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Self-perceived halitosis and associated factors among university students in Dhaka, Bangladesh

Annesha Dey^{1,2}, Md. Abdullah Saeed Khan^{2,3}, Fahima Nasrin Eva^{1,2}, Tariful Islam^{1,2,4} and Mohammad Delwer Hossain Hawlader^{1*} 

Abstract

Background Bad breath (halitosis) is a common problem affecting psycho-social wellbeing of young people. We aimed to explore the extent of self-perceived halitosis and associated factors among university students in Dhaka, Bangladesh.

Methods A cross-sectional study was conducted among university students from November 2021 to April 2022. Six private and two public universities were approached. A total of 318 participants were conveniently selected for the study. A self-administered questionnaire was used for data collection. Students unwilling to participate were excluded. Multivariable logistic regression analysis was used to examine factors associated with halitosis. Statistical analysis was conducted using Stata Version 17.

Results A total of 55.97% of students had self-perceived halitosis, with females (74.53%) having a significantly higher proportion than males (36.94%) ($p < 0.001$). A significantly higher proportion of halitosis was found among participants who were overweight (61%), had obesity (60.77%), smoked cigarette (46.79%), consumed alcohol (71.43%), lacked exercise (66.29%), were on unhealthy diet (57.35%), consumed coffee/tea (61.35%), breathed through mouth (64.60%), brushed tooth infrequently (85.71%), changed toothbrush after 6 months (77.42%), did not use toothpaste (94.74%), did not use/ sometimes used fluoride toothpaste (75.76%), lacked dental floss use (60.85%), did not use toothpick (62.87%), did chew or sometimes chewed sugar-free chewing gum (75.82%), did not clear / cleaned tongue sometimes (76.14%), did use mouth freshener regularly or occasionally (64.97%), did not use or used mouthwash sometimes (58.87%) were also associated with higher self-perceived halitosis ($p < 0.05$ for all). Students with gum bleeding, swollen gums, dry mouth, dental caries, food accumulation, and tooth sensitivity had a significantly ($p < 0.05$ for all) higher proportion of self-perceived halitosis (76.85%, 81.82%, 72.50%, 67.78%, 64.13% and 67.40%, respectively) compared to those without this problem. Being female (OR = 5.04; 95% CI: 2.01–12.62; $p < 0.001$), alcohol consumers (OR 7.35; 95% CI: 1.77–30.50; $p = 0.006$); not using sugar free chewing gum (OR = 0.25; 95% CI: 0.10–0.58; $p = 0.001$), lack of tongue cleaning (OR 4.62; 95% CI: 2.16–9.84; $p < 0.001$), and gum bleeding (OR = 7.43; 95% CI: 3.00–18.35; $p < 0.001$) were independently associated with halitosis on multivariable regression.

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Conclusion This study reveals a high proportion of self-perceived halitosis and relevant factors. There should be more public education on the causes of halitosis and potential management approaches.

Keywords Self-perceived halitosis, Halitosis, Oral Hygiene, Prevalence, Smoke, Alcohol, Gender, Tongue clean, University students, Dhaka, Bangladesh

Introduction

Halitosis is a common oral condition characterized by an unpleasant or offensive odor originating from the oral cavity. It is also commonly known as 'bad breath'. Halitosis can occur in individuals of any age and sex, irrespective of their social status [1] and may cause profound societal shame and psychological impact [2]. Globally, many people suffer from halitosis. An estimated 31.8% of the general population (95% CI 24.6–39.0%) were found to suffer from halitosis in 2017 [3]. However, due to the lack of an accepted definition of halitosis, the subjective nature of reporting, and the different methodologies used, there is much heterogeneity in the reporting of its prevalence across the globe. In Bangladesh, the only study exploring halitosis was among women in Dhaka city, where the prevalence of halitosis was found to be 75% [4].

Halitosis may occur for various physiological and pathologic reasons [1, 5]. The foul-smelling morning breath of physiologic halitosis is caused by desquamated epithelial cells, stagnant saliva, and putrefaction of trapped food particles through the accumulation of bacteria. The pathological reasons involve local or systemic infections, chronic diseases, genetic problems, and metabolic failures [5]. However, some individuals may have halitosis but deny the same, while others have an exaggerated fear of halitosis (halitophobia) or may believe they have halitosis despite absence of such (pseudo-halitosis) [6]. Irrespective of the cause of halitosis, it should be diagnosed and treated by a dentist or physician as it is associated with significant personal discomfort and social embarrassment. [6] and decrease the oral health-related quality of life of the sufferers [7].

To differentiate between genuine halitosis from pseudo-halitosis and halitophobia, doctors often employ techniques like organoleptic measurement, gas chromatography, sulfide monitoring, and several other ways of chemical sensing [8]. People may present to the physician with complaints of halitosis when they develop a self-awareness of bad breath or when other complaints of bad odor coming out of their mouth. Consequently, self-perceived halitosis could impact a patient's quality of life and lead to anxiety, reduced levels of self-esteem, and misinterpretation of other people's attitudes [9].

Only a few research have investigated self-perceived halitosis among university students [10, 11] around the world. In Bangladesh, very few research explored self-perceived halitosis and fewer to none had been

conducted among university students. Hence, although many studies have explored halitosis prevalence, little is known about halitosis perception among students in Dhaka, which this study aims to elucidate.

Methodology

Study design and population

This cross-sectional study was conducted among university students in Dhaka city using a convenience sampling method. The study included students from eight universities: North South University, Independent University, American International University Bangladesh, Dhaka University, Khilgaon Model College and University, Ahsanullah University of Science and Technology, State University of Bangladesh, and Jahangirnagar University. Data collection took place from November 1, 2021, to April 30, 2022. The study recruited participants who were permanent residents of Bangladesh with valid student ID cards from their respective institutions. Foreign nationals and individuals affected by mental illness were excluded from the study. The sample size was calculated using the formula for an unknown population: $n = z^2 \times p \times (1-p) / d^2$; where: $z = 1.96$ for a confidence level of 95%, $p =$ proportion (from Nazir et al.(2017) [12]=75.1%), $d =$ margin of error=0.05. Considering the 10% non-response, the final adjusted sample size was 318 participants, who met the inclusion criteria.

Data collection tools

A semi-structured questionnaire was used to gather data from the study participants. This questionnaire was developed and modified during the initial one month period of the study by the researchers from the ones used in previous studies [11, 13, 14]. Initially, it was created in English and then translated into Bengali by different translators using a forward-backward translation process. The Bengali version was then face-validated by experts and pre-tested, with a Cronbach's alpha score of 0.73. The questionnaire covered five domains: sociodemographic factors, lifestyle and behavioral factors, oral hygiene habits, dental problems, and parameters related to self-reported halitosis, with a total of 35 questions. The full questionnaire was designed to be completed in approximately 10–12 min.

Data collection procedure

Data was collected online using the Google Forms platform. The questionnaire was distributed digitally through

various social media channels. One of the authors was responsible for sharing a secure link to the survey and reaching out to study participants who voluntarily agreed to take part by completing the consent form. Once all responses from the expected number of respondents were collected, the survey link was deactivated. The response rate for this study was 100% as all participants who were approached and met the eligibility criteria agreed to participate in the study and completed the questionnaire.

Variables of interest

The independent variables in this study included sociodemographic factors such as age, gender, height (in meters), weight (in kilograms), BMI, and marital status. Lifestyle and behavioral factors encompassed self-reported responses on smoking, alcohol consumption, sleep patterns, exercise, food habits, stress levels, tea/coffee intake, depression, mouth breathing, and anxiety.

For smoking status, 'yes' was defined as current daily smokers, 'occasionally' as current smokers who do not smoke daily, and 'no' as never smokers and past smokers (who had quit smoking at least one year prior). Similarly, for alcohol consumption, 'yes' was defined as individuals who currently consume alcohol, 'occasionally' as those who consume alcohol but not on a regular basis, and 'no' as individuals who have never consumed alcohol or have abstained for at least one year. Furthermore, stress levels were assessed as perceived stress described by the participant and measured using a single question with a 5-point Likert scale (options: "Not at all", "Not much", "A little", "Very much", "A lot"). Oral hygiene habits were assessed by examining practices such as tooth brushing, flossing, mouth washing, the use of toothpicks and miswak, tongue cleaning, mouth breathing, use of sugar-free chewing gum, and mouth fresheners. Dental problems considered in the study included participants' self-reports of gum bleeding, gum swelling, tooth sensitivity, dry mouth, dental caries, tooth mobility, and food impaction. The dependent variable was self-perceived halitosis, categorized as either present or absent (yes or no).

Data management and analysis plan

Before conducting the analysis, all data were reviewed for completeness, outliers, and assumption violations. Descriptive statistics were used to summarize the socio-demographic characteristics of the participants and their self-perceived halitosis. Pearson's Chi-squared test was used to examine the relationship between respondents' characteristics and outcome variables. A multivariable logistic regression analysis was performed to investigate the connection between self-reported halitosis and various factors, including sociodemographic factors, lifestyle

and behavioral factors, oral hygiene habits, and dental problems. We entered all the selected variables at once to build the multivariable logistic regression model. Variables that yielded complete separation across outcome categories were excluded from the multivariable analysis. The study reported adjusted odds ratios (AOR) and their corresponding 95% confidence intervals (CI). A p-value of less than 0.05 was considered statistically significant for all tests. The statistical analyses were carried out using STATA (Version 17).

Ethical considerations

All procedures were carried out in compliance with the ethical guidelines established by the Institutional Review Board (IRB)/Ethical Review Committee (ERC) of North South University (approval number: 2023/OR-NSU/IRB/0901). We followed the ethical principles outlined in the 1964 Helsinki Declaration and its subsequent amendments, or comparable ethical standards, as appropriate. Before starting the survey, every participant was required to complete the informed consent section. Participants were informed that their involvement was entirely voluntary and that they could withdraw at any time before submitting their signed consent. They were also assured that only the researchers would have access to the data, which would be reported at the group level without any personal identifiers. No personal data were collected. Throughout data collection and analysis, all data were handled with strict confidentiality and transmitted via a secure connection. Access to the questionnaire data was restricted to the research team only.

Results

Prevalence of self-perceived halitosis

Figure 1 illustrates the proportion of self-perceived halitosis among the study participants. The overall prevalence of Self-Perceived halitosis was 55.97% (Fig. 1).

Socio-demographic variables

Among the 318 participants, the majority of respondents were between the ages of 22–28 years (82.70%) and were females (50.63%). Among those who had self-perceived halitosis (SPH), a significant proportion were females (74.53%). Within the age group of 29–35 years, 58.18% reported having SPH, whereas in the age group of 22–28 years, 55.51% reported having SPH. Additionally, a large proportion of participants with SPH were either overweight (61.00%) or obese (60.77%). Both sex and BMI were significantly associated with self-perceived halitosis ($p < 0.05$) (Table 1).

Lifestyle & behavioral factors

According to Table 2, it appears that the majority of the study participants were non-smokers (45.60%) and

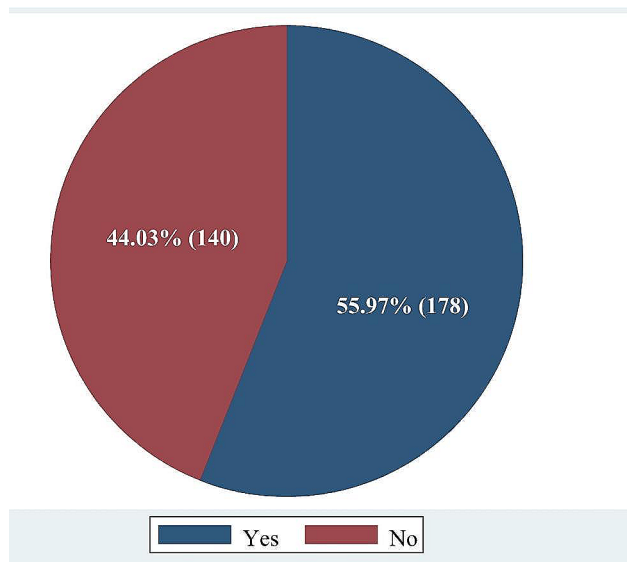


Fig. 1 Prevalence of self-perceived halitosis. (NB: data from a study conducted at universities in Dhaka city, Bangladesh)

Table 1 Socio-demographic variables of the participants

Variables	Self-Perceived halitosis		N (%)	p-value
	Yes (%)	No (%)		
Age				
22–28 years	146 (55.51)	117 (44.49)	263 (82.70)	0.710
29–35 years	32 (58.18)	23 (41.82)	55 (17.30)	
Sex				
Female	120 (74.53)	41 (25.47)	161 (50.63)	<0.001
Male	58 (36.94)	99 (63.06)	157 (49.37)	
BMI				
Underweight (≤ 18.4 kg/m ²)	2 (33.33)	4 (66.67)	6 (1.89)	0.040
Healthy (18.5 to 24.9 kg/m ²)	36 (43.90)	46 (56.10)	82 (25.79)	
Overweight (25 to 29.9 kg/m ²)	61 (61.00)	39 (39.00)	100 (31.45)	
Obese (30 or more kg/m ²)	79 (60.77)	51 (39.23)	130 (40.88)	
Marital Status				
Single or other	132 (53.88)	113 (46.12)	245 (77.04)	0.160
Married	46 (63.01)	27 (36.99)	73 (22.96)	

N=Number of observations among study participants, p-values were determined by chi-square tests and were significant at <0.05 (marked as bold)

non-alcoholic (56.60%). However, among those who reported SPH, approximately 73% were occasional smokers. Similarly, about 71% of participants who consumed alcohol reported SPH. Furthermore, 63.33% of respondents who experienced SPH reported having either

Table 2 Lifestyle & behavioral factors

Variables	Self-Perceived halitosis		N (%)	p-value
	Yes (%)	No (%)		
Smoke				
Yes	51 (46.79)	58 (53.21)	109 (34.28)	0.003
No	80 (55.17)	65 (44.83)	145 (45.60)	
Occasionally	47 (73.44)	17 (26.56)	64 (20.13)	
Alcohol				
Yes	30 (71.43)	12 (28.57)	42 (13.21)	0.003
No	86 (47.78)	94 (52.22)	180 (56.60)	
Occasionally	62 (64.58)	34 (35.42)	96 (30.19)	
Stress level				
A little/a lot/very much	129 (59.17)	89 (40.83)	218 (68.55)	0.090
Not at all/not much	49 (49.00)	51 (51.00)	100 (31.45)	
Feeling anxious				
Yes/Occasionally	87 (54.72)	72 (45.28)	159 (50.00)	0.650
No	91 (57.23)	68 (42.77)	159 (50.00)	
Sufficient sleep				
Completely sufficient/sufficient/moderate sleep	140 (54.26)	118 (45.74)	258 (81.13)	0.200
Not sufficient/not at all sufficient	38 (63.33)	22 (36.67)	60 (18.87)	
Exercise				
Yes/occasionally	60 (42.86)	80 (57.14)	140 (44.03)	<0.001
No	118 (66.29)	60 (33.71)	178 (55.97)	
Healthy food				
Yes/occasionally	139 (55.60)	111 (44.40)	250 (78.62)	0.790
No	39 (57.35)	29 (42.65)	68 (21.38)	
Drink tea/coffee				
Yes	154 (61.35)	97 (38.65)	251 (78.93)	0.001
No	14 (36.84)	24 (63.16)	38 (11.95)	
Occasionally	10 (34.48)	19 (65.52)	29 (9.12)	
Depression				
Yes/Occasionally	81 (60.00)	54 (40.00)	135 (42.45)	0.210
No	97 (53.01)	86 (46.99)	183 (57.55)	
Mouth breathing				
Yes	104 (64.60)	57 (35.40)	161 (50.63)	0.002
No	74 (47.13)	83 (52.78)	157 (49.37)	

*p-values were determined by Chi-square tests and were significant at <0.05 (marked as bold)

insufficient or not at all sufficient sleep. Additionally, a large proportion of participants who reported SPH were non-exercisers (66.29%), regular consumers of tea or coffee (61.35%), and consistent mouth breathers (approximately 65%). Moreover, among the participants who had SPH, 59.17% reported varying levels of stress (a little, a lot, or very much), 54.72% reported feeling anxious (yes or occasionally), 57.35% mentioned not consuming healthy food, and 60% reported having depression (yes or occasionally). Significant associations were observed between smoking, alcohol consumption, exercise habits, tea or coffee consumption, and mouth breathing with self-perceived halitosis ($p < 0.05$).

Oral hygiene habit and self-perceived halitosis

The data depicted in Table 3 highlights that 85.71% of participants with SPH did not brush their teeth regularly or only brushed occasionally. Additionally, significant proportions of participants with SPH exhibited various other oral hygiene deficiencies: over 99% did not use a toothbrush, 94.74% did not use toothpaste, 75.76% did not use fluoride-containing toothpaste, 77.42% changed their toothbrushes after six months, and 60.85% did

Table 3 Association between oral hygiene habits and self-perceived halitosis

Variables	Self-Perceived halitosis		N (%)	p-value
	Yes (%)	No (%)		
Brushing teeth				
Yes	166 (54.61)	138 (45.39)	304 (95.60)	0.020
No/occasionally	12 (85.71)	2 (14.29)	14 (4.40)	
If yes, times of tooth brushing				
once/twice	150 (53.38)	131 (46.62)	281 (92.43)	0.130
3 times or more	16 (69.57)	7 (30.43)	23 (7.57)	
Toothbrush use				
Yes	157 (53.22)	138 (46.78)	295 (97.04)	0.005
No/occasionally	9 (100.00)	0 (0.00)	9 (2.96)	
Toothbrush change				
Less than or equal 6	109 (46.78)	124 (53.22)	233 (78.98)	<0.001
After 6 months	48 (77.42)	14 (22.58)	62 (21.02)	
Toothpaste use				
Yes	160 (53.51)	139 (46.49)	299 (94.03)	<0.001
No/occasionally	18 (94.74)	1 (5.26)	19 (5.97)	
If yes, fluoride containing toothpaste				
Yes	60 (35.93)	107 (64.07)	167 (55.85)	<0.001
No/occasionally	100 (75.76)	32 (24.24)	132 (44.15)	
Dental floss				
Yes/occasionally	49 (46.23)	57 (53.77)	106 (33.33)	0.010
No	129 (60.85)	83 (39.15)	212 (66.67)	
Miswak				
Yes/occasionally	21 (47.73)	23 (52.27)	44 (13.84)	0.230
No	157 (57.30)	117 (42.70)	274 (86.16)	
Mouthwash				
Yes	22 (41.51)	31 (58.49)	53 (16.67)	0.020
No/occasionally	156 (58.87)	109 (41.13)	265 (83.33)	
Tongue clean				
Yes	44 (30.99)	98 (69.01)	142 (44.65)	<0.001
No/occasionally	134 (76.14)	42 (23.86)	176 (55.35)	
Toothpicks				
Yes/occasionally	51 (43.97)	65 (56.03)	116 (36.48)	<0.001
No	127 (62.87)	75 (37.13)	202 (63.52)	
Sugar free chewing gum				
Yes/occasionally	116 (75.82)	37 (24.18)	153 (48.11)	<0.001
No	62 (37.58)	103 (62.42)	165 (51.89)	
Mouth freshener				
Yes/occasionally	115 (64.97)	62 (35.03)	177 (55.66)	<0.001
No	63 (44.68)	78 (55.32)	141 (44.34)	

*Note In this table, "Occasionally" indicates infrequent or irregular occurrences, typically less than once a week. P-values were determined by Chi-square tests and were significant at <0.05 (marked as bold)

not use dental floss. Moreover, among the participants who had SPH, 76.14% did not clean their tongue or only cleaned it occasionally, 62.87% did not use toothpicks, more than 75% chewed gum regularly or occasionally, 58.87% did not use mouthwash or only used it occasionally, and 64.97% used mouth fresheners regularly or occasionally.

Statistically significant associations were observed between several oral hygiene practices—including brushing teeth, toothbrush use, toothbrush replacement, toothpaste use (both regular and fluoride-containing), dental flossing, tongue cleaning, toothpick usage, sugar-free chewing gum consumption, mouthwash application, mouth freshener usage—and self-perceived halitosis, all with a p-value of less than 0.05.

Dental problems and self-perceived halitosis

From Table 4, we can see that gum bleeding, gum swelling, dry mouth, dental caries, tooth sensitivity, and food impaction were associated significantly with self-perceived halitosis ($p < 0.05$). From those with SPH: 76.85% had gum bleeding, 81.82% had swollen gums, 72.50% had dry mouth, 67.78% had dental caries, 67.40% had sensitive teeth, and 64.13% had food impaction regularly or sometimes in their teeth.

Multivariable logistic regression analysis exploring factors associated with self-perceived halitosis

Table 5 provides insights from a multivariable logistic regression analysis investigating factors associated with self-perceived halitosis (SPH). The likelihood of experiencing SPH was 5.04 times higher in females compared to males (OR=5.04; 95% CI: 2.01–12.62; $p < 0.001$). Participants who reported consuming alcohol were 7.35 times more likely to have SPH than those who did not (OR 7.35; 95% CI: 1.77–30.50; $p = 0.006$). Moreover, individuals who did not clean their tongue or only did so occasionally have 4.62 times higher odds of SPH compared to those who cleaned their tongue regularly (OR 4.62; 95% CI: 2.16–9.84; $p < 0.001$). Furthermore, participants who didn't use sugar-free chewing gum exhibited a 0.25% lower likelihood of experiencing self-perceived halitosis compared to those who used it regularly or occasionally (OR=0.25; 95% CI: 0.10–0.58; $p = 0.001$). Additionally, individuals with gum bleeding, either occasionally or regularly, were 7.43 times more likely to experience SPH than those without gum bleeding (OR=7.43; 95% CI: 3.00–18.35; $p < 0.001$).

Discussion

Self-perceived halitosis (SPH) represents a prevalent oral health concern transcending demographic boundaries [15]. Beyond its apparent social implications, SPH exerts considerable influence on individuals' quality of life [16].

Table 4 Association between dental problems and self-perceived halitosis

Variables	Self-Perceived halitosis		N%	P-value
	Yes (%)	No (%)		
Gum bleeding				
Yes/sometimes	83 (76.85)	25 (23.15)	108 (33.96)	<0.001
No	95 (45.24)	115 (54.76)	210 (66.04)	
Swollen gum				
Yes	45 (81.82)	10 (18.18)	55 (17.30)	<0.001
No	133 (50.57)	130 (49.43)	263 (82.70)	
Dry mouth				
Yes	58 (72.50)	22 (27.50)	80 (25.16)	0.001
No	120 (50.42)	118 (49.58)	238 (74.84)	
Dental caries				
Yes	61 (67.78)	29 (32.22)	90 (28.30)	0.008
No	117 (51.32)	111 (48.68)	228 (71.70)	
Tooth sensitivity				
Yes/sometimes	122 (67.40)	59 (32.60)	181 (56.92)	<0.001
No	56 (40.88)	81 (59.12)	137 (43.08)	
Tooth mobility				
Yes	18 (64.29)	10 (35.71)	28 (8.81)	0.350
No	160 (55.17)	130 (44.83)	290 (91.19)	
Food impaction				
Yes/occasionally	118 (64.13)	66 (35.87)	184 (57.86)	0.001
No	60 (44.78)	74 (55.22)	134 (42.14)	

*p-values were determined by Chi-square tests and were significant at <0.05 (marked as bold)

Particularly within the university milieu, where academic pursuits intertwine with social dynamics, the impact of SPH extends beyond mere discomfort, potentially affecting academic performance and interpersonal relationships [17]. Therefore, this study aimed to assess SPH and its associated factors among Bangladeshi university students.

Our study found that approximately 55.97% of the participants reported self-perceived halitosis. This finding is consistent with previous research conducted in India and Saudi Arabia among comparable populations, where the prevalence of self-reported halitosis ranges from 40 to 60% [14, 18]. Additionally, several former studies have investigated the prevalence of SPH, revealing varying rates across different regions and demographics. For instance, studies conducted in North America, Europe, Asia, and other regions have documented SPH prevalence rates spanning from approximately 20% to over 60% [19–23], highlighting the widespread nature of this oral health concern. Furthermore, research suggests that SPH is not confined to specific geographic regions or socio-economic statuses but affects individuals across diverse populations globally [9]. In developed nations, estimates indicate a broad spectrum of oral malodor perception, with prevalence rates ranging from 8 to 50% [24]. This variability underscores the universal nature of the

concern surrounding halitosis, regardless of geographical location or socioeconomic status.

One notable finding of the study was that females exhibited significantly higher odds of experiencing SPH compared to males. This aligns with previous research conducted by Su et al. [25] and Kateeb [26], which indicates that females are more aware of and concerned about oral health issues, including halitosis, possibly due to gender roles and societal norms that socialize women to prioritize appearance and cleanliness. Furthermore, a cross-sectional study by Alzoman et al. [27] demonstrates that hormonal fluctuations throughout the menstrual cycle and during pregnancy can affect oral health and breath odor perception, thereby increasing awareness of halitosis among females. Moreover, research by Lipsky et al. [28] and Mamai-Homata et al. [29] suggests that women are more likely to engage in preventive oral health behaviors like regular brushing, flossing, and dental visits compared to men, making them more sensitive to changes in their oral health status. Recognizing and addressing these complex factors is imperative for devising comprehensive strategies to advance gender-inclusive approaches to promoting oral health.

The study unveiled a strong correlation between alcohol consumption and an increased propensity to report SPH, reinforcing earlier research by Oyapero et al. [30], which associates alcohol intake with diverse oral health issues, including halitosis. The primary mechanism behind this correlation is alcohol's drying effect on the oral mucosa, which reduces saliva production. Reduced saliva creates an environment conducive to bacterial overgrowth and malodor formation [31, 32]. Additionally, research by Khan et al. [33] and Poniewierka et al. [34] shows that the high sugar and acid content in alcoholic beverages can exacerbate these issues by providing a food source for bacteria and altering the mouth's pH balance. Moreover, prior literature documents lifestyle-related factors commonly associated with alcohol consumption, such as smoking and irregular dental care, which further compound these effects [35, 36]. This emphasizes the importance of recognizing alcohol's role in SPH development and implementing targeted oral health interventions.

In our study, we identified the significant impact of poor tongue-cleaning habits on the increased likelihood of experiencing SPH. This correlation resonates with existing literature, underlining the crucial role of tongue cleanliness in averting the onset of bad breath, as outlined by Banotra et al. [37]. The tongue, serving as a reservoir for oral bacteria, food particles, and dead cells, provides an ideal environment for bacterial proliferation if not adequately cleaned. Consequently, neglecting tongue cleaning allows these microorganisms to thrive, leading to the production of volatile sulfur compounds responsible for halitosis [37]. Furthermore, research by

Table 5 Multivariable logistic regression analysis exploring factors associated

Variables	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Sex				
Male	Ref		Ref	
Female	4.99 (3.09–8.07)	<0.001	5.04 (2.01–12.62)	<0.001
Body Mass Index				
Healthy	Ref			
Underweight	0.64 (0.11–3.68)	0.610	0.38 (0.03–4.83)	0.450
Overweight	1.99 (1.10–3.62)	0.022	1.26 (0.46–3.42)	0.650
Obese	1.98 (1.13–3.46)	0.017	1.37 (0.58–3.27)	0.470
Smoking				
No	Ref		Ref	
Yes	0.71 (0.43–0.18)	0.180	0.68 (0.19–2.34)	0.540
Occasionally	2.25 (1.18–4.28)	0.010	2.03 (0.65–6.38)	0.220
Drink Alcohol				
No	Ref		Ref	
Yes	2.73 (1.32–5.67)	0.007	7.35 (1.77–30.50)	0.006
Occasionally	1.99 (1.19–3.32)	0.008	2.49 (0.94–6.58)	0.060
Exercise regularly				
Yes/Occasionally	Ref		Ref	
No	2.62 (1.66–4.14)	<0.001	1.55 (0.72–3.35)	0.260
Drinks tea or coffee				
No	Ref		Ref	
Yes	2.72 (1.34–5.52)	0.005	1.52 (0.49–4.65)	0.460
Occasionally	0.90 (0.33–2.48)	0.842	0.70 (0.316–3.18)	0.650
Mouth Breathing				
Yes	Ref		Ref	
No	0.49 (0.31–0.77)	0.002	0.52 (0.25–1.08)	0.080
Brushing teeth				
No/Occasionally	Ref			
Yes	0.20 (0.04–0.91)	0.037		
Toothbrush change				
less than or equal 6	Ref		Ref	
After 6 months	3.90 (2.04–7.46)	<0.001	0.90 (0.33–2.48)	0.840
Fluoride pastes				
Yes	Ref		Ref	
No/Occasionally	5.57 (3.35–9.26)	<0.001	1.75 (0.79–3.85)	0.160
Dental floss				
Yes/Occasionally	Ref		Ref	
No	1.81 (1.13–2.89)	0.014	2.19 (0.92–5.21)	0.070
Mouthwash				
Yes	Ref		Ref	
No/Sometimes	0.49 (0.27–0.90)	0.020	1.68 (0.55–5.11)	0.360
Tongue clean				
Yes	Ref		Ref	
No/Occasionally	7.11 (4.32–11.68)	<0.001	4.62 (2.16–9.84)	<0.001
Toothpicks				
Yes/Occasionally	Ref		Ref	
No	2.16 (1.36–3.43)	0.001	1.34 (0.61–2.94)	0.470
Sugar Free Gum				
Yes/Occasionally	Ref		Ref	
No	0.19 (0.12–0.32)	<0.001	0.25 (0.10–0.57)	0.001
Mouth Freshener				
Yes/Occasionally	Ref		Ref	
No	0.44 (0.28–0.69)	<0.001	0.60 (0.27–1.30)	0.190

Table 5 (continued)

Variables	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Gum Bleeding				
No	Ref		Ref	
Yes/Sometimes	4.02 (2.38–6.78)	< 0.001	7.42 (3.00–18.35)	< 0.001
Swollen gum				
No	Ref		Ref	
Yes	4.39 (2.13–9.09)	< 0.001	0.68 (0.17–2.81)	0.600
Dry mouth				
No	Ref		Ref	
Yes	2.59 (1.49–4.50)	0.001	0.88 (0.32–2.41)	0.810
Dental caries				
No	Ref		Ref	
Yes	1.99 (1.19–3.33)	0.008	0.56 (0.22–1.47)	0.240
Tooth Sensitivity				
No	Ref		Ref	
Yes/Sometimes	2.99 (1.89–4.74)	< 0.001	1.99 (0.87–4.56)	0.100
Food Impaction				
No	Ref		Ref	
Yes/Occasionally	2.20 (1.39–3.47)	0.001	0.99 (0.41–2.35)	0.990

*OR=Odds ratio, CI=Confidence interval, p-values were significant at <0.05(marked as bold)

Peng et al. [38]. and Santacroce et al. [39]. suggests inadequate management of oral bacteria can lead to a range of dental issues, including plaque formation, gum disease, and tooth decay, while specific bacterial strains are additionally associated with systemic health conditions such as cardiovascular disease and respiratory infections [38, 39]. By promoting and emphasizing proper tongue cleaning practices, oral health professionals can empower individuals to proactively combat halitosis and mitigate the risk of associated oral and systemic health issues.

An interesting finding emerged in the analysis of this study regarding the use of sugar-free chewing gum and its association with self-perceived halitosis (SPH). Contrary to expectations, participants who did not use sugar-free chewing gum exhibited a markedly lower likelihood of experiencing SPH compared to those who used it regularly or occasionally. Comparing our results with previous studies, which have generally indicated a positive relationship between sugar-free gum (SFG) usage and reduced halitosis, reveals a noteworthy discrepancy. For instance, studies by Shiyao et al. [40] and Al-Haboubi et al. [41] demonstrated that consistent use of SFG resulted in notable enhancements in Plaque and Gingival Index scores, reduced malodor levels, and improved self-perceived oral health. Similarly, a systematic review and meta-analysis by Nasseripour et al. [42] reported that chewing SFG, particularly xylitol SFG, for a designated period reduces the quantity of plaque in the oral cavity and decreases malodor levels in participants. Several factors may contribute to this unexpected association observed in our study. Firstly, it's possible that participants who refrained from using SFG had established

better oral hygiene practices overall, leading to a reduced likelihood of experiencing halitosis. Secondly, individual differences in oral microbiota and saliva composition could influence how SFG affects malodor perception. Additionally, variations in gum ingredients, flavorings, and usage patterns among different studies may also contribute to divergent findings. Further investigation is needed to elucidate the underlying mechanisms linking sugar-free gum usage to SPH.

Moreover, our analysis revealed a notable association between gum bleeding and self-perceived halitosis (SPH). Participants experiencing gum bleeding, whether occasionally or regularly, exhibited a higher likelihood of SPH compared to those without gum bleeding. This finding aligns with previous research conducted by Music et al. [43]., which established a connection between periodontal disease, characterized by gum bleeding, and halitosis. Additionally, a systematic review by Memon et al. [44]. documented that individuals with periodontal disease are more susceptible to halitosis due to the presence of oral bacteria and inflammation in the gums. The association observed in our study suggests that gum bleeding may serve as a marker for underlying periodontal disease, which in turn contributes to the development of halitosis. This highlights the importance of addressing periodontal health as part of oral hygiene practices to reduce the risk of halitosis.

Limitations of the study

Firstly, our study was based on self-perceived halitosis and did not employ any objective measures of halitosis. By objective measures we could have find the accurate

results which include like organoleptic assessment, Halimeter, and gas chromatography which are known as the main diagnostic methods to detect oral malodor but with a questionnaire in google form along over phone or without evaluation by healthcare providers, so it was impossible to determine the reliability as a result. Secondly, only university students within the capital city of Dhaka potentially affect the generalizability of the results to other university students outside the capital. Thirdly, the convenience sampling approach may limit the generalizability of the result to all university students. This non-random sampling method may introduce bias by primarily selecting respondents who are easily accessible.

Conclusion and recommendation

According to the research, we can conclude that Self-perceived halitosis is a problem for a considerable number of university students in Dhaka, Bangladesh. Sex, BMI, smoking, drinking alcohol, exercise, drinking tea/coffee, mouth breathing, tooth brushing, duration of changing toothbrush, toothbrush use, use of toothpaste, fluoride-containing toothpaste, dental floss, mouthwash, toothpick, sugar-free chewing gum, mouth freshener, tongue cleaning, gum bleeding, gum swelling, dry mouth, dental caries, tooth sensitivity, food impaction were the factors significantly associated with self-perceived halitosis. Nonetheless, an objective assessment is required to determine the prevalence of these findings. The role of dental professionals in maintaining excellent oral health should be highlighted in the community, and they should also be made aware of the various causes of halitosis, as the public is likely not fully aware of these causes and their management.

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Author contributions

A.D (Annesha Dey)M.K (Md. Abdullah Saeed Khan)F.E (Fahima Nasrin Eva) T.I (Tariful Islam)M.H (Mohammad Delwar Hossain Hawlader)A.D did the conceptualization and design of the study, wrote the final Draft of the manuscript, and did data entry and analysis.M.K. helped write the first, second, third, fourth, and final drafts of the manuscript and the analysis section as well as in whole correction process.F.E did help to correct the third, fourth and final drafts of the manuscript.T.I help to corrected the methodology part of the manuscript.M.H did conceptualization and design Supervision.

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Data availability

The data can be provided on a valid request to the corresponding author.

Declarations

Ethical approval and consent to participate

Ethical clearance was obtained from the Institutional Review Board/Ethical Review Committee (ERC) of North South University (#2023/OR-NSU/IRB/0901). The study's objectives were provided to each respondent prior to data collection, and informed consent was obtained from the respondents. Informed written consent was obtained before data collection in the Google Form. The confidentiality of the information provided by the respondent was maintained. The moral principles outlined in the Helsinki Declaration of 1964 and subsequent amendments were followed.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Tungare S, Zafar N, Paranjpe AG. Halitosis [Internet]. StatPearls. 2024. <http://www.ncbi.nlm.nih.gov/pubmed/22722640>.
2. Azodo CCOPN and OM. Psychological and social impacts of halitosis: a review. *J Soc Psch Sc*. 2011;9:1–11.
3. Silva MF, Leite FRM, Ferreira LB, Pola NM, Scannapieco FA, Demarco FF, et al. Estimated prevalence of halitosis: a systematic review and meta-regression analysis. *Clin Oral Investig*. 2018;22(1):47–55.
4. Hasan SMM, Afrin S, Chowdhury NU. Female are More Prone to Halitosis Due to the Changing of the Hormonal Balance-A Cross Sectional Study in Bangladesh. *Am J Biomed Sci Res* [Internet]. 2019;3(2):106–10. <https://biomedgrid.com/fulltext/volume3/female-are-more-prone-to-halitosis-due-to-the-changing-of-the-hormonal-balance-a-cross-sectional-study.000643.php>.
5. Kapoor U, Sharma G, Juneja M, Nagpal A. Halitosis. Current concepts on etiology, diagnosis and management. *Eur J Dent* [Internet]. 2016;10(02):292–300. <http://www.thieme-connect.de/DOI/DOI?10.4103/1305-7456.178294>.
6. Wu J, Cannon RD, Ji P, Farella M, Mei L. Halitosis: prevalence, risk factors, sources, measurement and treatment – a review of the literature. *Aust Dent J*. 2020;65(1):4–11.
7. De Geest S, Laleman I, Teughels W, Dekeyser C, Quirynen M. Periodontal diseases as a source of halitosis: a review of the evidence and treatment approaches for dentists and dental hygienists. *Periodontol* 2000 [Internet]. 2016;71(1):213–27. <https://onlinelibrary.wiley.com/doi/https://doi.org/10.1111/prd.12111>.
8. Ayilicki B, Çolak H. Halitosis: from diagnosis to management. *J Nat Sci Biol Med*. 2013;4(1):14–23.
9. Carmela M, Lombardo C, Mariacristina M, Whithorn NI, Boronat-Catalá M, Almiñana-Pastor PJ, et al. Adolescence, adulthood and self-perceived halitosis: a role of psychological factors. *Med*. 2021;57(6):1–23.
10. Bin Mubayrik A, Al Hamdan R, Al Hadlaq EM, AlBagieh H, Alahmed D, Jaddoh H, et al. Self-perception, knowledge, and awareness of halitosis among female university students. *Clin Cosmet Investig Dent*. 2017;9:45–52.
11. Maha S, Mezied, 1 Dalal Al Bouri, 2 Ahad Al Omani, 2 Ghadeer Al Ramadhan, 2 Sara Al Bootie, 2 Ali Barakat 3 and Pradeep Koppolu4. A cross-sectional study on Self-Perceived Halitosis among Undergraduate University Students in Riyadh, Saudi Arabia.
12. Nazir MA, Almas K, Majeed MI. The prevalence of halitosis (oral malodor) and associated factors among dental students and interns, Lahore, Pakistan. *Eur*

- J Dent [Internet]. 2017;11(04):480–5. http://www.thieme-connect.de/DOI/DOI?10.4103/ejd.ejd_142_17.
13. AlSadhan SA. Self-perceived halitosis and related factors among adults residing in Riyadh, Saudi Arabia. A cross sectional study. Saudi Dent J [Internet]. 2016;28(3):118–23. <https://doi.org/10.1016/j.sdentj.2016.06.001>.
 14. Ashwath B, Vijayalakshmi R, Malini S. Self-perceived halitosis and oral hygiene habits among undergraduate dental students. J Indian Soc Periodontol. 2014;18(3):357–60.
 15. Alssum L, Alsaleh L, Alzoman H. Self-perceived halitosis and its social impact on females: a cross-sectional study. Med (United States). 2023;102(38):E35164.
 16. Schertel Cassiano L, Abdullahi F, Leite FRM, López R, Peres MA, Nascimento GG. The association between halitosis and oral-health-related quality of life: A systematic review and meta-analysis. J Clin Periodontol [Internet]. 2021;48(11):1458–69. <https://onlinelibrary.wiley.com/doi/https://doi.org/10.1111/jcpe.13530>.
 17. Obute P, Oyira EJ, Obeten JN. Knowledge and perception of Halitosis of Self-Esteem among students in University of Calabar. J Posit Sch Psychol. 2022;6(3):7265–78.
 18. Mezied MS, Al Bouri D, Al Omani A, Al Ramadhan G, Al Bootie S, Barakat A et al. A Cross-Sectional Study on Self-Perceived Halitosis among Undergraduate University Students in Riyadh, Saudi Arabia. J Pharm Bioallied Sci [Internet]. 2023;15(Suppl 1):S575–81. https://journals.lww.com/https://doi.org/10.4103/jpbs.jpbs_680_22.
 19. Harmouche L, Reingewirtz Y, Tuzin N, Lefebvre F, Davideau JL, Huck O. Knowledge and Management of Halitosis in France and Lebanon: A Questionnaire-Based Study. J Clin Med [Internet]. 2021;10(3):502. <https://www.mdpi.com/2077-0383/10/3/502>.
 20. Kim SY, Sim S, Kim SG, Park B, Choi HG. Prevalence and associated factors of subjective halitosis in Korean adolescents. PLoS ONE. 2015;10(10):1–11.
 21. Lee PPC, Mak WY, Newsome P. The aetiology and treatment of oral halitosis: an update. Hong Kong Med J. 2004;10(6):414–8.
 22. Lu HX, Tang C, Chen X, Wong MCM, Ye W. Characteristics of patients complaining of halitosis and factors associated with halitosis. Oral Dis. 2014;20(8):787–95.
 23. Arinola J, Oluokujo O. Halitosis amongst students in tertiary institutions in Lagos state. Afr Health Sci [Internet]. 2013;12(4). <http://www.ajol.info/index.php/ahs/article/view/85079>.
 24. Porter SR, Scully C. Oral malodour (halitosis). BMJ [Internet]. 2006;333(7569):632–5. <https://www.bmj.com/lookup/doi/10.1136/bmj.38954.631968.AE>.
 25. Su S, Lipsky MS, Licari FW, Hung M. Comparing oral health behaviours of men and women in the United States. J Dent [Internet]. 2022;122:104157. <https://linkinghub.elsevier.com/retrieve/pii/S0300571222002135>.
 26. Kateeb E. Gender-specific oral health attitudes and behaviour among dental students in Palestine. East Mediterr Heal J [Internet]. 2010;16(03):329–33. http://applications.emro.who.int/emhj/v16/03/16_3_2010_0329_0333.pdf.
 27. Alzoman H, Alssum L, Helmi M, Alsaleh L. Relationship between hormonal changes and self-perceived halitosis in females: a cross-sectional study. Healthc. 2023;11(1):1–15.
 28. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. Am J Mens Health [Internet]. 2021;15(3):155798832110163. <http://journals.sagepub.com/doi/10.1177/15579883211016361>.
 29. Mamai-Homata E, Koletsi-Kounari H, Margaritis V. Gender differences in oral health status and behavior of Greek dental students: A meta-analysis of 1981, 2000, and 2010 data. J Int Soc Prev Community Dent [Internet]. 2016;6(1):60. <https://journals.lww.com/https://doi.org/10.4103/2231-0762.175411>.
 30. Oyapero A, Oyapero O, Akinleye A. Burden of tobacco, kola nut and alcohol consumption and its association with periodontal disease, potentially malignant lesions and quality of life among bus drivers, Lagos State, Nigeria. Popul Med [Internet]. 2020;2(March). <http://www.journalssystem.com/popmed/Burden-of-tobacco-and-alcohol-consumption-and-its-association-with-periodontal-disease,118726,0,2.html>.
 31. Fan X, Peters BA, Jacobs EJ, Gapstur SM, Purdue MP, Freedman ND et al. Drinking alcohol is associated with variation in the human oral microbiome in a large study of American adults. Microbiome [Internet]. 2018;6(1):59. <https://microbiomejournal.biomedcentral.com/articles/https://doi.org/10.1186/s40168-018-0448-x>.
 32. Federica Romano 1. Enrico Pigella 2, Nicoletta Guzzi 2, Valeria Manavella 2, Lorena Campanelli 2 MA 2. Etiology and characteristics of halitosis in patients of a halitosis center in Northern Italy.
 33. Khan KM, Hameed S, Shamim S. Natural Products to Cure Bad Breath. In: Pharmacological Studies in Natural Oral Care [Internet]. Wiley; 2023. pp. 217–52. <https://onlinelibrary.wiley.com/doi/https://doi.org/10.1002/9781394167197.ch12>.
 34. Poniewierka E, Pleskacz M, Łuc-Pleskacz N, Klanięcka-Broniek J. Halitosis as a symptom of gastroenterological diseases. Gastroenterol Rev [Internet]. 2022;17(1):17–20. <https://www.termedia.pl/doi/https://doi.org/10.5114/pg.2022.114593>.
 35. Izidor C, Botelho J, Machado V, Reis AM, Prouença L, Alves RC et al. Revisiting Standard and Novel Therapeutic Approaches in Halitosis: A Review. Int J Environ Res Public Health [Internet]. 2022;19(18):11303. <https://www.mdpi.com/1660-4601/19/18/11303>.
 36. Zanetti F, Zivkovic Semren T, Battey JND, Guy PA, Ivanov NV, van der Plas A et al. A Literature Review and Framework Proposal for Halitosis Assessment in Cigarette Smokers and Alternative Nicotine-Delivery Products Users. Front Oral Heal [Internet]. 2021;2. <https://www.frontiersin.org/articles/https://doi.org/10.3389/froh.2021.777442/full>.
 37. Banotra MDP, Prasanth CDT, Kosala LCDM, Bhandari BS, Nanavati SLCDG. The Influence of Tongue Cleaning Habit on the Occurrence of Adverse Halitosis Outcomes: A Review of Literature on the Current Evidence. Int J Sci Res Publ [Internet]. 2020;10(10):530–6. <http://www.ijrsrp.org/research-paper-1020.php?rp=P10610639>.
 38. Peng X, Cheng L, You Y, Tang C, Ren B, Li Y et al. Oral microbiota in human systematic diseases. Int J Oral Sci [Internet]. 2022;14(1):14. <https://www.nature.com/articles/s41368-022-00163-7>.
 39. Santacroce L, Passarelli PC, Azzolino D, Bottalico L, Charitos IA, Cazzolla AP et al. Oral microbiota in human health and disease: A perspective. Exp Biol Med [Internet]. 2023;248(15):1288–301. <http://journals.sagepub.com/doi/https://doi.org/10.1177/15353702231187645>.
 40. Shiyao L, Yamei X, Deyu H. [Anti-halitosis effect of sugar-free chewing gum]. Hua Xi Kou Qiang Yi Xue Za Zhi [Internet]. 2015;33(2):166–8. <http://www.ncbi.nlm.nih.gov/pubmed/26189234>.
 41. Al-Haboubi M, Zoiopoulos L, Beighton D, Gallagher J. The potential benefits of sugar-free chewing gum on the oral health and quality of life of older people living in the community: a randomized controlled trial. Community Dent Oral Epidemiol [Internet]. 2012;40(5):415–24. <https://onlinelibrary.wiley.com/doi/https://doi.org/10.1111/j.1600-0528.2012.00685.x>.
 42. Nasseripour M, Newton JT, Warburton F, Awojobi O, Di Giorgio S, Gallagher JE et al. A Systematic Review and Meta-Analysis of the Role of Sugar-Free Chewing Gum on Plaque Quantity in the Oral Cavity. Front Oral Heal [Internet]. 2022;3. <https://www.frontiersin.org/articles/https://doi.org/10.3389/froh.2022.845921/full>.
 43. Musić L, Par M, Peručić J, Badovinac A, Plančak D, Puhar I. Relationship Between Halitosis and Periodontitis: a Pilot Study. Acta Stomatol Croat [Internet]. 2021;55(2):198–206. <https://hrcak.srce.hr/file/376419>.
 44. Memon MA, Memon HA, Muhammad FE, Fahad S, Siddiqui A, Lee KY et al. Aetiology and associations of halitosis: A systematic review. Oral Dis [Internet]. 2023;29(4):1432–8. <https://onlinelibrary.wiley.com/doi/https://doi.org/10.1111/odi.14172>.

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