Self-reported, subjectively-determined breath malodor, associated factors, treatment seeking behavior and oral hygiene practices among adults in Kinondoni, Tanzania

Mumghamba EGS[1], Rutaihwa RD[2]

[1]Department of Restorative Dentistry, School of Dentistry, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania.
[2]Department of Orthodontics, Pedodontics and Community Dentistry, School of Dentistry, Muhimbili University of Health and Allied Sciences, Dar-es-Salaam, Tanzania.

Mumghamba EGS, Rutaihwa RD
Self-reported, subjectively-determined breath malodor, associated factors, treatment seeking behavior and oral hygiene practices among adults in Kinondoni, Tanzania. Tanz Dent J 2013, 18 (1): 1-13

Abstract
Aim: To study the self-reported (SRM) and subjectively-determined breath malodor (OSM), associated factors, treatment seeking behavior and oral hygiene practices among adults in Kinondoni district.
Subjects and methods: This was a cross-sectional, descriptive and community-based study in convenient sample of 290 adults aged ≥ 18 years in Kinondoni district. The SRM, OSM of the exhaled air using the same individual's nose, associated factors, treatment seeking behavior and oral hygiene practices were assessed using a self-administered structured questionnaire.
Results: The prevalence of SRM was 76.6% and of OSM (16.6%), while tooth brushing practice and use of dentifrices was 100%, tongue cleaning (73.4%), awareness on presence of hard deposits on teeth (30%), gum bleeding on tooth brushing (69.7%), mobile teeth (7.2%) and medical problems (13.4%). The proportion of study participants who used ginger-spiced tea were (32.8%), tobacco smoking (16.6%), alcohol consumption (37.9%), dental floss (6.9%) and seeking treatment for breath malodor (TSM) was 11.8%. On logistic regression analyses, (AOR 95% CI), SRM was associated with ginger-spiced tea 3.27 (1.54-6.95), medical problems 3.25 (1.12-9.44) and smoking 7.92 (1.76-35.77). OSM was associated with Not-brushing the tongue 2.21 (1.08-4.54) and mobile teeth 6.01 (2.15-16.84). The TSM was associated with secondary education or higher, being married and awareness of having hard deposits on teeth.
Conclusion: Breath malodor was a common problem, associated with not-cleaning the tongue, mobile teeth; tobacco smoking, ginger-spiced tea, and general medical problems whereby the majority sought no care. All participants reported daily tooth brushing with dentifrice but practiced limited interdental flossing.

Running Title: Breath malodor and oral hygiene practices, Tanzania

Correspondence: Dr. Mumghamba E.G.S., Department of Restorative Dentistry, School of Dentistry, Muhimbili University of Health and Allied Sciences, P.O. Box 65014, Dar-es-Salaam, Tanzania.

Background

Breath malodor (BM) refers to an unpleasant smell of the exhaled air. Other terminologies for the BM are oral malodor, halitosis or foetor ex ore. Oral malodor is a very restrictive terminology that applies to bad smell originating from the oral cavity and excludes other causes from non-oral sites. The prevalence of breath malodor in the general population has been reported as high as 50% (1). The breath malodor is a cause of concern, social embarrassment and frustration on the part of general public; whereas at an individual level may lead to social isolation, personal discomfort, divorce proceedings, depression and even contemplation of suicide (1, 2). A term psychosomatic breath malodor (halitophobia, pseudo-halitosis) is used when breath malodor doesn't exist in actual fact but the patient imagines and believes that he or she has breath malodor. Halitophobia cannot be objectively determined and is mostly associated with suicidal attempts (3, 4).

Genuine breath malodor from the oral cavity contains volatile sulphur compounds (VSCs) particularly hydrogen sulphide, methylmercaptan, dimethyl-sulphide, and organic acids (3, 5). The causes for BM are multifactorial in that it may arise from dental plaque, bacterial products from deep periodontal pocket, tongue, tonsils and pharynx and rarely from gastrointestinal tract (5). Breath malodor is also associated with gingival bleeding on tooth brushing (6) and higher number of bleeding sites on probing (7). Oral prosthetics such as acrylic dentures, especially when retained in the mouth at night or are poorly and irregularly cleaned, can also producetypical smell associated with candidiasis (8). Non-oral causes for genuine breath malodor include medical problems such as renal failure, cirrhosis of the liver, and diabetes mellitus (1, 8, 9). Although breath malodor can originate from oral and a non-oral sites, about 85% are generally related to an oral cause (1, 8).

Individuals that are experiencing breath malodor make desperate attempts to mask the problem with mints and chewing gums, compulsive tooth brushing, and repeatedly rinsing with mouthwashes (9).

Major methods of analyzing BM include organoleptic measurement (judges for BM), gas chromatography and sulphide monitors (3, 10). In addition to these methods, clinical application of a questionnaire for diagnosis and treatment of breath malodor has been developed for use (11). A strategy to control breath malodor includes reduction of oral bacterial load, reduction of nutrient/substrate availability to the oral microbes, conversion of VSC to non-volatiles and masking the malodor (1, 3, 8). Chewing gum containing tea extracts for its deodorizing mechanisms as it changes the VSC to non volatile products has also been attempted (8).

The information on bad oral breath in African countries including East Africa and in particular Tanzania general population is scarce. The prevalence of self perceived bad oral breath was 72% among adolescents in Temeke district, Tanzania (12), 14% in young women at maternity block in Muhimbili National Hospital (6) and 44% in Muhimbili dental outpatients (13). Most of the studied Muhimbili dental out-patients (66%) were of the opinion that BM was a problem in their society, and the majority of these respondents (64.5%) were residents in Kinondoni district (13). The importance of oral hygiene practices as a prerequisite for plaque control and good oral health cannot be overemphasized. Tooth brushing practice in most of the studied adult population in Tanzania is about 95% or more using plastic toothbrush, chewing-stick, and rarely dental floss (14, 15). However, in relation to the effectiveness of tooth brushing practices and in particular among Tanzanians has been questioned due to the high prevalence of plaque biofilm on teeth, dental calculus, and gingival bleeding (15, 16). Since microbial plaque is known to cause breath malodor (8, 10), it was thought then that the Tanzania general adult population would be experiencing breath malodor problem but this assumption had never been substantiated. Therefore, the purpose of the present study was to find out the prevalence of the self-reported (SRM) and subjectively-determined breath malodor (OSM), associated factors, treatment seeking behavior and oral hygiene practices among adults in Kinondoni district. The findings would provide baseline information that can be used for planning interventional strategy.

Study participants and methods

Study design, place of study and participants

This was a cross-sectional descriptive community based study. The study was conducted in Mabibo and Magomeni in Kinondoni district, Dar-es-Salaam, Tanzania, which were conveniently selected. All adults found in the residential houses and business sites in particular the markets, shops, offices at the time of data collection were eligible to participate. Only those who consented were included in the study.

Questionnaire

Yaegaki and Coil questionnaire (11) was translated into Kiswahili and necessary modifications made to suit the local environment. The questionnaire included; personal particulars (demographic data), oral health habits that have been shown to influence oral malodor, awareness on oral malodor and on periodontal health.

Determination of oral malodor

The persistent or long standing problem of breath malodor (not related to momentarily ingestion of foods like garlic or onions as well as drinks like coffee or alcohol) was self-reported (SRM) and the on-spot self-smelling of the self-exhaled air was subjectively determined using individual's nose for sense of smell as an organoleptic approach (OSM). For smelling own exhaled air, the study participants were requested to hold their palms together in a cup-like fashion and exhale into the palms thus holding the "exhaled air" and immediately smell the exhaled air to note for the presence or absence of breath malodor.

Data management and statistical analysis

Data was entered into a computer and analyzed using Statistical Package for Social Sciences (SSPS) version 17.0. Frequency and cross-tabulation tables were generated. Chi-Square test or Fisher's Exact Test were used to detect associations. In all the analyses, the statistical significance level was set at "$p < 0.05$". The variables that showed association in bivariateanalyses were entered in a logistic regression model using Backward (LRB) stepwise method based on the likelihood ratio criterion (p_{in} =0.05, p_{out} = 0.10) to determine their relative importance in oral malodour. In the LRB stepwise method, all potentially important explanatory variables are included in the full model as an initial step. Afterwards, at each step, while running the analysis the variable with the smallest contribution to the model (or the largest P value) is removed as long as that P value is greater than the chosen level

($P < 0.05$). After removing unimportant variables one at a time (stepwise), the model stops at certain point and retains only those variables that have significant contribution.

Ethical considerations

This work was an elective study which part of the requirement for the doctor of dental surgery (DDS) undergraduate training at the Muhimbili University of Health and Allied Sciences (MUHAS). Ethical clearance was granted by the Research and Publication Committee of the School of Dentistry on behalf of MUHAS ethical committee.

Results

Study participants

A total of 290 adults (49.7% females) aged 18-70 years (mean = 31.2 ± 11.7) participated in the study (Table 1). The level of education of the study participants was primary (38.8%), Secondary (36.6%) and college (20.0%) education. Only 5.2% had no formal education.

Table 1: Distribution of the study participants by age-group and sex

Age group (years)	Males		Females		Total	
	n	(%)	n	(%)	n	(%)
≤19	20	(13.7)	23	(16.0)	43	(14.8)
20-29	54	(37.0)	60	(41.7)	114	(39.3)
30-39	35	(24.0)	32	(22.2)	67	(23.1)
40-49	20	(13.7)	14	(9.7)	34	(11.7)
50+	17	(11.6)	15	(10.4)	32	(11.0)
Total	146	(100)	144	(100)	290	(100)

P = 0.767

Oral hygiene practices

All study participants claimed to be brushing their teeth daily. The reported frequency of tooth brushing was once/day (63.1%), twice or more/day (36.9%). The proportion of participants brushing their teeth before breakfast was 92.1%, after breakfast 7.9% and before going to bed (36.2%), with no significant differences between age groups, sex, level of education and marital status. Tooth cleaning devices used were plastic toothbrush (98.6%), chewing stick or "mswaki" (0.7%), both the plastic tooth brush and the chewing stick (0.7%). More than half (53.1%) of study participants reported to be cleaning the inter-dental spaces, of whom 97.8% used tooth picks and 2.2% used dental floss.

All the participants claimed to use dentifrices during tooth brushing and the types were in particular Whitedent (55.9%), Colgate (26.9), more than one type of toothpaste (7.2%) and other-toothpaste(s) (10.0%). Three quarters (73.4%) claimed to brush the tongue, the percentage being 74.7% among males and 72.2% among females.

Table 2: Distribution of participants by oral hygiene practices and self-reported breath malodor (SRM)

Associated factors	Study participants (N = 290)	Self-reported breath malodor (SRM)				P - Value
		Yes		No		
		(n = 222)	(%)	(n = 68)	(%)	
Tooth brushing (once/day versus twice/day)						< 0.001
Yes	183	162	(73.0)	21	(30.9)	
Not brushing before sleep						
Yes	185	162	(73.0)	23	(33.8)	< 0.001
Inter-dental cleaning						
Yes	136	109	(49.1)	27	(39.7)	0.174
Not using tooth picks						
Yes	157	121	(54.5)	36	(52.9)	0.821
Not using dental floss						
Yes	270	212	(95.5)	58	(85.3)	0.004
Self-reported dental hard deposits						
Yes	87	71	(32.0)	16	(23.5)	0.183
Not brushing the tongue						
Yes	77	60	(27.0)	17	(25.0)	0.741
Use “Whitedent” tooth paste only						
Yes	162	128	(57.7)	34	(50.0)	0.266
Use “Other-toothpaste(s)” only						
Yes	29	24	(10.8)	5	(7.4)	0.406
Use “Colgate” toothpaste only						
Yes	78	52	(23.4)	26	(38.2)	0.016
Use >1 toothpaste types						
Yes	21	18	(8.1)	3	(4.4)	0.425*
Gum bleeding on tooth brushing						
Yes	202	161	(72.5)	41	(60.3)	0.055
Mobile teeth present						
Yes	21	21	(9.5)	0	(0.0)	0.006*
Space development between teeth						
Yes	19	18	(8.1)	1	(1.5)	0.054*
Use of chewing gum						
Yes	150	117	(52.7)	33	(48.5)	0.547

*Fisher’s Exact Test (when one some of the cell count was less than 5)

Self-awareness on dental hard deposits, gum bleeding and mobile teeth

Thirty percent reported to be aware of the presence of hard deposits (calculus) on their teeth, 69.7% experience gum bleeding on tooth brushing and 7.2% having mobile teeth.

Use of tobacco, alcohol, ginger-spiced tea, coffee, and gum-chewing

Use of tobacco, alcohol, ginger-spiced tea, coffee, and gum-chewing was reported by 16.6%, 37.9%, 32.8%, 24.5% and 51.7% of the study participants respectively.

Table 3: The prevalence of long standing subjectively-determined breath malodor (LBM) and associated factors

Associated factors	Study population (n)	Long standing subjectively-determined breath malodor				p -value
		Yes		No		
		n	(%)	n	(%)	
Age group ≤ 28 years						0.524
Yes	142	111	(50.0)	31	(45.6)	
No	148	111	(50.0)	37	(54.4)	
Sex						0.084
Male	146	118	(53.2)	28	(41.2)	
Female	144	104	(46.8)	40	(58.8)	
Marital Status						
Ever-married	140	107	(48.2)	33	(48.5)	0.962
Never-married	150	115	(51.8)	35	(51.5)	
Level of Education						
Primary education or less	126	100	(45.0)	26	(38.2)	0.322
Secondary education/higher	164	122	(55.0)	42	(61.8)	
Smoking tobacco						
Yes	48	46	(20.7)	2	(2.9)	< 0.001
No	242	176	(79.3)	66	(97.1)	
Consumption of alcohol						
Yes	111	84	(37.8)	27	(39.7)	0.782
No	179	138	(62.2)	41	(60.3)	
Frequency of alcohol intake: x 1-2/wk vs non/occasional users#						
Yes	47	35	(16.9)	12	(17.9)	0.850
No	227	172	(83.1)	55	(82.1)	
Have medical problems						
Yes	39	34	(15.3)	5	(7.4)	0.092
No	251	188	(84.7)	63	(92.6)	
Stomach ulcers						
Yes	8	7	(3.2)	1	(1.5)	0.686*
No	282	215	(96.8)	67	(98.5)	
Diabetic						
Yes	6	5	(2.3)	1	(1.5)	1.00*
No	284	217	(97.7)	67	(98.5)	
Non-specific medical problem						
Yes	28	26	(11.7)	2	(2.9)	0.034*
No	262	196	(88.3)	66	(97.1)	
Currently on vitamins						
Yes	12	11	(5.0)	1	(1.5)	0.306*
No	278	211	(95.0)	67	(98.5)	
On special diet						
Yes	2	0	(0)	2	(2.9)	0.054*
No	288	222	(100)	66	(97.1)	
Use of ginger spiced tea						
Yes	95	82	(36.9)	13	(19.1)	0.006
No	195	140	(63.1)	55	(80.9)	
Use of coffee						
Yes	71	56	(25.2)	15	(22.1)	0.595
No	219	166	(74.8)	53	(77.9)	

*Fisher's Exact Test (when one some of the cell count was less than 5), # Not specified/Others (n=16) were excluded from the analysis

Medical problems, use of vitamins, anti-acids and laxatives

General medical problems were reported by 39 (13.4%) of all the study participants. At the time of data collection, 4.1% of study participants were on vitamins, 2.8% on anti-acids and 1.7% on laxatives.

Breath malodor

Among the studied population, the prevalence of SRM was 76.6% and 16.6% for OSM. A total of 191 (65.9%) participants admitted to have met people who had SRM problem. Study participants reported to experience breath malodor after waking-up (47.9%), when talking to others (2.1%), all the time (4.8%), in the evening (10.0%), and at night (8.6%) (Figure 1). Participants with SRM reported that the condition is an embarrassing social problem (81.5%), particularly among those aged >28 years ($p = 0.003$), having ≥ secondary education ($p = 0.003$), and among married individuals ($p = 0.019$). The most frequent reasons given as causes for breath malodor include lack of or improper tooth brushing, cavities in teeth and dry mouth (Figure 2).

Long standing breath malodor and the associated factors

The distribution of participants by oral hygiene practices and self-reported breath malodor (SRM) is shown in Table 2. The problem of SRM was reported much more among those who brushes their teeth once per day or less frequently ($p < 0.001$), not brushing before sleep ($p <0.001$), and among those not using dental floss ($p < 0.004$). The proportion of participants with SRM was higher among those who had gum bleeding on tooth brushing (72.5%) than in those without (60.3%), however, the difference was not statistically significant. The problem of SRM was less reported among colgate toothpaste users, ($p = 0.016$).

Other factors associated with the occurrence of SRM (Table 3) were tobacco smoking ($p < 0.001$), use of ginger spiced-tea ($p = 0.006$), and non-specific/general medical problems ($p = 0.034$). In the bivariate analysis, the group with non-specific medical conditions had significantly higher proportion of participants that had experienced SRM (11.7%) than in those without SMB (2.9%), $p = 0.034$ (Table 3). The use of vitamins, anti-acids, and laxatives were not associated with the occurrence of SRM. Presence of SRM was higher among those who consumed alcohol everyday (95.7%), once/week (54.2%), occasionally (70.8%), and others (77.1%) compared to those who did not consume alcohol ($p = 0.005$, Not in table).

In the logistic regression analyses the factors that were more likely associated with the occurrence of SRM (Table 4) were tobacco smoking (OR^a 7.92, 95% CI: 1.76-35.77, $p = 0.007$), use of ginger-spiced tea (OR^a 3.27, 95% CI: 1.54-6.95, $p = 0.002$) and having other general medical problems (OR^a 3.25, 95% CI: 1.12-9.44, $p = 0.03$). Tooth brushing practice was found to be significantly protective against SRM ($OR^a = 0.15$, 95% CI: 0.08, 0.28, $p < 0.001$).

Table 4: Multivariate analyses - Logistic regression analysis: Backward stepwise (Wald) for the factors associated with long-standing self-reported breath malodor (SRM)

Factors associated to Long-standing self-reported breath malodor (SRM)	Beta	Standard Error	Adjusted Odds Ratio (OR^a)	95.0% CI for OR^a		P - Value
				Lower	Upper	
Smoking tobacco	2.07	0.77	7.92	1.76	35.77	0.007
Use of ginger spiced tea	1.19	0.38	3.27	1.54	6.95	0.002
Tooth brushing practice	-1.91	.33	0.15	0.08	0.28	< 0.001
Not using dental floss	0.99	0.52	2.70	0.97	7.50	0.057
Having other medical problems	1.18	0.54	3.25	1.12	9.44	0.030
Use of chewing gum	0.58	0.33	1.79	0.95	3.39	0.074

Variables in the Equation were significant $p < 0.001$, Nagelkerke R Square = 0.331 and the Classification Table -Overall percentage was 80.7.

Organoleptically self-determined breath malodor and the associated factors

The distribution of participants by oral hygiene practices and the occurrence of organoleptically self-determined malodor of the exhaled air (OSM) are shown in Table 5. The OSM problem was found to be significantly higher among participants that brushed their teeth once/day or less frequently ($p = 0.004$), not brushing before sleep ($p = 0.006$), not cleaning the spaces between the teeth ($p = 0.001$), and not using tooth picks ($p = 0.026$). Furthermore, the proportion of participants that had OSM problem were much more in the group of those who did not brush the tongue ($p = 0.001$), those who had mobile teeth or space development between the teeth at adult age ($p < 0.001$) and those who were aware of having dental hard deposits ($p = 0.023$).

Table 5: The Bivariate analyses: The prevalence of organoleptically subjectively-determined breath malodor (OSM) of self-exhaled air and oral hygiene practices

Associated factors	Study participants (N=290)	Organoleptically subjectively-determined breath malodor (OSM)				P -Value
		Yes (n = 48)		No (n = 242)		
		n	(%)	n	(%)	
Tooth brushing (once/day versus twice/day)						0.004
Yes	183	39	(81.3)	144	(59.5)	
Not brushing before sleep						
Yes	185	39	(81.3)	146	(60.3)	0.006
Inter-dental cleaning						
Yes	136	33	(68.8)	103	(42.6)	0.001
Not using tooth picks						
Yes	157	33	(68.8)	124	(51.2)	0.026
Not using dental floss						
Yes	270	47	(97.9)	223	(92.1)	0.216*
Self-reported dental hard deposits						
Yes	87	21	(43.8)	66	(27.3)	0.023
Not brushing the tongue						
Yes	77	22	(45.8)	55	(22.7)	0.001
Use of “WhiteDent” tooth paste						
Yes	162	32	(66.7)	130	(53.7)	0.099
Use of “Other-toothpaste(s)”						
Yes	29	9	(18.8)	20	(8.3)	0.027
Use of “Colgate” tooth paste						
Yes	78	5	(10.4)	73	(30.2)	0.005
Use >1 toothpaste types						
Yes	21	2	(4.2)	19	(7.9)	0.368
Self-reported gum bleeding						
Yes	202	36	(75.0)	166	(68.6)	0.378
Mobile teeth present						
Yes	21	11	(22.9)	10	(4.1)	< 0.001
Space development between teeth						
Yes	19	10	(20.8)	9	(3.7)	< 0.001
Use of chewing gum						
Yes	150	24	(50.0)	126	(52.1)	0.794

*Fisher’s Exact Test (when one some of the cell count was less than 5)

Not specified/Others (n=16) were excluded from the analysis

OSM was found more among the study participants that were ≤ 28 years of age (p = 0.04) and among those with informal or primary education (p = 0.05) (Not in table). The occurrence of OSM among non-smokers, smokers 1-5 cigarette/day as well as smokers 6-10 cigarettes/day was 14.7%, 22.5%, 60%, respectively, (p = 0.014) (Not in table). In the logistic regression analyses, the most important factors that were more likely associated with the

OSM were self awareness of the presence of mobile teeth (OR^a 6.01, 95% CI: 2.15-16.84, p = 0.001), and not cleaning or brushing the tongue (OR^a 2.2, 95% CI: 1.08-4.54, p = 0.03) (Table 6).

Treatment seeking behavior for breath malodor

Of the 222 study participants who had breath malodor, only 11.8% reported treatment seeking behavior for breath malodor (TSM) problem. In multivariate logistic regression analysis (Table 7), study participants that were currently married had higher Odds of seeking treatment for breath malodor than those who were single or living alone (not married, separated, divorced, widows or widowers) (OR^a = 3.85, 95% CI: 1.29, 11.49, p = 0.016). This was also true for participants that had attained secondary education or higher and those who were aware of having hard deposits on their teeth (OR^a = 3.32, 95% CI: 1.15, 9.56, p = 0.026) and (OR^a = 2.92, 95% CI: 1.14, 7.48, p = 0.026), respectively. Unexpectedly, the study participants that had OM problem and have experienced gum bleeding on tooth brushing, had lower Odds of seeking treatment for BM problem (OR^a = 0.39, 95% CI: 0.16, 1.00, p = 0.050).

Table 6: Multivariate analyses - Logistic regression analysis: Backward stepwise (Wald) for factors associated with organoleptically subjectively-determined breath malodor (OSM)

Factors associated to organoleptically subjectively-determined oral malodor (OSM)	Beta	Standard Error	Adjusted Odds Ratio (OR^a)	95.0% CI for OR^a		P - Value
				Lower	Upper	
Not cleaning/brushing the tongue	0.79	0.37	2.21	1.08	4.54	0.030
Tooth brushing (x1 versus (vs) x2/day)	-0.77	0.42	0.47	0.21	1.06	0.067
Use >1 toothpaste type vs Whitedent	0.77	0.79	2.17	0.46	10.16	0.327
Use >1 toothpaste type vs Colgate	-0.68	0.90	0.51	0.09	2.96	0.449
Use >1 toothpaste type vs "Other-toothpaste(s)"	1.04	0.88	2.82	0.51	15.75	0.238
Self-reported presence of mobile teeth	1.79	0.53	6.01	2.15	16.84	0.001

Variables in the Equation were significant p < 0.001, Nagelkerke R Square = 0.212 and the Classification Table - Overall percentage was 84.8.

Discussion

Epidemiologically, this study is among the few reports in Tanzania dealing with the problem of subjectively-determined breath malodor at a community level, as all others had reported findings from health facility based populations (6, 13). As regards to methodology, the study area and population was chosen for convenience and therefore inferences to the whole general population would not be very appropriate.

Table 7: Logistic regression analysis - Backward stepwise (Wald): factors associated with treatment-seeking behavior for long-standing self-reported breath malodor (SRM)

Factors associated with treatment seeking behavior for self-reported breath malodor (SRM)	Beta	Standard Error	Adjusted Odds Ratio (OR[a])	95.0% CI for OR[a]		P – Value
				Lower	Upper	
Currently married	1.35	0.56	3.85	1.29	11.49	0.016
Self-reported (SRT) Hard deposits on teeth	1.08	0.48	2.92	1.14	7.48	0.026
Level of education: Secondary or higher	1.20	0.54	3.32	1.15	9.56	0.026
SRT - Gum bleeding on tooth brushing	-0.93	0.48	0.39	0.16	1.00	0.050
Embarrassed due to oral malodor	1.16	0.60	3.18	0.99	10.28	0.053
SRT - Space development between teeth	1.24	0.68	3.46	0.91	13.06	0.068

Variables in the Equation were significant p < 0.001, Nagelkerke R Square = 0.220 and the Classification Table -Overall percentage was 87.3. Among the 222 study participants who had SRM, only about one fifth of them (19.8%) had breath malodor on XMB (p = 0.007). The use of questionnaire to diagnose breath malodor in a country with emerging economy and constraints in resources was thought to be appropriate as was in line with what has been recommended elsewhere (11, 17). Other methods that employ equipments to determine breath malodor and malodor judges (3, 10) clearly appeared to be out of reach and therefore could not be used.

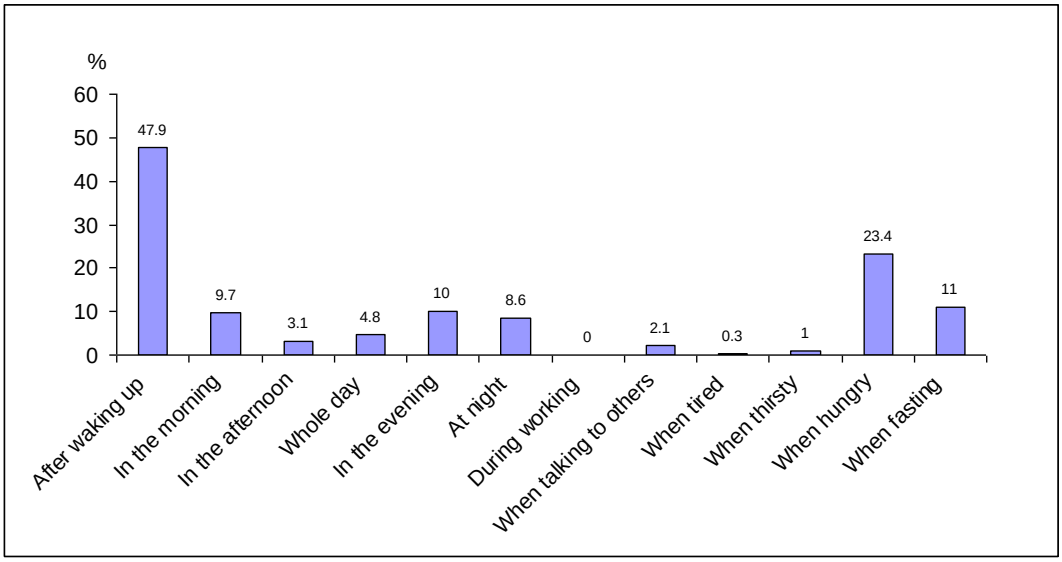

Figure 1: Time of the day when study participants' experiences long standing self-reported breath malodor (in percentages)

In respect to the occurrence of breath malodor, about two thirds of the study participants acknowledged to have met a person in their community with such problem, and the fact that more than three quarter of the study participants had experienced breath malodor, all shows how common was this embarrassing problem in the community and thus considered to be a public social health problem as reported in other populations elsewhere (18). There were no gender-specific differences in the prevalence of breath malodor and this is in agreement with other findings reported elsewhere (19). In comparison, the prevalence of SRM in Kinondoni was higher than the 15% reported among Brazil general population (20). Also the occurrence of morning breath malodor that was experienced just after waking up was higher than the 32%-44% experienced in Saudi population (17). The Kinondoni participants' knowledge on the causes of breath malodor was low and it corroborates what had been observed among Jordanian adults (21). Probably the level of education and type of information being delivered at schools might have contributed to this scenario. It was commendable that all the participants practiced regular tooth cleaning. However, as advocated for good oral health, tooth brushing twice or more per day and at night before sleep was practiced by only about one third of the study participants and this level was lower than what has been reported among Kuwait adults (22).

Not brushing the tongue and also awareness of having mobile teeth were both highly associated with the occurrence of OSM in this study population. The possible explanation for this as pointed by De Boever and Loesche (23) is that the un-cleaned tongue is usually harboring periodontal bacteria such as *Prevotella intermedius*, *Porphyromonas gingivalis* and *Fusobacterium* species that are responsible for producing volatile sulfur compounds (VSC) that accounts for the breath malodor. The presence of mobile teeth is most likely a sign of advanced periodontal disease that is seated with deep periodontal pockets with anaerobic bacteria that contributes to the production of VSC (7). Also, the association between periodontal disease and breath malodor has been reported earlier among Tanzanians (10).

In Tanzania, attempts to manufacture local brands of dentifrices like "Whitedent", and "Others" have been in progress to enhance and at the same time compete with the existing market of dentifrices that includes Colgate. Although colgate appeared to be protective against SRM in the bivariate analysis, in the multivariate analysis, none of the used toothpaste brands appeared to prevent breath malodor. However, the importance of dentifrices still remains for an expectation that some of the brands' chemical-formulation as reported elsewhere, might be effective in controlling breath malodor (24). The use of dental floss though important for the control of breath malodor, its application in this study population has remained uncommon as reported earlier from other populations in the country (14, 15) and was also very low compared to the experience (19%) among the Jordanian adults (21).

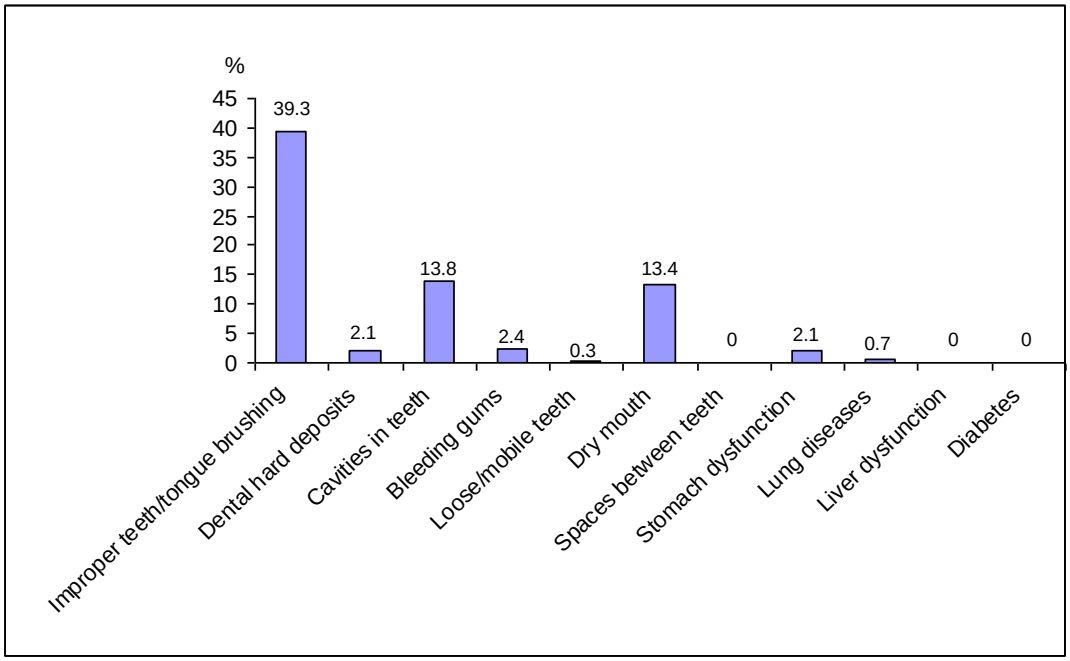

Figure 2: Study participants' knowledge on causes of breath malodor (in percentages)

In the assessment of tobacco smoking and alcohol consumption in this study population, it was only smoking that appeared to be a significant factor for the occurrence of breath malodor. However, no verification was done to see whether the breath malodor experienced was part and parcel of smoker's breath as explained by Rosenberg or not (25). In addition, it has been reported elsewhere that smokers as compared to non smokers did brush and floss the teeth less frequently (26). In general then, a program to advocate tobacco smoking cessation might appear to be a role of a dentist that will benefit the client in oral as well as general health (27). Contrary to our findings, it has recently been reported that alcohol intake could be considered as an important predictor for breath malodor (28). Interestingly enough, the use of ginger-spiced tea was found to be significantly associated with the occurrence of SRM. The possible explanation for this finding could not be elucidated and warrants further research. Although administration of green-tea has been reported to have an immediate and a temporary reduction of breath malodor due to antimicrobial and deodorant effects of polyphenols in tea, long-lasting effect from one hour or more has not been established (8, 29). The reason why some of the study participants preferred ginger-spiced tea was not studied and whether such people had possible other medical problems like stomach digestion problems is not known and therefore it remains to be an area for further research. The status of having other medical problems was found to be significantly associated with the occurrence of long standing breath malodor. The reason for this relationship is not known. However, one might speculate the possibility that such individuals might have some psychological problems as well (2, 4).

Factors that favored treatment seeking behavior for breath malodor were being-in-marriage, high education, and awareness of having hard deposits on teeth. The possible explanation for this might be that high education provides opportunity for seeking more information, and that being married favored atmosphere for mutual discussion on matters of interest and encourage a behavior to seek solution, and in this case, care for breath-malodor problem. When it comes to general oral health care, unfavorable self-care habits had been related to non-attendance to dental clinic/appointments behavior (7). Interestingly, bleeding gums on tooth brushing was not seriously considered as an important factor to seek treatment. The exact reasons for this behavior are not known, although it may be speculated that lack of pain to accompany gum bleeding might have altogether led to the indefinite scenario of wait and see.

The limitation of this study was that, the identification of breath malodor did not use the objective approach whereby the presence and quantification of offensive gases are assessed. Also, there was no trained smell judges (organoleptic approach) employed to assess the breath-smell, despite the fact that the method is still the one considered as gold standard (8). In addition, there was lack of agreement between the questionnaire (SRM) and the organoleptic approach (OSM) used to assess the breath malodor problem. Therefore, the possibility of miss-classification between those who had real from those that had false breath malodor might have occurred in this study. However, this kind of discordance between questionnaire and organoleptic approach has also been reported among Swiss young adults (30). Lastly, the selection of study participants did not follow a strict random sampling technique and therefore generalization of the present findings to the whole Kinondoni adult population would not be very appropriate. In future, efforts to employ objective and feasible methods to assess breath malodor in a randomly selected and representative study population, reasons for not seeking care and intervention strategy are recommended.

Conclusions

It can be concluded that, self-reported breath malodor was very common and was associated with tobacco smoking, use of ginger-spiced tea, having other medical problems and tooth brushing frequency less than twice per day. Self-determined breath malodor was prevalent and was associated with not cleaning the tongue and presence of mobile teeth. Most of those having breath malodor did not seek treatment and the treatment seeking behavior was associated with marital status, awareness of having hard deposits on teeth and having higher secondary education or higher. All participants reported daily tooth brushing with dentifrice but practiced limited interdental flossing. Recommendations include further research on most appropriate and feasible methods to diagnose breath malodor, reasons behind not-seeking for care and inclusion of interventional strategy.

Acknowledgements

Part of this study, especially the data collection and data entry into the computer was funded by the Muhimbili University of Health and Allied Sciences (MUHAS) and the Ministry of Education, Vocational Training, Tanzania, as "elective study" to the Co-author (RRD).

Authors Contribution

1st Author: Conceived the study, supervised the development of proposal and data collection tool, did all the data analysis, write-up, and submission.

2nd Author: Participated in developing the proposal and data collection tool, did all the data collection, and data entry into the computer.

References

1. Cortelli JR, Barbosa MD, Westphal MA. Halitosis: a review of associated factors and therapeutic approach. Braz Oral Res. 2008; 22 Suppl 1: 44-54.
2. Rosenberg M. Halitosis–the need for further research and education. J Dent Res 1992; 71: 424.
3. Yaegaki K, Coil JM. Examination, classification, and treatment of halitosis; clinical perspectives. J Can Dent Assoc 2000; 66: 257–261.
4. Oho T, Yoshida Y, Shimazaki Y, Yamashita Y, Koga T. Psychological condition of patients complaining of halitosis. J Dent 2001; 29: 31–33.
5. So¨der B, Johannson B, So¨der P. The relationship between foetor ex ore, oral hygiene and periodontal disease. Swed Dent J 2000; 24: 73–82.
6. Mumghamba EGS, Karim KP, Michael J. Oral hygiene practices, periodontal conditions, dentition status and self-reported bad mouth-breath among young mothers, Tanzania. Int J Dent Hygiene 2006; 4: 166-173.
7. Morita M, Wang HL. Relationship between sulfur sulfide level and oral malodor in subjects with periodontal disease. J Periodontol 2001; 72: 79-84.
8. Quirynen M, Van den Velden S, Vandekerckhove B, Dadamio J. Oral malodor. In: Newman MG, Takei HH, Klokkevold PR, Carranza FA, editors. Carranza's Clinical Periodontology, 11th Edition, St. Louis, Elsevier, Saunders, 2012: 331-338.
9. Bosy A. Oral malodor: philosophical and practical aspects. J Can Dent Assoc. 1997;63:196-201.
10. Shimura M, Yasuno Y, Iwakura M et al. A new monitor with a zinc-oxide thin film semiconductor sensor for the measurement of volatile sulfur compounds in mouth air. J Periodontol 1996; 67: 396–402.11.

    Yaegaki K, Coil JM. Clinical application of a questionnaire for diagnosis and treatment of halitosis. Quintessence Int 1999; 30: 302–306.
12. Kida IA, Manyori C, Masalu JR. Prevalence and correlates of perceived oral malodor among adolescents in Temeke district, Dar-es-Salaam. East Afr J Public Health. 2010;7: 49-53.
13. Fadhil OK, Mugonzibwa EA. Perception on halitosis among dental patients attending Muhimbili National Hospital dental clinic. Tanz Dent J 2005; 12: 13-17
14. Sarita PTN, Tuominen R. Tooth cleaning methods and their effectiveness among adults in rural Tanzania. Proc Finn Dent Soc 1992; 88: 139–145.
15. Mumghamba EGS, Fabian FM. Periodontal health status and oral hygiene practices among middle-aged adults in Mtwara Rural, Tanzania. Afr J Oral Health Sci 2003; 4: 192–197.
16. Mosha HJ, Ngilisho LA, Nkwera H, Scheutz F, Poulsen S: Oral health status and treatment needs in different age groups in two regions of Tanzania. Community Dent Oral Epidemiol 1994, 22: 307-310.
17. Almas K, Al-Hawish A, Al-Khamis W. Oral hygiene practices, smoking habit, and self perceived oral malodor among dental students. J Contemp Dent Pract 2003; 4: 77-90.
18. Rayman S, Almas K. Halitosis among racially diverse population: an update. Int J Dent Hygiene 2008; 6: 2-7.
19. Iwakura M, Yasuno Y, Shimura M, Sakamoto S. Clinical characteristics of halitosis: Differences in two patient groups with primary and secondary complaints of halitosis. J Dent Res 1994; 73: 1568-1574.
20. Nadanovsky P, Carvalho LB, Ponce de Leon A. Oral malodour and its association with age and sex in a general population in Brazil. Oral Dis 2007; 13: 105-159.
21. Tubaishat RS, Darby ML. Use of miswak versus toothbrushes: oral health beliefs and behaviors among a sample of Jordanian adults. Int J Dent Hyg 2005; 3: 126-136.
22. Al-Shammari KF, Al-Ansari JM, Al-Khabbaz AK, Dashti A, Honkala EJ. Self-reported oral hygiene habits and oral health problems of Kuwaiti adults. Med Princ Pract 2007; 16: 15-21.
23. De Boever EH, Loesche WJ. Assessing the contribution of anaerobic microflora of the tongue to oral malodor. J Am Dent Assoc 1995; 126: 1385-1393.
24. Gerlach RW, Hyde JD, Poore CL, Stevens DP, Witt JJ. Breath effects of three marketed dentifrices: A comparartive study evaluating single and cumulative use. J Clin Dent 1998; 9: 83-88.
25. Rosenberg M. Clinical assessment of bad breath: Current concepts. J Am Dent Assoc 1996; 127: 475-481.
26. Andrews JA, Severson HH, Lichtenstein E, Gordon JS. Relationship between tobacco use and self reported oral hygiene habits. J Am Dent Assoc 1998, 129: 313-320.

27. Petersen PE. Tobacco and oral health--the role of the world health organization. Oral Health Prev Dent. 2003; 1: 309-315.
28. Rosenberg M, Knaan T, Cohen D. Association among bad breath, body mass index, and alcohol intake. J Dent Res 2007; 86: 997-1000.
29. Lodhia P, Yaegaki K, Khakbaznejad A, Imai T, Sato T, Tanak T, Murata T, Kamoda T. Effect of green tea on volatile sulfur compounds in mouth air. J Nutr Sci Vitaminol (Tokyo) 2008; 54:89-94.
30. Bornstein MM, Stocker BL, Seemann R, Burgin WB, Lussi A. Prevalence of halitosis in young male adults: a study in swiss army recruits comparing self-reported and clinical data. J Periodontol 2009; 80:24-31.