

The Impact of COVID-19 on Halitosis among the General Population in Saudi Arabia: A Potential Symptom

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ABSTRACT

Background: This study assessed the impact of COVID-19 on levels of self-perceived halitosis among adults in Saudi Arabia.

Methods: A total of 1,143 participants completed the study questionnaire, which was distributed online via different social media platforms. The Halitosis Associated Life-quality Test (HALT) and other questions were used to assess halitosis and various behaviors related to halitosis during the COVID-19 pandemic.

Results: Participants' mean HALT score was 14.21 (out of 100), with a standard deviation of 17.52. Regarding self-perceived halitosis, 6.2% reported having halitosis, and 51% sometimes did. All participants used at least one natural remedy to protect themselves from or to treat COVID-19 during the lockdown; the most common item related to good breath was honey (38.40%), and for bad breath, it was garlic (15.5%). Participants who had COVID-19 and did not lose their sense of smell had significantly higher HALT scores than those not infected with COVID-19 ($p=0.01$). A total of 24% thought the COVID-19 pandemic improved their hygiene; 32.20% noticed a bad smell after wearing masks, and 30.7% thought that wearing the mask prevented others from noticing their halitosis.

Conclusion: This study indicated a low level of self-perceived halitosis among the population in Saudi Arabia during the COVID-19 pandemic. The lockdown changed Saudi Arabia residents' behaviours in ways that affected perception of and treatment for halitosis. It is suggested that halitosis might be a secondary symptom of COVID-19 infection; however, more studies are needed for validation.

Key words: COVID-19, Halitosis, HALT, Home remedies, Saudi Arabia

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INTRODUCTION

Halitosis is defined as an unpleasant smell emanating from the mouth [1] and is also known as oral malodor or bad breath [2]. Halitosis is the third most frequent cause of seeking dental treatment, and it has a significant effect on a person's social life, as many people who have halitosis are unaware of it until they are informed by other people. Halitosis has a significant impact on social interactions and can lead to others making negative assumptions about the person, resulting in worsening confidence for this with halitosis in both their public and private lives. Halitosis can affect a person on numerous levels, causing social discomfort, relationship problems, failure in business, and denial of employment or lack of career success. These effects are why halitosis is also referred to as the "social life killer" [3].

Findings that the prevalence of halitosis among the public varies from one country to another have come from numerous studies, including research conducted in Switzerland (32.5%) [4], Jordan (78%) [5], North Italy (53.51%) [6] and (66%) China [7]. Three studies investigated the prevalence of halitosis in Saudi Arabia. Two studies conducted in Riyadh found the prevalence ranged from 22% to 68.5% [8], and one study in Abha showed a prevalence of 51.9% [9]. Halitosis in Saudi Arabia was more prevalent among males (55.8%) than females (44.2%) and among younger people (17-24 years old) than older participants [8]. A total of 54.1% of the participants tried to treat halitosis using mouth rinses, toothpaste and mouth refreshing gum [8]. Half of the participants reported that halitosis affected their social life, making them feel isolated and excluded from society and causing a reduction in career opportunities [9].

In December 2019, the novel coronavirus known as COVID-19 was first reported in Wuhan, China [10]. This highly contagious respiratory disease accumulates in the nasal, oral and pharyngeal mucosa [11] and is primarily

transmitted through droplets expelled when talking, breathing, sneezing, or coughing [12]. The first case of COVID-19 in Saudi Arabia was reported on March 2, 2020 [13]. As of March 15, 2021, the total number of confirmed cases in Saudi Arabia was 382,000 [14]. The Center for Disease Control and Prevention has strongly encouraged social distancing, wearing face covers in the form of masks, and practicing proper hand washing hygiene to help prevent the spread of the virus [15]. These precautions have changed people's behaviors and lifestyles, and in the specific case of those with halitosis, wearing masks could potentially change the perception of halitosis and its management. It is suggested that wearing masks due to the pandemic made it more possible for people to notice their oral malodor. However, to the best of our knowledge, no studies have been conducted investigating the effects of COVID-19 on the perception and rates of halitosis.

Furthermore, during the COVID-19 pandemic, many people used home remedies and searched out information online to relieve acute dental pain because dental appointments are considered to put both the provider and the recipient at high risk [16]. The remedies many people found include onion and/or garlic, both of which can cause oral malodour [16]. However, other home remedy ingredients such as clove oil/eugenol that are used to treat dental problems or pain can also be useful for controlling halitosis [17], including clove oil/eugenol. Moreover, these ingredients might play a role in changing halitosis when dental patients were forced to use them during the partial or complete lockdown when they could not visit their dentist.

Such home remedies are popular in Saudi Arabia, and while their use might alter the prevalence rates and perception of halitosis, no studies have investigated these plant-based ingredients or their effects on halitosis, particularly during the COVID-19 pandemic lockdown. Therefore, this study aimed to assess the impact of COVID-19 on levels of self-perceived halitosis among adults in Saudi Arabia.

MATERIALS AND METHODS

Study design and population

This population-based cross-sectional study was conducted from September 2020 to February 2021. Sample size calculation was used to determine that 373 participants were needed for this study, based on a prevalence of 51.9%, 95% precision of 5% and confidence interval of 95%. The participants in this study were recruited via an online survey distributed on different social media platforms, including WhatsApp, Twitter, Facebook, Snapchat and Instagram, using a convenience sampling method. Inclusion criteria were that participants must be competent in both spoken and written Arabic, sign an informed consent document, and be a Saudi resident. Exclusion criteria were individuals less than 18 years of age. To maintain the confidentiality of patient information, each questionnaire was given an

identification number so that the respondent's identity remained protected. The study was approved by the institutional review board of Umm Al-Qura University, College of Dentistry, with approval number 191-20.

Study questionnaire

Data were collected with a self-administered questionnaire in Arabic, which is the official language of Saudi Arabia. The developing questionnaire has three sections. The first section gathers participants' demographic data: age, gender, marital status, family income, employment status, region, and nationality and education level. The next section includes 20 questions to assess halitosis using the Halitosis Associated Life-quality Test (HALT) [18]. HALT is a validated questionnaire that has been used cross-culturally and is validated in Chinese, Portuguese and Polish [19-21]. It also has a high level of consistency, with Cronbach's alpha of 0.92 to 0.95 [18]. Each question on the HALT is answered using a Likert scale ranging from 0 (no problem) to 5 (problem is as bad as it can be). The HALT score is calculated by totaling the scores for all of the questions. The total score ranges between 0 and 100, and the higher the score, the worse the halitosis problem. An additional question asked about self-perceived halitosis in general, with possible answers of yes, no and sometimes. The final section includes nine questions regarding the impact of COVID-19 on the participants' self-perceived halitosis. These questions also investigate consumption of natural remedies due to the COVID-19 pandemic that might affect halitosis; these questions were adapted from prior research [16]. Finally, there were more questions related to the perception of halitosis among companions and due to wearing masks. All the questions are closed-ended. The questionnaire took approximately 6 to 11 minutes to complete.

The final version of the questionnaire was used for a pilot phase with 15 participants who were eligible for this study. The questionnaire was given to them twice with a 1-week interval between them for test-retest validation. The questionnaires completed for the pilot phase were excluded from the main study sample. The HALT questionnaire translation into Arabic was conducted with a panel of five experts in the medical field. The questionnaire was face and content validated for syntax, organization, spelling, grammar and comprehension.

Statistical analysis

Data analysis was performed using Statistical Package for Social Science software version 21.0 (IBM Corp., Armonk, NY, USA). Test results with $p < 0.05$ were regarded as statistically significant. The data were descriptively analyzed using frequencies and percentages. Also, continuous data were represented by mean and standard deviation. Test-retest reliability was assessed using the kappa coefficient. Chi-square, t-test and ANOVA were used to find relationships between variables.

RESULTS

A total of 1,143 participants completed the study's questionnaire. The majority (78%) were female, and

53.1% of the participants were unmarried. Most of the participants (67.5%) had a bachelor's degree, and the majority of respondents (84.3%) were residents of the western region of Saudi Arabia, as shown in Table 1.

Table 1: Participants' demographic data.

Variable	N	%
Gender	Male	22
	Female	78
Marital	Married	46.9
	Unmarried	53.1
Education	Illiterate	1.3
	High school	17
	Bachelor's degree	67.5
	Postgraduate (master's/PhD)	14.3
Occupation	Student	34.4
	Employee/business owner	37.9
	Unemployed/retired	27.7
Region	Western	84.3
	Middle	6.7
	Eastern	4
	Northern	2.4
	Southern	2.5

The participants' answers on the HALT questionnaire were varied, as illustrated in Table 2. With most of the HALT questions, more than half of the participants (53.3% to 84.5%) answered "No problem" except for Item 3, "Frequent sinus infections"; Item 4, "Worrying about or self-conscious about your breath"; and Item 13 "Spending time related to halitosis," which were the areas with noteworthy variability in the answers.

When the total HALT score was calculated, the participants had a mean of 14.21 (out of 100) and a standard deviation (SD) of 17.52.

When participants were asked if they thought they had halitosis via a separate question (self-perceived halitosis question), 71 (6.2%) answered yes, while 583 (51%) answered sometimes, and 489 (42.8%) answered no.

ANOVA revealed a significant relationship ($p < 0.001$) between the HALT score and the question about self-perceived halitosis, with a participant mean of 40.59 ($SD = 19.87$) for those who answered yes, a mean of 17.38 ($SD = 16.94$) for those who answered sometimes, and a mean of 6.61 ($SD = 12.19$) for those who answered no.

The ANOVA result had an effect size eta squared (η^2) of 0.238, which is considered high (> 0.138) according to Cohen's guidelines [22].

The results of linear regression, t-test and ANOVA showed no significant relationships ($p > 0.05$) between the HALT scores and age, gender, region, education or marital status.

Table 2: Halitosis associated life-quality test (HALT) answers.

Statement	No problem N (%)	Very mild N (%)	Mild or slight problem N (%)	Moderate problem N (%)	Severe N (%)	Problem as bad as it can be N (%)
1. Mainly mouth breathing	658 (57.60)	204 (17.80)	129 (11.30)	79 (6.90)	41 (3.60)	32 (2.80)
2. Frequent tonsillar infections	703 (61.50)	237 (20.70)	97 (8.50)	64 (5.60)	12 (1.00)	30 (2.60)
3. Frequent sinus infections	559 (48.90)	235 (20.60)	154 (13.50)	103 (9.00)	39 (3.40)	53 (4.60)

4. Worrying about or self-conscious about your mouth breath	354 (31.00)	278 (24.30)	187 (16.40)	153 (13.40)	78 (6.80)	93 (8.10)
5. Miserable or tense due to halitosis	664 (58.10)	222 (19.40)	97 (8.50)	81 (7.10)	41 (3.60)	38 (3.30)
6. Difficulty chewing or limiting certain food due to halitosis	854 (74.70)	143 (12.50)	66 (5.80)	41 (3.60)	22 (1.90)	17 (1.50)
7. Change of taste	909 (79.50)	119 (10.40)	58 (5.10)	25 (2.20)	15 (1.30)	17 (1.50)
8. Problems speaking (or mouth covering) due to halitosis	678 (59.30)	197 (17.20)	118 (10.30)	55 (4.80)	49 (4.30)	46 (4.00)
9. Appearance affected due to halitosis	904 (79.10)	105 (9.20)	59 (5.20)	36 (3.10)	14 (1.20)	25 (2.20)
10. Depressed due to mouth breath	870 (76.10)	120 (10.50)	65 (5.70)	40 (3.50)	19 (1.70)	29 (2.50)
11. Problems concentrating due to halitosis	805 (70.40)	168 (14.70)	73 (6.40)	44 (3.80)	29 (2.50)	24 (2.10)
12. Embarrassed due to halitosis	609 (53.30)	228 (19.90)	130 (11.40)	66 (5.80)	46 (4.00)	64 (5.60)
13. Spending time related to halitosis	526 (46.00)	263 (23.00)	162 (14.20)	84 (7.30)	58 (5.10)	50 (4.40)
14. Talking from afar due to halitosis	625 (54.70)	240 (21.00)	119 (10.40)	63 (5.50)	54 (4.70)	42 (3.70)
15. Avoid going out due to halitosis	972 (85.00)	74 (6.50)	48 (4.20)	20 (1.70)	14 (1.20)	15 (1.30)
16. Communication problems due to halitosis	865 (75.70)	116 (10.10)	68 (5.90)	39 (3.40)	25 (2.20)	30 (2.60)
17. mentioned about halitosis	871 (76.20)	130 (11.40)	57 (5.00)	42 (3.70)	13 (1.10)	30 (2.60)
18. Suffer financial loss due to halitosis	959 (83.90)	90 (7.90)	42 (3.70)	28 (2.40)	10 (0.90)	14 (1.20)
19. Suffer social/ personal loss due to halitosis	966 (84.50)	86 (7.50)	33 (2.90)	24 (2.10)	15 (1.30)	19 (1.70)
20. Reduced life satisfaction due to halitosis	914 (80.00)	97 (8.50)	60 (5.20)	35 (3.10)	12 (1.00)	25 (2.20)

Participants answered several questions regarding their behavior and perceptions of halitosis during the COVID-19 pandemic, as shown in Table 3.

A total of 88.3% had never been diagnosed with COVID-19 (Group A), 7.1% had COVID-19 and lost their sense of smell (Group B) and 4.6% had COVID-19 but did not lose their sense of smell (Group C).

Thus, the total proportion of participants who had COVID-19 in the study was 11.7%. All the participants had used at least one natural remedy to protect themselves from or to treat COVID-19.

Among the various natural remedies that can contribute to improved breath, honey (38.40%) was the most commonly used for COVID-19, followed by anise (16.2%).

Other natural remedies used by participants for managing dental pain during the COVID-19 lockdown included salt water (28.8%), cloves (21.1%) and others that are as listed in Table 3.

A total of 17.60% of the participants thought their use of a natural remedy during the COVID-19 pandemic contributed to improvements in their bad breath.

Table 3: Participant behaviors and perceptions regarding halitosis during the COVID-19 pandemic.

Question	Responses	n	%	HALT score, mean (SD)
Have you been diagnosed with COVID-19?	No, I was not diagnosed with COVID-19 (Group A)	1,009	88.30%	13.69 (17.14)
	Yes, and I lost my sense of smell (Group B)	81	7.10%	16.47 (17.91)
	Yes, and I did not lose my sense of smell (Group C)	53	4.60%	20.85 (22.39)**
Natural remedies used for dental pain during lockdown*	Onion	23	2.00%	
	Garlic	0	0.00%	
	Honey	74	6.50%	
	Cloves	241	21.10%	
	Cinnamon	0	0.00%	
	Salt water	329	28.80%	
	Others	76	6.60%	
	I did not use any of the above for dental pain	682	59.70%	
Natural remedies used to protect or treat yourself for COVID-19*	Onion	124	10.80%	
	Garlic	177	15.50%	
	Honey	439	38.40%	
	Cinnamon	0	0.00%	
	Salt water	119	10.40%	
	Anise	185	16.20%	
	Others	136	11.90%	
	I did not use any of the above to protect or treat myself for COVID-19	0	0.00%	
Do you think the natural remedies caused you to have bad breath during COVID-19?	Yes	66	5.80%	
	No	1,077	94.20%	
Do you think the natural remedies made you have good breath during COVID-19?	Yes	201	17.60%	
	No	942	82.40%	
Has the COVID-19 pandemic changed your oral hygiene routine?	Yes (Better)	274	24.00%	
	Yes (Worse)	30	2.60%	
	No	839	73.40%	
Have you noticed any bad smell while you were wearing your mask as a preventative measure during the COVID-19 pandemic?	Yes	368	32.20%	
	No	775	67.80%	
Do you think wearing a mask during the COVID-19 pandemic prevented others from noticing your halitosis?	Yes	351	30.70%	
	No	187	16.40%	
	I do not have bad breath	605	52.90%	
Have any of your close relatives noticed your bad breath during the COVID-19 lockdown?	Yes	70	6.10%	
	No, despite the fact I did have bad breath	247	21.60%	
	I do not have bad breath	826	72.30%	

* More than one answer can be chosen for this question.

** There was a significant difference only between groups A and C.

In terms of natural remedies that are usually associated with bad breath, it should be noted that there was a

considerable number of participants in this study who used onion for dental pain (2%) or for COVID-19

(10.8%), and garlic was used by 0% for dental pain and 15.5% for COVID-19 protection or management during the lockdown. Only 5.80% thought that using the natural remedies contributed to having bad breath.

The ANOVA test assessing the association between HALT scores and having a diagnosis of infection with COVID-19 found a significant relationship ($p=0.007$). A Tukey's post hoc test showed that only the participants who had been diagnosed with COVID-19 and had not lost their sense of smell (Group C) ($m=20.84$, $SD=22.39$) had a significantly higher HALT score than the participants with no COVID-19 infection (Group A) ($m=13.68$, $SD=17.14$; $p=0.01$). However, there was no significant difference in HALT scores between participants in Group C and those in Group B (those with COVID-19 who lost the sense of smell; $m=16.46$, $SD=17.91$; $p=0.331$), nor was there any significant difference between Group A and Group B ($p=0.353$).

A majority of respondents (73.4%) believed that the COVID-19 pandemic had not changed their oral hygiene routines, while 24% thought that the pandemic lockdown had improved their oral hygiene, and only 2.6% who thought the COVID-19 pandemic had made their oral hygiene routines worse. There was 32.20% who had noticed their bad breath while wearing a mask during the COVID-19 pandemic. Nearly the same percentage of respondents, 30.7%, believed that wearing a mask during the pandemic prevented others from noticing their halitosis. Only 6.10% noticed that their relatives became more aware of their bad breath due to the lockdown during the COVID-19 pandemic.

DISCUSSION

There were 6.2% of participants who reported having self-perceived halitosis. Their HALT scores were not different with regard to age, gender, region or education. All of the participants used at least one natural remedy to deal with COVID-19 or dental pain, where the remedy also improved their breath: these included honey, anise, salt water, and cloves. However, a few used other remedies that usually contribute to bad breath, such as onion and garlic. Participants who had been diagnosed with COVID-19 but had not lost their sense of smell had significantly higher HALT scores than those who had lost their sense of smell or those who were not diagnosed with COVID-19. One-fourth of the participants believed that COVID-19 had improved their oral hygiene routine. One-third were more aware of their bad breath after wearing masks during the COVID-19 pandemic. Very few reported their relatives had become more aware of their bad breath during the COVID-19 lockdown.

Our study used two methods to assess halitosis: one was HALT, which is a more reliable and validated method, and the other questions were with regard to self-perception of halitosis. These two methods are significantly related, with a sizable effect size. Some of the prior studies in the literature had used HALT, while others had used simple questions with yes/no answers [8,23]. With HALT, our study found a mean score of 14.21 ($SD=17.52$), which is

higher than one of the studies conducted in Brazil ($m=10.1$, $SD=13.4$) [24] but lower than other Brazilian studies ($m=22.6$, $SD=27.2$) [20] and US studies ($m=67.1$, $SD=16.2$) [18]. This might be due to the differences in the sample sizes along with diet or oral hygiene practices differing from one country or city to the next.

When we compared the prevalence of halitosis based on the self-perceived question in the categorical format, the percentage of participants who believed they had halitosis was 6.2%. This is considered to be low, and is lower than any prior studies in Saudi Arabia, which had results of 22.8% to 42.1% [8,25] Kuwait (23.3%) [26] and Italy (19.4%) [27]. These differences may be due to the prior studies using yes/no answers with a single question, which could have caused the results to be over-estimated. Conversely, our study had answers of yes, sometimes and no, and interestingly, 51% of the participants answered that they sometimes had halitosis. This variation in possible answers could explain the differences in results. It is important to note that other studies have highlighted the possibility that halitosis can be occasional [8,28,29]. Thus, having more answer choices, such as sometimes seems to provide a wider scale than only two answers. In fact, HALT seems to be more accurate in measuring halitosis when used as a continuous scale. It is recommended that future studies aiming to measure halitosis in Saudi Arabia use HALT for better comparisons, as we believe this might be the first study to use such a validated continuous scale.

One of the interesting findings from this study is that the participants who had COVID-19 without losing their sense of smell had significantly higher halitosis scores than those who did lose their sense of smell or those who had not contracted COVID-19. This might be due to the fact that people infected with COVID-19 became more aware of themselves and are likely to be more paranoid and self-diagnosing [30].

However, another explanation is that halitosis could be a symptom of COVID-19 infection. One recent case report suggested that COVID-19 might have secondary oral manifestations [31]. In fact, COVID-19 has been associated with a sore throat, which has been shown to be a contributing factor in halitosis [32,33]. However, whether halitosis is a symptom of COVID-19 cannot be determined by our data, so more research is needed for a future confirmation. Such a finding suggesting halitosis as a secondary symptom could potentially be used to help diagnose COVID-19.

Our data indicated that natural remedies are used frequently by the public in Saudi Arabia for the management of dental problems, which is consistent with the prior study conducted in Madinah, Saudi Arabia [34]. What was also interesting is that people also used some of the same natural remedies to manage or prevent COVID-19 infection rather than for dental purposes. These remedies included honey, garlic and onion. Such natural substances can alter the mouth odor [16,35]. Indeed, 17.60% of our respondents believed that these remedies improved their breath, but fewer respondents

(5.8%) believed that these treatments resulted in worse breath. This can lead us to surmise that COVID-19 was behind changes to aspects of the public's daily habits that impacted oral health, including halitosis, either directly or indirectly.

Since the beginning of the pandemic, people in many countries around the world, including Saudi Arabia, have been advised to wear face masks [15], and in our study, that led to 32.2% of respondents noticing their halitosis when wearing a mask. This is a new behavior for the public that may, by making individuals more aware of their oral condition, help them improve their oral hygiene routines, which was seen in 24% of the participants in our study.

This is the first study in Saudi Arabia that assessed halitosis in relation to COVID-19 using a well-validated questionnaire (HALT). Our study has a relatively large sample size that was taken from different regions in Saudi Arabia, which makes the results more representative in general. However, there are some limitations, including the use of questions related to self-perceived factors, the use of a convenience sampling method, and the many changes made to local rules, regulations and lockdown periods on a national and global level aimed at mitigating the impact of COVID-19 that necessitated adjustments to research protocols.

CONCLUSION

This study indicated that there has been a low level of self-perceived halitosis among the population of Saudi Arabia during the COVID-19 pandemic. The incidence of halitosis was not significantly different among the sample population in terms of age, gender, region of residence, and education level. However, it did reveal that there is a considerable percentage of Saudi Arabians who treated COVID-19 or dental pain with natural remedies that can improve breath, such as honey, anise, salt water, and cloves. In addition, other people used remedies that can contribute to bad breath, such as onion and garlic. The incidence of halitosis was significantly higher among participants who had COVID-19 but did not lose their sense of smell. Many participants became initially or more aware of their bad breath while wearing a mask during the pandemic, and some participants reported improved oral hygiene routine as a result. In fact, COVID-19 has altered public behavior resulted in affecting self-perceived halitosis, and further investigation is needed to assess halitosis as potential symptom. Finally, we recommend spreading more awareness regarding the impact of halitosis on people's life, whither socially or personally.

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LIST OF ABBREVIATIONS

- Coronavirus disease 2019 (COVID-19).
- Standard deviation (SD).

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