke | 145/58.9 | 7.870 | 0.005     |
|                               | 1. Have a habit of mouth breathing or have a habit of smoking | 101/41.1 |       |           |
| Drinking                      | 0. Drinking once or none in a week | 186/75.6 | 64.537 | $<$ 0.001 |
|                               |                       | 60/24.4        |           |           |
1. Drinking more than twice in a week

| Character | 0. Extroverted | 1. Introverted | $\chi^2$ | P-value |
|-----------|----------------|----------------|---------|---------|
|           | 62/ 25.2       | 182/ 74.0      | 59.016  | < 0.001 |

| Unstimulated Saliva | 0. Above the level of 3.0mL / 3min | 1. Below the level of 3.0mL / 3min | $\chi^2$ | P-value |
|---------------------|-----------------------------------|-----------------------------------|---------|---------|
|                     | 53/ 21.5                          | 193/ 78.5                         | 79.675  | < 0.001 |

| Stimulated Saliva | 0. Above the level of 3.0mL / 3min | 1. Below the level of 3.0mL / 3min | $\chi^2$ | P-value |
|-------------------|-----------------------------------|-----------------------------------|---------|---------|
|                   | 214/ 87.0                         | 32/ 13.0                          | 134.650 | < 0.001 |

| Sedimentation ratio | 0. Below the level of 10% | 1. Equal or above the level of 10% | $\chi^2$ | P-value |
|---------------------|---------------------------|-----------------------------------|---------|---------|
|                     | 139/ 56.5                 | 107/ 43.5                         | 4.163   | 0.041   |

| Red or Coated Tongue | 0. No | 1. Yes | $\chi^2$ | P-value |
|----------------------|-------|--------|---------|---------|
|                      | 21/ 8.5 | 225/ 91.5 | 169.171 | < 0.001 |

| PND or PTC | 0. No | 1. Yes | $\chi^2$ | P-value |
|------------|-------|--------|---------|---------|
|            | 7/ 2.8 | 227/ 92.3 | 206.838 | < 0.001 |

**Table 4.** Results of chi-squared independence test among statistically significant questionnaire variables, observed and measured variables
| Variable A           | Variable B                  | $\chi^2$ | Degree of Freedom | $p$-value | Phi  |
|---------------------|-----------------------------|---------|-------------------|-----------|------|
| SEX                 | Self-awareness              | 5.099   | 1                 | 0.024     | 0.144|
| SEX                 | Red or Coated Tongue        | 5.243   | 1                 | 0.022     | 0.146|
| Breakfast Pattern   | Regular Diet                | 38.104  | 1                 | < 0.001   | 0.394|
| Breakfast Pattern   | Soft Drink                  | 7.079   | 1                 | 0.008     | 0.170|
| Regular Diet        | TB frequency                | 4.624   | 1                 | 0.032     | 0.137|
| Regular Diet        | Mouth Br. or Smoking        | 4.783   | 1                 | 0.029     | 0.139|
| Stimulating Menu    | Drinking                    | 13.928  | 1                 | < 0.001   | 0.238|
| Water Intake        | Mouth Br. or Smoking        | 9.467   | 1                 | 0.002     | 0.196|
| Mouth Br. or Smoking| Drinking                   | 6.375   | 1                 | 0.012     | 0.161|
| Unstimulated Saliva | Stimulated Saliva           | 10.102  | 1                 | 0.002     | 0.203|
| Unstimulated Saliva | Sedimentation ratio         | 31.891  | 1                 | < 0.001   | 0.360|
| Stimulated Saliva   | Sedimentation ratio         | 21.334  | 1                 | < 0.001   | 0.294|

As a result of the correlation analysis between the bivariate variables with an independence test, as shown in Table 4, the Phi values of the five pairs of the bivariate variables were above 0.200, and the Phi values of the seven pairs of the bivariate variables were under 0.200. The Phi value between the breakfast pattern variable and the regular diet variable was 0.394, the Phi value between the stimulating menu variable and the drinking variable was 0.238, the Phi value between the unstimulated saliva variable and the stimulated saliva variable was 0.203, the Phi value between the unstimulated saliva variable and the sedimentation ratio of saliva variable was 0.360, and the Phi value between the stimulated saliva variable and the sedimentation ratio of saliva variable was 0.294.

**Discussion**
Many preceding research results show that the correlation between the measurement values by use of halitosis measuring devices such as Halimeter™ or Oral Chroma™ and the organoleptic test (OLT) results is high [4, 23], although F. Brunner et al. argued that the organoleptic test would be a gold standard that could be used to diagnose halitosis so far [23]. Based on these arguments, we performed an organoleptic test in the KUMC Halitosis Clinic, measuring the perceivable distance of oral malodor with the patient's own mouth open, measuring the perceivable distance of exhaled oral malodor, based on the standards suggested by Seemann et al. [17, 24]. Among those who were complaining of physiological halitosis symptoms, we judged the patient with perceivable oral malodor at a distance of 10 cm or more from the patient's lips (which is more than grade 1 by Seemann et al. [24]) as having physiological halitosis. At the same time as the organoleptic test, we measured the oral malodor of the 246 physiological halitosis patients with oral malodor measurement devices such as mBA-21 (TAIYO, Japan), Twin-Breasor II (iSenLab, Korea), and mBA-400 (TAIYO, Japan), all approved by the Ministry of Food and Drug Safety in Korea. But the measurement results of these three types of devices did not show consistent correlations with the organoleptic test results, as Halimeter™ and Oral Chroma™ used in previous studies [3, 4, 23]. Therefore, in this study process we excluded those measurement results from our analysis. Because the gas output patterns of patients with physiological halitosis symptoms might differ from patient to patient, and because the three types of oral malodor measuring devices would each have their own characteristic measuring spectrum, we thought a separate research report on this topic should be made in near future.

And as shown in Table 3 and Fig 1, patients who replaced with fast food or skipped breakfast were analyzed to be more than those who used to have breakfast of ordinary Korean menu, then it was inferred that the breakfast pattern could cause symptoms and it was also interpreted to uphold the assertion of A Wälti et al., who claimed to consume foods high in fiber for breakfast in order to reduce the occurrence of oral malodor [17]. Whereas patients who had preferred coffee, tea, or carbonated beverages were found to be more numerous than those who seldom drank those beverages, we concluded that patient preference for these beverages could affect the occurrence of physiological halitosis symptoms. There were more patients who drank insufficient amounts of water during a day as compared to those who regularly drank sufficient amounts of water. Thus we concluded that the amount of water drunk daily could affect the occurrence of physiological halitosis. Among patients with physiological halitosis symptoms, 89.0% of them were aware of their own halitosis, and 97.6% of those had anxiety or stress because of oral malodor. It was found that by recognizing their own halitosis, they were worrying about this condition and progressed through to physiological halitosis symptoms. This was in accord with the results of reports from Wang and He, Troger B et al., and M. Fukui et al., who insisted that in many halitosis patients, anxiety, stress and worry could be found [8, 15, 20]. In the evaluation of the patient's own personality, a statistically significant number of responding patients said that their own personality was introverted. Therefore, it was thought that people with tendencies towards introversion were likely to be exposed to the risk of physiological halitosis symptoms as compared to people with a tendency to extraversion.

As shown in Table 3 and Fig 1, the frequencies of several factors that were expected to cause physiological halitosis symptom were statistically analyzed to be significantly high in the proportion of
patients with a healthy lifestyle \((p < 0.05)\). Thus, we inferred that the patients’ failure to adhere to a three-meal-a-day habit, their preference for a stimulating diet, a toothbrushing frequency of at least four times a day, their smoking or mouth breathing habits, or a drinking frequency at least twice a week might only be a problem in a small number of the patients suffering physiological halitosis symptoms. In addition, there was no statistical difference in patient snack preference that could remain in the oral cavity for a long time, which had been suspected as a predisposition to physiological halitosis symptom. Thus we concluded that a questionnaire related to this factor could be omitted if such would be developed later for investigating Korean physiological halitosis patients.

When we measured the amount of salivation, we adopted one of the standards (the adopted standard: 3.0mL / 3.0min) suggested by the JAMS [3] and the Korean Academy of Halitosis Control under the KAPDOH [1]. As for the domestic research related to the amount of salivation in Korean people, Kim et al. suggested that the unstimulated salivation amount was \(0.66 \pm 0.41\)g/min and the stimulated salivation amount was \(1.61 \pm 0.69\)g/min [25]. Most other domestic researchers had only suggested a range of salivation amount according to age groups. So, we inferred that research aimed at suggesting a standardized amount of salivation for men and women in Korea was needed. In this study, in the case of the unstimulated saliva, 78.5% of patients showed lower measurement values than the baseline measurement value (3.0mL / 3.0min), and this result was also consistent with the report of N. Suzuki et al., who insisted that there was a decrease of unstimulated salivation amounts in the halitosis patients [12]. In the case of stimulated salivation amounts, some sufficient amount of saliva was measured, so 87.0% of the patients exceeded the reference value that the JAMS had suggested [3] and that the KAPDOH had approved [1] \((p < 0.05)\). Only in a few cases was it confirmed that the level of the stimulated salivation amount was less than the suggested value. Therefore, it could be inferred that if there were no properly applied stimulations for salivary secretion, most patients with physiological halitosis symptoms could not utilize their properly produced saliva. This would then cause dryness in the oral cavity, resulting in oral malodor. On the other hand, the patients with a salivary sedimentation ratio of less than 10%, also determined by the standard suggested and approved by the JAMS and the KAPDOH [1, 3], were statistically significantly greater than the number of patients with a salivary sedimentation ratio of 10% or more. But in about 43.5% of the physiological halitosis symptom patients, we could measure salivary sedimentation ratios of 10% or greater. So we could not help reasoning the relationship between the salivary sedimentation ratio and the physiological halitosis symptom. M. Ueno et al. argued that salivary turbidity was associated with halitosis [18]. Thus we inferred that in our study, the degree of salivary turbidity and of salivary contamination of patients with a salivary sedimentation ratio of 10% or more was highly correlated with the occurrences of physiological halitosis.

As a result of the analysis of patient tongue records, cases of patient red tongue or coated tongue caused by excessively wiping off or the accumulation of tongue coating, occurred in 91.5% of the patients. We concluded that incorrect management of the patient’s own tongue could be closely related to physiological halitosis. This conclusion is in accord with the results of studies by previous scholars [9, 12, 21], so we suggest patient education on correct tongue management. As a result of our analysis of intraoral photographs, we found postnasal drip in the throat and posterior tongue coating in 92.3% of the
patients with physiological halitosis, and it could be expected that postnasal drip and posterior tongue coating would increase the viscosity of the patient’s saliva. Based on the argument of M. Ueno et al., who stated that high saliva viscosity could increase the possibility of physiological halitosis [19], we thought that postnasal drip in the throat and posterior tongue coating could be also one cause of physiological halitosis. It would then be desirable to add an intraoral photograph of the postnasal drip in the patient’s throat and the posterior tongue coating to aid in diagnosing physiological halitosis.

By synthesizing the results of the frequency analysis as described above, we identified the 10 variables as being “the sex” variable, “the breakfast pattern” variable, “the soft drink” variable, “the water intake” variable, “the self-awareness” variable, “the anxiety or stress for one’s own halitosis” variable, “the character” variable, “the unstimulated saliva” variable, “the red tongue or coated tongue” variable, and “the postnasal drip or posterior tongue coating” variable. We set these variables as being the potential common risk factors related to physiological halitosis. Then, when examining or consulting patients with physiological halitosis, we concluded that it would be necessary to investigate these 10 factors in our investigation.

On the other hand, as shown in the results of the correlation analysis between the bivariate variables in Table 4, the correlation coefficient Phi of twelve combinations were all recognized as being statistically significant, but considering the research report of DK Lee that a moderate correlation could be recognized when the Phi value should be 0.20 - 0.40 [26], we could conclude that in the results of this study, the Phi values between the breakfast pattern variable and the regular diet variable(0.394), between the stimulating menu variable and the drinking variable(0.238), between the unstimulated saliva variable and the stimulated saliva variable(0.203), between the unstimulated saliva variable and the sedimentation ratio of saliva variable(0.360), and between the stimulated saliva variable and the sedimentation ratio of saliva variable(0.294) could be judged to have a moderate correlation. Therefore, in a future study on the causative factors or treatment methods of physiological halitosis symptoms, we would suggest that a comprehensive study on the possibility of physiological halitosis outbreaks caused by the interactions of these correlated factors would be necessary.

**Conclusion**

The authors could identify 10 variables as being sex, breakfast pattern, soft drink, water intake, self-awareness, anxiety or stress for one’s own halitosis, character, unstimulated saliva, red tongue or coated tongue, and postnasal drip or posterior tongue coating, and we suggest that these are the potential common risk factors related to physiological halitosis. And the Phi values between the breakfast pattern variable and the regular diet variable, between the stimulating menu variable and the drinking variable, between the unstimulated saliva variable and the stimulated saliva variable, between the unstimulated saliva variable and the sedimentation ratio of saliva variable, and between the stimulated saliva variable and the sedimentation ratio of saliva variable could be judged to have a moderate correlation. Therefore, in a future study on physiological halitosis, we would suggest that a comprehensive study on the
possibility of physiological halitosis symptom outbreaks caused by these potential common risk factors and the interactions of these moderately correlated factors would be necessary.

**Abbreviations**

KUMC: Korea University Medical Center; JAMS: Japanese Academy of Malodor Syndrome; KAPDOH: Korean Academy of Preventive Dentistry and Oral Health; Anxiety and Stress: Anxiety or Stress for one's own halitosis; TB Frequency: Toothbrushing frequency a day; Mouth Br. or Smoking: Mouth Breathing or Smoking habit; Sedimentation ratio: Sedimentation ratio of Saliva; Red or Coated Tongue: Red Tongue or Coated Tongue; PND or PTC : Postnasal Drip or Posterior Tongue Coating.

**Declarations**

**Ethics approval and consent to participate**

This retrospective research protocol was approved by the Institutional Review Board of Korea University Guro Hospital.(IRB No. 2021GR0246)

**Consent for publication**

Not applicable

**Availability of data and materials**

The data that support the findings of this study are available from Korea University Guro Hospital, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Korea University Guro Hospital.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors’ contributions**

Y Kim's role on this research were conceptualization, design of the work, data curation, formal analysis, interpretation of data, project administration, supervision, visualization, and writing-original draft, and D Ma's role on this research were investigation, validation, writing-review and editing. All authors read and approved the final manuscript.
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Figures
Figure 1

Radial chart of frequency analysis results for the 246 physiological halitosis symptom patients. Using the data of the survey, the clinical observations and measurements of 246 physiological halitosis patients, the authors performed a frequency analysis. The analysis result for 18 bivariate variables was that the proportions of data collected as “1” were higher than the proportions of data collected as “0” in 10 bivariate variables, and their differences were all statistically significant (p < 0.05).