

The Effect of Mask Use on Bad Breath Awareness During the COVID-19 Pandemic

COVID-19 Pandemisi Sırasında Maske Kullanımının Ağız Kokusu Farkındalığına Etkisi

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ABSTRACT Objective: The aim of this study is to examine the relationship between the use of masks, that have become almost part of our lives during coronavirus disease-2019 (COVID-19) pandemic, and bad breath (halitosis). **Material and Methods:** This study is based on a questionnaire conducted from April 1 to May 1, 2021, among physicians, healthcare workers and their relatives in a tertiary center hospital. **Results:** A total of 778 individuals, comprised of 401 (51.5%) male and 377 (48.5%) female, were included in the study. Halitosis was present in 394 (50.6%) of all participants. Halitosis was present statistically higher in males than females (225 vs 169, $p=0.002$). The duration of the halitosis was statistically associated with not only the number of the diseases but also change in complaint of halitosis after started using mask ($p=0.006$ and $p<0.001$, respectively). The type of used mask had a strong association with the frequency of mask change ($p=0.009$). There was a strong relationship between the frequency of tooth brushing and frequency of mask change or starting/increasing complaint of halitosis after using mask ($p=0.002$ for both). **Conclusion:** Our study suggests that COVID-19 pandemic has a great impact on the awareness of halitosis. It also caused lifestyle changes of the individuals. More studies are needed to detect the effect of the halitosis on quality of life after started using mask.

ÖZET Amaç: Bu çalışmanın amacı, koronavirüs hastalığı-2019 [coronavirus disease-2019 (COVID-19)] pandemisi sırasında hayatımızın neredeyse bir parçası hâline gelen maske kullanımı ile ağız kokusu (ağız kokusu) arasındaki ilişkiyi incelemektir. **Gereç ve Yöntemler:** Bu çalışma, 1 Nisan-1 Mayıs 2021 tarihleri arasında 3. basamak bir hastanede hekim, sağlık çalışanı ve yakınları arasında yapılan ankete dayanmaktadır. **Bulgular:** Çalışmaya 401 (%51,5) erkek ve 377 (%48,5) kadın olmak üzere toplam 778 birey dâhil edildi. Tüm katılımcıların 394'ünde (%50,6) ağız kokusu mevcuttu. Ağız kokusu erkeklerde kadınlara göre istatistiksel olarak daha yüksekti (225'e karşı 169, $p=0,002$). Ağız kokusu süresi sadece hastalık sayısı ile değil, maske kullanmaya başladıktan sonra ağız kokusu şikâyetindeki değişiklik ile de istatistiksel olarak ilişkiliydi (sırasıyla $p=0,006$ ve $p<0,001$). Kullanılan maske tipi ile maske değiştirme sıklığı arasında güçlü bir ilişki vardı ($p=0,009$). Diş fırçalama sıklığı ile maske kullanımı sonrası maske değiştirme veya ağız kokusu şikâyetinin başlama/artma sıklığı arasında güçlü bir ilişki vardı (her ikisi için $p=0,002$). **Sonuç:** Çalışmamız, COVID-19 pandemisinin ağız kokusu farkındalığı üzerinde büyük etkisi olduğunu göstermektedir. Aynı zamanda, bireylerin yaşam tarzı değişikliklerine de neden olmuştur. Maske kullanmaya başladıktan sonra oluşan ağız kokusunun yaşam kalitesine etkisini saptamak için daha fazla çalışmaya ihtiyaç vardır.

Keywords: COVID 19; halitosis; mask; pandemic

Anahtar Kelimeler: COVID 19; ağız kokusu; maske; pandemi

Coronavirus disease-2019 (COVID-19), which emerged in Wuhan, China in December 2019 and spread rapidly to the world, was announced as a pandemic to the world by the World Health Organization on March 11, 2020.¹

The fight against COVID-19 pandemic is continuing worldwide, and some studies have shown that the

best and most effective method in preventing the spread of COVID-19 is the use of masks throughout the society.^{2,3} However, the use of masks throughout the day as shown in various studies, may cause nausea, shortness of breath, visual difficulty, headache, dizziness and difficulty communication, as well as contact dermatitis (irritant or allergic) and acneiform lesions on the face.⁴⁻⁶

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Peer review under responsibility of Journal of Ear Nose Throat and Head Neck Surgery.

Received: 15 Aug 2022

Received in revised form: 10 Nov 2022

Accepted: 02 Dec 2022

Available online: 13 Dec 2022

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Although the use of mask has an active role in the control of the outbreak, it has been observed that people who have to use a mask at a long time of the day have difficulty in harmony with mask use due to various disturbing and comfortable situations. Bad breath, also known as halitosis, is among the most uncomfortable situations encountered in people who have to use a mask for a long time and is one of the increasing complaints in society.

Bad breath is often defined as an unpleasant or disturbing odor spreading from the oral cavity due to the volatile sulfur compounds produced by gram negative bacteria living in the tongue back and periodontal region through food residues. Oral cavity diseases, gastrointestinal disorders and upper respiratory tract infections are often diseases that cause bad breath.⁷ Bad breath has a negative impact of on the quality of life and especially on interpersonal relationships. Social and personal embarrassment is the main reason why individuals seek bad breath treatment by a professional.⁸ Since bad breath also causes social isolation of people in society, it also adversely affects business productivity. Although there are many different results about the prevalence of bad breath in the English literature, the estimated prevalence of bad breath was reported to be approximately 32% in a meta-analysis.^{9,10}

As a result of the use of masks due to the COVID-19 pandemic, it was observed that the complaints of bad breath in the community have increased and many articles have been published on the complaint of bad breath due to the use of masks on the websites. The aim of this study is to examine the relationship between the use of masks, that have become almost part of our lives during COVID-19 pandemic, and bad breath (halitosis).

MATERIAL AND METHODS

STUDY DESIGN AND POPULATION

This study is based on a questionnaire conducted from April 1 to May 1, 2021, among physicians, healthcare workers and their relatives in a tertiary center hospital. We asked them to participate in the study via the internet (e-mail or messaging apps) and

asked them to arbitrarily distribute the questionnaire among the other collages or relatives. The subjects without using mask and under at the age of 18 were excluded from the study.

ETHICAL CONSIDERATIONS

This study was performed in line with the principles of the Declaration of Helsinki. The study protocol was approved by the Health Sciences University Gülhane Scientific Research Ethics Committee (date: April 8, 2021; no: 2020-435). Participants voluntarily participated in this study and their written consent was obtained. They were assured that no personal information was required and that their filled-in data would be kept confidential. An online survey using Google Forms was used to collect the data.

QUESTIONNAIRE

As presented in [Table 1](#), the individuals were asked to fill their demographic characteristics (age, gender, job, and educational status) without any personal privacy information and a 12-items questionnaire including yes/no or multi-choice questions.

STATISTICAL ANALYSIS

The power analysis of the study was performed using the Epi Info software for Windows (version 7.2.4.0, Centers for Disease Control and Prevention, Atlanta, Georgia). The minimum sample size was determined as 335 participants with the power analysis (80%) performed at the 95% confidence interval using Faria et al.'s article.¹¹

Statistical analyzes were performed using IBM Statistical Package for Social Sciences for Windows (version 22.0, SPSS Inc., Chicago, IL) software. The distribution of the variables was examined using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The descriptive statistics were presented as mean±standard deviation (SD) for the numerical variables and the number of cases (%) for the categorical variables. Since the variables were in normal distribution for independent groups, independent sample *t*-test was performed. Pearson's chi-square analysis was used to compare the categorical variables. A result of $p < 0.05$ was considered to be statistically significant.

TABLE 1: The questionnaire.

The Effect of Mask Use on Bad Breath Awareness During the COVID-19 Pandemic

Dear Participant,

Due to the COVID-19 epidemic, the use of masks in social areas has become mandatory. Although the use of masks for a long time during the day has a protective aspect against the COVID-19 epidemic, various adaptation problems have been observed in those who use masks all day long. This survey study has been prepared on one of these problems, halitosis, and consists of questions that you will answer in an average of 5 minutes. Your personal information will not be shared openly with third parties.

Age:

Gender:

Job:

Education Status:

1. Do you have bad breath complaints?

Yes No

Those who answer 'yes' are required to answer the other questions of the questionnaire. For those who answer 'No', the survey will be terminated with the delivery of the survey form to the survey administrator.

2. Did you notice yourself that you have bad breath? Or was it noticed by your relative?

Myself My relative

3. How long have you had bad breath?

More than 1 year 6 months-1 year 3 months-6 months 3 months-6 months Less than 1 month

4. What type of mask do you use?

High security mask (FFP2-N95 etc.) Standard mask (Surgical mask etc.)

Washable mask Other (Please specify.)

5. Did you have bad breath before using the mask? If yes, has your complaint increased/decreased?

Didn't exist, it appeared with the use of mask. There was, it increased with the use of mask.

There was, it did not change with the use of mask. There was, it decreased/disappeared with the use of mask.

Please go to the other page.

6. Do you need to change masks because of bad breath?

Yes No

7. How often do you change your mask?

Twice a day or more Once a day Once every 2 or 3 days Once a week or less

8. How many hours a day do you use a mask on average?

Less than 1 hour 1-4 hours 4-8 hours More than 8 hours

9. Have you consulted a doctor about your bad breath complaint?

Yes No

10. Do you have any of the following diseases? You can choose more than one.

Reflux Tooth decay Gum diseases Wound in the mouth (Aphtha)

Sinusitis Pharyngitis Dry mouth Stiffness

Other (Please specify.)

11. How often do you brush your teeth?

Twice a day or more Once a day Once a day or not Never

12. Have you had an increase in the frequency and duration of tooth brushing after you started using the mask?

Yes No

Please hand over the questionnaire form to the surveyor with the complete answers.

Thank you.

RESULTS

A total of 778 individuals, comprised of 401 (51.5%) male and 377 (48.5%) female, were included in the study. The mean age was 36.05 (minimum: 18, maximum: 76, standard deviation-SD: 13.56). Their educational status was primary or secondary school of 46 (5.9%), high school or associate degree of 221 (28.4%), and bachelor's, master's or doctorate of 511 (65.7%) of the respondents. While 91 (11.7%) of the participants were healthcare professionals, 687 (88.3%) were from other professions.

Halitosis was present in 394 (50.6%) of all participants. There was no relationship between halitosis and occupation or age ($p>0.05$). However, halitosis was present statistically higher in males than females (225 vs 169, $p=0.002$).

Of the 394 patients with halitosis, 225 (57.1%) were male and 169 (42.9%) were female. The mean age was 36.15 (minimum: 18, maximum: 70, SD: 13.42). Their educational status was primary or secondary school of 25 (6.3%), high school or associate degree of 124 (31.5%), and bachelor's, master's or doctorate of 245 (62.2%) of the respondents. While 42 (10.7%) of the participants were healthcare professionals, 352 (89.3%) were from other professions.

Table 2 represents the answers of the respondents, given as used for statistics. We found that all of the individuals with halitosis expressed that the use of mask has increased or been caused to notice the halitosis (Table 2). The duration of the halitosis was statistically associated with not only the number of the diseases but also change in complaint of halitosis after started using mask ($p=0.006$ and $p<0.001$, respectively). Gender, job or educational status had not an effect on the frequency of mask change ($p>0.05$). We did not detect a relationship between the frequency of mask change and starting or increasing complaint of halitosis after using mask ($p>0.05$). However, the type of used mask had a strong association with the frequency of mask change ($p=0.009$). Moreover, as the number of diseases increased, the duration of the halitosis also increased [likelihood ratio (LR): 22.84, $p=0.006$].

Contrary to occupation, gender and educational status of the respondents were found to be statisti-

cally significant with the frequency of tooth brushing ($p=0.024$ and $p<0.001$, respectively). There was a strong relationship between the frequency of tooth brushing and frequency of mask change or starting/increasing complaint of halitosis after using mask ($p=0.002$ for both). However, the frequency of tooth brushing did not show a statistical difference with the frequency of mask change ($p>0.05$).

DISCUSSION

In this study, we investigated the effect of using mask on awareness of halitosis during COVID-19 pandemic. The prevalence of halitosis was detected to be 50.6% and this rate is well above previous studies.^{9,10,12}

Longer periods of wearing masks throughout daily life may lead more awareness to their bad breath.¹¹ The type of the mask may increase the attention depending on the decrease of air circulation.

In our study, the most common cause associated with halitosis was dental diseases (68.8%) followed by stuffiness (22.1%), dry mouth (19.8%), gastroesophageal reflux disease (19.5%), sinusitis (19.3%), oral aft (16.8%). Only 2.8% of the respondents had no associated disease as far as they knew.

As the number of diseases that cause bad breath increases, it is directly proportional to the increase in the onset of bad breath.

It has been also shown that starting the use of mask caused lifestyle changes such as frequency of tooth brushing and frequency of mask change (LR: 12.75 and 18.18, respectively, $p=0.002$ for both). The reason for frequent mask changes may be drooling of mouth secretion and saliva into the mask and bad smelling of the mask due to infiltration of odor molecules in the expiratory air into the mask.

Interestingly, 89.6% of the sufferers did not consult a physician related to their complaint. It may be due to the reluctance of patients to go to health institutions for fear of getting sick during the COVID-19 pandemic.

The prevalence of halitosis is highly variable and affected by various factors as shown in previous published reports.^{9,10,12} Oral cavity is considered to be the

TABLE 2: Answers of the respondents.

Question	Response	Count (%)
1	Yes	394 (50.6)
	No	384 (49.4)
2	Myself	319 (81)
	My relative	75 (19)
3	Less than 1 month	33 (8.4)
	1 month-6 months	42 (10.7)
	3 months-6 months	43 (10.9)
	6 months-1 year	50 (12.7)
	More than 1 year	226 (57.4)
4	Standard mask	369 (93.7)
	High security mask	7 (1.8)
	Washable mask	18 (4.6)
5	Didn't exist, it appeared with the use of mask	105 (26.6)
	There was, it increased with the use of mask	289 (73.4)
6	Yes	222 (56.3)
	No	172 (43.7)
7	Twice a day or more	131 (33.2)
	Once a day	201 (51)
	Once every 2 or 3 days	50 (12.7)
	Once a week or less	12 (3)
8	Less than 1 hour	70 (17.8)
	1-4 hours	157 (39.8)
	4-8 hours	96 (24.4)
	More than 8 hours	71 (18)
9	Yes	41 (10.4)
	No	353 (89.6)
10	Absent	22 (5.6)
	One of them	202 (51.3)
	Two or more	170 (43.1)
11	Twice a day or more	156 (39.6)
	Once a day	222 (56.3)
	Never	16 (4.1)
12	Yes	80 (20.3)
	No	314 (79.7)

major cause of halitosis.¹³ Although we investigated the relationship between mask and halitosis in our study, the oral cavity manifestations of COVID-19 that may affect the prevalence of halitosis is worth discussing. As COVID-19 is so abundant in saliva, Czumbel et al. concluded that saliva test may be a promising diagnostic tool with the sensitivity of 91% [confidence interval (CI): 80-99%] and may be an alternative nasopharyngeal swab test with the sensitivity of 98% (CI: 89-100%).¹⁴ It may be therefore inevitable to occur oral cavity manifestations of COVID-19. Swain et al. reviewed oral cavity mani-

festations of COVID-19 and summarized as white and red plaques, aphthous like lesions, xerostomia, dysgeusia, herpetiform lesions, Kawasaki like disease, Merkelson-Rosenthal syndrome, petechia, vesicles and pustules, oral mucositis, periodontal diseases, ulcer and erosions.¹⁵ However, the frequency of them still remains unclear. Similarly, Riad et al. has discussed possible effects of COVID-19 and using mask on halitosis.⁷ In our study, although dental diseases, oral aphthous lesions, and xerostomia were present in most of the respondents, we do not know how much COVID-19 has contributed to halitosis.

In their study, Faria et al. found that the self-perception of breath odor after wearing a mask was 33.8% and, in our study, it was 50.6% of all respondents.¹¹ Similar to our study, they found a statistical significance between lifestyle changes such as tooth brushing and halitosis after wearing a mask ($p < 0.001$). Moreover, they also detected that almost all the individuals did not seek a healthcare professional for the halitosis because of COVID-19 pandemic in consistent with our results ($p = 0.004$).

Wearing an aroma face mask would be a transient solution until COVID-19 is over.¹⁶ Additionally, aroma masks may be effective that is not found the possible cause of halitosis.

Even halitosis negatively affects the quality of life and causes social isolation, anxiety, depression, and behavioral changes, awareness for halitosis after wearing a mask may be considered as an advantage to increase the seeking for healthcare professionals and to treat the underlying disease.^{8,11} Understanding and treating the possible local or systemic causes including psychosocial effects of halitosis with a multidisciplinary approach are crucial.^{9,11}

Our study has some limitations. We focused on the effect on using mask on halitosis during COVID-19 and we believe that we have proven it. However, we did not investigate the effect of COVID-19 infection as a possible cause of halitosis. The other one is that our study did not include a questionnaire about the effect of halitosis on quality of life and their relationship with using mask. The another one is that we did not question smoking status of the subjects. The

last one is that this was a survey study based on self-reports not objective measurements and it should be considered that some response bias may have occurred. Nonetheless, our study may be a guide for future studies.

CONCLUSION

Our study suggests that COVID-19 pandemic has a great impact on the awareness of halitosis. It also caused lifestyle changes of the individuals. More studies are needed to detect the effect of the halitosis after started using mask on quality of life.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Hakan Genç, Umut Erol; Design: Hakan Genç, Salih Cengiz Meral; Control/Supervision: Hakan Genç, Umut Erol; Data Collection and/or Processing: Salih Cengiz Meral; Analysis and/or Interpretation: Levent Yücel; Literature Review: Hakan Genç, Levent Yücel; Writing the Article: Levent Yücel, Hakan Genç; Critical Review: Hakan Genç, Umut Erol, Levent Yücel.

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