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HALITOSIS

Bemhemba IBA, Rapheal Kehinde FALEGBE, Yomi Isaac ASA, Thelma Ebere NWAOHABUENYI, and Ada Cynthia IBEOBI

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Halitosis

Iba, B. [1], Falegbe, R. K. [2], Asa, Y. I. [3], Nwaohabuenyi, T. E. [4], & Ibeobi. A. C.[5]

Lead-Author: Mr. Bemhemba Iba *(ibabemhemba@gmail.com)*

[1] *Department of Dental Health, NKST College of Health Technology, Mkar, Gboko, Benue State, Nigeria*
[2] *Department of Dental Technology, Dental Design Laboratory, Lagos, Nigeria*
[3] *Department of Dental Technology, Babcock University Teaching Hospital, Ilishan Remo, Ogun State, Nigeria*
[4] *Department of Dental Therapy, Federal College of Dental Technology and Therapy, Enugu, Nigeria*
[5] *Department of Dental Therapy, Bethel Dental Clinic, Abuja, Nigeria*

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ABSTRACT

Halitosis is an offensive odour emanating from the mouth whose effects are so devastating on the social and psychological state of individuals. Over 50% of the world population is claimed to have halitosis and it is the third commonest complaint patients present to the dental clinic. The objective of this review was to present a succinct discussion on the epidemiology, aetiology, classification, social and psychologic effects, diagnosis, and management of halitosis based on conventional and recently introduced information. An extensive literature review was conducted on several published peer-review journal articles but only articles from 2017-2021 and those written in the English language which fulfilled the study's inclusion criteria were considered. The review also considered all relevant subject headings such as halitosis, bad breath, oral malodour, and volatile sulfur compounds in PubMed/Medline, Google Scholar, JSTOR, Medscape, and Microsoft academia databases. Several articles were related to the subject area but only 52 full-text articles were used for this review. According to the reviewed articles, the studies pointed to the fact that a multidisciplinary approach is extremely crucial in managing halitosis to assist in identifying the right diagnosis and administering the correct treatment aimed at eliminating the aetiological agents and maintaining proper hygiene. Daily oral hygiene practice with the mechanical removal of dental biofilm using toothbrush and dentifrice, flossing and utilization of antimicrobial agents will significantly reduce the number of microorganisms causing bad breath.

Keywords: *bad breath, halitosis, oral malodour, volatile sulfur compounds*

INTRODUCTION

Halitosis is a disorder that manifests as an unpleasant smell that comes from the mouth during respiration or during simple eloquence (Bernardi et al., 2019; Cecchini et al., 2018). This medical-social problem which might also be referred to as fetor oris, oral malodour, mouth odour or bad breath could be a worldwide public pathological problem (Abidi et al., 2018; Renvert et al., 2020). It is caused by volatile molecules which originate from an oral or non-oral source that could be pathological or non-pathological. The volatile molecules are sulfur compounds, amines, nitrogen-containing compounds, alcohols, aromatic compounds, short-chain fatty acids, aliphatic compounds, and ketones (Du et al., 2019; Teshome et al., 2021).

Dental caries and periodontal diseases are ranked first and second with halitosis pegged at third among the foremost common reasons why patients visit the dental clinic with over 50% of the world population presenting its symptoms (Ajith et al., 2019; Huang et al., 2018; Ziaei et al., 2021). This undesirable condition may be a common complaint in all age groups and both genders though studies have shown that females were more anxious about mouth odour and 0than their male counterparts (Tsuruta et al., 2017).

Halitosis can be broadly classified on the premise of its origin as genuine halitosis {like morning breath, pathological halitosis, and halitosis caused by other factors like eating garlic} and delusional halitosis {which include pseudo-halitosis and halitophobia} (Çoban & Sönmez, 2017; Du et al., 2019). Recently, the classification of halitosis has been modified into physiologic {type 0}, oral {type 1}, airway {type 2}, gastroesophageal {type 3}, blood-born {type 4} and subjective {type 5} (Teshome et al., 2021; Tsuruta et al., 2017). Though none of these classifications is universally accepted, for the sake of this review, the former shall be discussed.

The origin of halitosis is multifactorial though nearly 90% of all cases of halitosis emanate from the rima oris (Aguiar et al., 2017; Choi et al., 2018; Du et al., 2019). Tongue coating and periodontal status are a variety of the foremost important risk factors. Others include fixed orthodontic brackets, dry mouth, oral mucosal diseases, and oral malignancy (Du et al., 2019; Huang et al., 2018). The remaining 10% is caused by upper tract infection and other sources (Ziaei et al., 2021).

Halitosis is a condition whose effects are so devastating on the social and psychological state of individuals causing professional relationships, communication, and social and private isolation. It hampers an individual's confidence, self-esteem, reduces employment opportunities and overall quality of life (Teshome et al., 2021; Du et al., 2019). Despite these challenges, there is limited information on the subject especially in developing countries like Nigeria. Therefore, this review focused on discussing succinctly published information from recent peer-reviewed journal articles about the epidemiology, aetiology, classification, social and psychologic effects, diagnosis, and management of halitosis.

An extensive literature review was conducted on several published peer-review journal articles but only articles from 2017-2021 written in the English language, which fulfilled the inclusion criteria of the study were considered. The review also considered all relevant subject headings such as halitosis, bad breath, oral malodour, and volatile sulfur compounds in PubMed/Medline, Google Scholar, JSTOR, Medscape, and Microsoft academia databases. Several articles were related to the subject area but only 52 full-text articles were used for this review.

EPIDEMIOLOGY OF HALITOSIS

There is currently no robust data regarding the prevalence of halitosis (Renvert et al., 2020). However, estimates reported in published literature indicate that the prevalence of halitosis ranges from 22 to 50% around the world (American Dental Association {ADA} 2019; Guedes et al., 2019). A recent systematic review and meta-analysis reported an estimated halitosis prevalence of 31.8% (Silva et al., 2018).

The prevalence of halitosis has been reported by studies and ranges from 23.6% in Asia, 23% to 50% in Africa, and 30% in the Middle East, (Ajike & Okon-Essien, 2020). In the USA, a 50% prevalence rate was reported; 21.7% and 35.3% in males and females respectively among the Indian population (Renvert et al., 2020). The study by Nazir et al. (2017) in Pakistan reported a prevalence of 75%, while Ueno et al. (2018) in their study in Japan pegged the prevalence rate at 44.9% and Du et al. (2019) reported a prevalence rate of 65.9% in China. In Nigeria, a recent published study that captured the prevalence of halitosis was among adolescents and it reported a 13% prevalence rate indicating the presence of halitosis among the adolescent population (Ajike & Okon-Essien, 2020).

AETIOLOGY OF HALITOSIS

Halitosis has multifactorial causes, though the most reason behind bad breath is the chemical compound composition induced by proteolytic anaerobic bacteria within the mouth (Heboyan et al., 2019). These anaerobic bacteria mainly gram-negative bacteria degrade organic substances like food debris, desquamated epithelial cells, and saliva into primarily volatile sulfur compounds {VCSs} (Zardawi et al., 2018).

Approximately 90% of Volatile sulfur compounds to blame for halitosis originate from mouth-associated pathological conditions {periodontitis and gingivitis} and physiologic conditions of the tongue's microbial coating (Zhang et al, 2021; Ye et al., 2019). The volatile sulfur compounds produce gases like sulfide,

methyl mercaptan, and dimethyl sulfide. Not only do volatile sulfur compounds play a role in halitosis formation, volatile aromatic compounds like indole, skatole, organic acids {ethanoic acid, propionic acid} and amines {like cadaverine and putrescine} are also effective in the formation of halitosis (Suzuki et al., 2019).

The volatile sulfur compounds-producing bacteria are commonly found at the dorso-posterior surface of the tongue. Pericoronitis, oral ulcers, periodontal abscess, and herpetic gingivitis are a number of the pathologies that end in increased volatile sulfur compounds (Renvert et al., 2020; Seerangaiyan et al., 2018). Additionally, reduced salivary rate, stress, mouth breathing, unbalanced diet, low daily amount of water, and coffee are co-factors that significantly influence halitosis (Okunade, 2021).

Halitosis may also be caused by pharmacological therapies, bad habits like excessive consumption of alcohol and cigarette smoking, spicy foods, onions, garlic, and leek (Cecchini et al., 2018; Karimi, 2017). Other conditions that predispose to halitosis are systemic diseases like diabetes, respiratory infections, gastrointestinal illness, and kidney failure (Hennessy, 2020; Ajith et al., 2019).

SOCIAL AND PSYCHOLOGICAL EFFECTS OF HALITOSIS

Halitosis is taken into account to be one of the foremost unattractive aspects of social interactions. It can have a distressing effect, which will become a social handicap and therefore, the affected person may avoid socializing (Kayombo & Mumghamba, 2017). Individuals with halitosis often experience psychological consequences that may cause social, professional, and affective limitations, and poor oral health-related quality of life (Renvert et al., 2020).

In a study on the psychological effects of halitosis among young adults, it has been observed that lack of self-confidence, conversational and socializing skills, inability to attain academic goals, poor relationships, and embarrassment were all related to halitosis (Deolia et al., 2018). Similarly, patients with oral malodour have a notable higher countless of anxieties, phobic anxiety, depression, obsessive-compulsive disorders, and paranoid ideation (Heboyan et al., 2019). In a study in Nigeria on the causes and effects of halitosis among secondary school students, 88% of respondents reported having felt ashamed of the realization that they had mouth odour (Okunade, 2021).

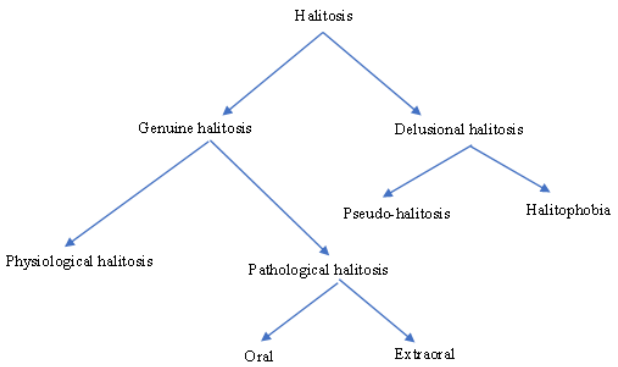
Patients with halitosis complaints have the conviction that they have an issue that might be easily noticed by others (Canceicao et al., 2018). In some cases, patients still believe that their halitosis persists, despite no significant evidence to justify their belief. Such a belief can have numerous consequences like feelings of self-depreciation, and low self-esteem; constant intuitive thought of having mouth odour; interpreting others' normal gestures and attitude as if they were expressions of disgust associated with their bad breath; and behavioural changes like talking less or avoiding talking with folks that are physically close and unnecessary social distancing (Alazmi, 2021; Mubayrik et al., 2017).

CLASSIFICATION OF HALITOSIS

The classification of halitosis was established by the international society for breath odour through scientific analysis. This method of classification helps the dental team to ascertain the potential treatment protocols and facilitate the identification of the causative agents of halitosis (Aydin et al., 2017).

Clinically, halitosis may be classified on the premise of treatment needs as genuine halitosis, pseudo halitosis, and halitophobia (Miyazaki et al., 1999 as cited in Gudadhe et al., 2017).

Figure 1:
A schematic representation of the classification of halitosis



Genuine halitosis

Genuine halitosis may well be seen as an intensified social malodour that is perceived beyond a socially acceptable level (Herman et al., 2018). This kind of halitosis is further divided into physiological halitosis and pathological halitosis

a) **Physiological halitosis:** This is often the kind of malodour that comes out in the mouth through the decomposition of food remnants, exfoliated epithelial cells, and saliva stagnation resulting in the accumulation of bacterial plaque on the dorsum of the tongue which is manifested clinically by the tongue coating (Heboyan et al., 2019). It is normally related to the dorsoposterior region of the tongue and is neither caused by a pathological condition nor a particular disease. The malodour is alleged to be transient as its presence comes and goes since it is determined by temporary localized conditions within the mouth (Patel et al., 2017).

b) **Pathological halitosis:** This is bad breath or malodour that emanates as a result of disease or other pathological conditions (Herman et al, 2018). It is further countermined into two different types namely:

   i. ***Oral:*** this involves situations where a person's malodour is related to a disease or other pathologic conditions {such as periodontal diseases, xerostomia} in relevancy to the tissues inside the mouth (Khozeimeh et al., 2017).

   ii. ***Extraoral:*** This can be the sort of bad breath that originates from the nasal, paranasal or laryngeal regions, pulmonary tract, or upper digestive tract (examples include, chronic sinusitis, tonsillitis, acute viral or bacterial infection) or any other part of the body (Dedania et al., 2017).

Pseudo-halitosis

This is the kind of malodour that is not perceived by others, although the patient ceaselessly complains of its existence (Mubayrik et al, 2017).

Halitophobia

This is a situation during which the patient persists in believing they suffer from halitosis even after treatment of halitosis or pseudo-halitosis (Ajith et al., 2019). Patients present with the delusion of self-oral malodour in the absence of objective oral malodour. Here, the perception of a patient's breath problem continues to exist regardless of successful treatment of their genuine halitosis or pseudo-halitosis condition even after receiving counselling (Tsuruta et al., 2017).

DIAGNOSIS OF HALITOSIS

Diagnostic methods of halitosis help to differentiate between genuine halitosis, pseudo-halitosis and halitophobia thus preventing incorrect or unnecessary treatment (Çoban & Sönmez, 2017). The assorted tests disbursed to work out the presence of halitosis are direct and indirect methods (Renvert et al., 2020).

Direct breath odour diagnostic method: this method includes the organoleptic method, gas chromatography, and portable sulfide monitoring

a. ***Organoleptic assessment***: it is based on the examiner's subjective perception (Heboyan et al., 2019). This system involves placing a tube within the patient's mouth and telling the patient to breathe slowly into the tube. During this period, the examiner evaluates the smell from the opposite side of the tube (Bicak, 2018). Organoleptic measurement is the gold standard for the assessment of halitosis, and it involves analysing a patient's exhaled breath by a trained clinician and further documentation of scores in step with intensity (Ajith et al., 2019; Falcao et al., 2017). The scores vary from 1 to 5 based on the intensity of the odour {0 - being no appreciable odour, 1 - questionable malodour, barely detectable, 2 - slight but noticeable, 3 - Malodour is detected, 4 - strong malodour, 5-extremely strong malodour} (Bicak, 2018).

   Organoleptic scoring has the merit of detecting a wide range of odours, being inexpensive and straightforward. However,

it suffers a setback of being extremely subjective and lacks reliability, and reproducibility (Nakhleh et al., 2017)

b. ***Gas chromatography***: it is an objective, reproducible and reliable method, which analyses air, incubated saliva, tongue debris, or crevicular fluid for volatile sulfur compounds (Heboyan et al., 2019). Gas chromatography encompasses a high specificity to volatile sulfur compounds and can detect odorous molecules even in low concentrations (Das & Pal, 2020). During this method, samples are analysed by a detector and mass spectra of existing compounds are compared and determined by a computer-based database (Bicak, 2018). Although gas chromatography is an objective method, it is expensive, requires trained staff, is bulky, is not suitable for daily practice and application takes much time (Heboyan et al., 2019).

c. ***Portable sulfur compounds***: This method involves letting the patient keep his mouth closed for five minutes. Then, the patient is asked to breathe into a transparent tube that carries the breath to a suction pump that is connected to the sulfide monitor. The monitor is provided with an electrochemical sensor that takes place with the compounds containing sulfur within the breath and brings the electrical current in proportion to the amount of the compounds (Gudadhe et al., 2017). This method is reproducible and simple to use though, the flexibility to detect only sulfur-containing compounds can result in an incorrect assessment of the source and intensity of oral malodour (Çoban & Sönmez, 2017).

Table 1:
Diagnostic methods of halitosis

Diagnostic method	Description
Direct method	
Organoleptic assessment	It is based on the examiner's subjective perception and is the gold standard for the assessment of halitosis. This method is cheap, does not need equipment, and detects a wide range of odour. It is however subjective, lacks quantification and repeatability.
Gas chromatography	Gas chromatography encompasses a high specificity to volatile sulfur compounds and can detect odorous molecules even in low concentrations.
Portable sulfur compounds	The sulfide monitor is a portable device that allows easy measurement of the VSCs found in the expiration air outside the laboratory environment
Indirect method	
BANA test	Detects short-chain fatty acids & proteolytic obligate gram-negative anaerobes
Ammonia monitoring	Detects ammonia quantity which is produced by oral bacteria.
Ninhydrin method	Used for examination of amino acids and polyamines that cannot be detected using the sulfur monitor. It is simple, fast and less expensive.
Polymerase chain reaction (PCR)	PCR is used for quantitative analysis of microorganisms causing VSCs from oral specimens like saliva, tongue coating, and subgingival plaque. It is a rapid, sensitive, and specific diagnostic technique.

Indirect diagnostic methods: they include Benzoyl-DL-Arginine-Alpha-Naphthylamide (BANA) test, ammonia monitoring, ninhydrin technique, and polymerized chain reaction among others.

i. ***BANA (Benzoyl-DL-arginine- a-Naphthylamide) Test:*** it detects short-chain fatty acids & proteolytic obligate gram-negative anaerobes. It plays an important role in the identification of three major bacteria *Treponema denticola*, *Porphyromonas gingivalis*, and *Tannerella forsythia* that are highly related to adult periodontitis. When these proteolytic bacteria are treated with an artificial trypsin substrate BANA, the arginine hydrolase enzyme successfully reacts with the embedded diazo dye to produce a permanent blue colour indicating a positive test. Thus, the presence of bacteria is proved (Gudadhe et al., 2017; Newman, 2018).

ii. ***Ammonia Monitoring:*** it detects ammonia quantity which is produced by oral bacteria. The ammonia monitor consists of a pump that pulls the expiratory air into the ammonia gas detector and a disposable tube that is inserted into the patient's mouth. The patient is allowed to rinse with urea and then blow into the tube and therefore, the amount of ammonia is read by the gas detectors. The ammonia concentration produced by the bacteria is read directly from the scale (Bicak, 2018).

iii. ***Ninhydrin Method:*** Ninhydrin method is employed for the detection of amines and polyamines that cannot be detected using the sulfur monitor. It involves mixing isopropanol with the sample taken from the patient and therefore the mixture is centrifuged. It is then read in keeping with its light permeability employing a spectrometer. This method is straightforward to use, faster, and less expensive (Çoban & Sönmez, 2017).

iv. ***Polymerase Chain Reaction (PCR):*** Polymerase Chain Reaction (PCR) has become highly regarded in that they are rapid, sensitive, and specific procedures. With the PCR, the measure of the microorganisms causing mouth odour from oral specimens like saliva, tongue coating, and subgingival plaque are often performed (Bicak, 2018).

MANAGEMENT OF HALITOSIS

The right diagnosis is vital for the effective treatment of halitosis. A multidisciplinary approach remains the best way of managing halitosis however, because 90% of halitosis cases emanate from the oral cavity, improving oral hygiene by brushing twice a day, regular flossing and tongue cleaning is considered the first treatment option in the management of halitosis (Mandal, 2019; Patil, 2021; West & Tawhid, 2019).

There are different approaches to the management of halitosis however, for this study, it shall be discussed based on this classification:

Physiological halitosis: The first stage of treatment consists of mechanical removal of Biofilm and microorganisms. The mechanical methods are used to clean the dorsum of the tongue, such as tongue scraping and tongue brushing. This procedure is important in reducing the level of volatile sulfur compounds, tongue coating, and malodour, especially morning breath-related malodour in subjects with healthy periodontium and patients with gingivitis. Cleaning the interdental space with dental floss is also essential for the control of oral microorganisms and plaque (Chen et al, 2018; Wang & He, 2017).

Mouthwashes with antimicrobial properties are beneficial in reducing bad breath by reducing the number of microorganisms. They include chlorhexidine (CHX), essential oils (EOs), triclosan, and cetylpyridinium chloride (CPC). Those that have a neutralizing or therapeutic effect include metal ions and oxidizing agents (Tungare et al, 2021).

The application of dentifrices, rinsing liquids that contain fluoride, chewing gums and mint tablets have short-term effects on halitosis. Diet plays an important role and should be balanced to effectively fight against oral malodour. The patients suffering from halitosis should consider quitting smoking, minimising alcohol intake, and avoiding dentifrices containing baking soda (Heboyan et al., 2019).

Table 2:
Management of halitosis

Classification	Management procedure
Physiological halitosis	The method of managing physiological halitosis could be termed TN-1 (Treatment Needs) and it involves: i. Explanation of halitosis and instructions for oral hygiene. ii. Improve oral health by professional and patient-administered tooth cleaning. Regular tongue cleaning. iii. Regular use of antimicrobial toothpaste and mouthwashes such as Chlorhexidine gluconate. iv. Regular clinical review to ensure maintenance of effective oral hygiene. v. Nutritionist intervention. vi. Quitting habits that do not promote oral health like smoking.
Pathological halitosis	

✓ Oral	TN-1 + Oral prophylaxis, professional cleaning, and treatment for oral diseases, especially periodontal diseases
✓ Extraoral	TN-1 + Referral to a physician or a medical specialist
Pseudo-halitosis	TN-1 + Explanation of examination data, further professional instruction, education, and reassurance
Halitophobia	TN-1 + Referral to a clinical psychologist, a psychiatrist, or other psychology specialists

Pathologic halitosis of oral origin: halitosis arising from the oral cavity is chiefly because of pathologic conditions within the mouth like periodontal disease (Liu et al., 2017). Therefore, reduction of the bacterial load is an essential means of controlling halitosis of intra-oral origin. This can be achieved through periodontal treatment {scaling and root planing} which reduces the severity of gingival inflammation, alleviate the depth of the periodontal pocket and eliminate halitosis caused by bacteria. Other conditions such as xerostomia, dental caries, pericoronitis, oral ulceration, or malignancy also cause halitosis and should be diagnosed and treated as appropriate (West & Tawhid, 2019).

Unsuitable prosthetics and conservative restorations, can create avenues for food impactions and hinder proper oral hygiene practices thereby creating a reservoir area for bacteria. Replacement or renewing of such restorations with adequate and proper restorations will eliminate those reservoirs and facilitate effective oral hygiene (Heboyan et al., 2019).

Pathologic halitosis of extra-oral origin: Patients with halitosis that originate from non-oral causes and underlying systemic disorders (such as respiratory, gastrointestinal, hepatic, renal, endocrine, or haematological disease) should be referred to an appropriate specialist for further management (West & Tawhid, 2019).

Pseudo-halitosis: In the management of patients with pseudo-halitosis, counselling, explanation of examination results to the patient, oral hygiene instructions, education and reassurance are sufficient and well accepted by the patient (Ajith, et al, 2019; Villa, 2019).

Halitophobia: The management of halitophobia is quite complex and requires a multidisciplinary approach of different specialists such as psychologists and psychiatrists. The multidisciplinary approach is necessary because patients with halitophobia do not respond to counselling and education thus will need to see a psychologist (Heboyan, et al, 2019).

CONCLUSION

Halitosis is an unappealing social problem with a future negative impact on an individual's psychological state. It originates chiefly from intra-oral sources and existing co-factors. Proper diagnosis and identification of aetiologic agents are key to accurate diagnosis and subsequent management of halitosis. Therefore, a multidisciplinary approach involving dental practitioners, general medical personnel, psychologists, or psychiatrists will be effective in managing genuine and delusional halitosis.

Daily oral hygiene practice with mechanical removal of dental biofilm using toothbrush and dentifrice, flossing and utilization of antimicrobial agents will significantly reduce the number of microorganisms causing bad breath. With halitosis being a common complaint among the general public, healthcare providers should be trained on the proper diagnosis and management of halitosis while clinical trials are encouraged to get a deeper understanding of the chemical compounds found in halitosis and their effect on tissues.

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Authors' OrCID iDs:

[1] Iba, B.: 0000-0001-5519-5050
[2] Falegbe, R. K.: 0000-0002-5238-96150
[3] Asa, Y. I.: 0000-0003-4846-5395
[4] Nwaohabuenyi, T. E.: 0000-0003-0457-248X
[5] Ibeobi. A. C.: 0000-0003-2086-4861

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