

# Exploring the potential link between oral cancer infections and extra-oral factors in the context of cancer-related halitosis

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ABSTRACT

Research has been conducted to explore the link between oral diseases and numerous exogenous aspects that cause it to enhance bad breath. Oral diseases that cause bad breath consist of oral infections, poor oral hygiene, several foodstuffs, and basic medical conditions. Some of the prevalent oral diseases are periodontitis and gingivitis because they create bad breath resulting from overgrowth of microorganisms in the oral cavity.

Apart from the infection in the mouth, halitosis is also triggered by extra oral such as respiratory and gastrointestinal ailments and drugs; all these factors lead to the development of volatile Sulphur compounds as well as other odorizing molecules, which are subsequently spread through the blood and exhaled through the lungs.

In addition to situations mentioned above, extra oral factors, for example, respiratory and GI conditions and particular medicines, can cause the production of VSCs as well as additional odorous compounds. The bloodstream serves as a vehicle for these substances, and then the lungs expel them.

In general, the connection between oral illness and external factors that contribute to foul breath is intricate. A comprehensive approach to managing bad breath may involve addressing both oral and extra oral factors and addressing any underlying medical conditions.

**Keywords:** halitosis, oral cavity, halitogenic biofilm, bacterial infection, epidemiology

## INTRODUCTION

The overall population struggles frequently with halitosis. Halitosis has received attention from patients and dentists due to increased media exposure in recent years. The topic is nevertheless still frowned upon. The first person to call should be a dental professional because, in the majority of cases, the oral cavity is the cause of halitosis [1].

Most patients attempt self-treatment for halitosis before consulting a qualified halitosis clinic [2]. Gum, sweets, and mouthwash are the most often used antihalitosis products. However, it is well-known that these products just hide the problem; they are unable to affect its underlying causes [3].

Before their consultation at a halitosis clinic, more than half of the patients had already seen one or more primary care physicians or other medical professionals. According to Zürcher and Filippi [4], people with halitosis frequently have a lengthy history of the condition, which can lead to extremely high levels of social and psychological stress. The diagnosis, prevalence, and current therapies for oral halitosis are outlined in the current review.

Women appear to seek professional care more quickly than males, despite the fact that men and women appear to suffer in roughly equal amounts [4]. According to Miyazaki's research, there is a direct relationship between age and oral malodor: the older a person becomes, the worse the odor would be [5]. According to Zalewska et al. 90% of the time when a person has halitosis, the source of the bad breath is something in the mouth, most frequently odors produced by bacteria that are located below the gum line and on the back of the tongue.

Disorders of the nose, sinuses, throat, lungs, esophagus, stomach, and other organs and systems make up the remaining 10% of the total [6]. Due of the stigma around halitosis, psychological or social issues including anxiety, sadness, low self-esteem, or other mood disorders can frequently arise.

Halitosis can be diagnosed using both subjective (the examiner's sense of smell) and objective (instrumental) approaches (analyzing certain chemicals in the breath). In clinical practice, a straightforward, subjective assessment is considered as the gold standard. Recognizing the root cause is essential in cases of pathological halitosis. The detection and treatment of foul breath frequently call for a comprehensive approach after all oral illnesses have been ruled out or successfully treated [7].

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The mouth alone can be the source of a long variety of potential causes of halitosis, but by far the most frequent causes described are halitogenic biofilms on the posterior dorsal tongue, in gingival fissures, and in periodontal pockets [1].

Oral bacteria thrive on the dorsum of the tongue, which has an uneven shape and a surface area of 25 cm<sup>2</sup> [8]. Putrefaction happens because there are still food remains and desquamating epithelial cells present.

As a result, according to Faveri et al., the tongue surface appears to constitute a significant reservoir in the recolonization of tooth surfaces. According to de Souza et al., Poor oral hygiene, dental plaque, cavities, the accumulation and putrefaction of food residue, and dirty acrylic dentures (worn at night, irregularly cleaned, or with rough surfaces) are all causes of bad breath [9, 10].

According to Bollen and Beikler (2012), anaerobic, Gram-negative bacterial species are most likely to be responsible for the putrefactive activity in the mouth via proteolyzing sulfur-containing amino acids contained in food and salivary proteins. The purpose of this study is to evaluate the relationship between bacterial infection and bad breath from the mouth [6].

## LITERATURE REVIEW

### Bacterial infection and reaction

The typical mouth contains around 600 different species of bacteria. Proteins are hydrolyzed into individual amino acids, which is how most of the scents are produced. Some amino acids are then further broken down to form detectable bad gases. Volatile Sulfur Compounds (VSCs) are created as a result of this development. The three most significant VSCs in halitosis are dimethyl sulfide (CH<sub>3</sub>)<sub>2</sub>S, methyl mercaptan (CH<sub>3</sub>SH), and hydrogen sulfide (H<sub>2</sub>S). For instance, the ability of cysteine and methionine to generate H<sub>2</sub>S and CH<sub>3</sub>SH, respectively, is well recognized [11]. VSCs have been found to significantly correlate with levels of oral odor and often decline after a successful therapy.

Diamines (such as indole and skatole) and polyamines (such as cadaverine and putrescine) are other compounds implicated in this bacterial breakdown process. They appear to have less of an impact on how unpleasant breath is expressed. Tryptophan serves as the primary building block for the synthesis of skatole and indole, whilst lysine and ornithine serve as the building blocks for the synthesis of putrescine and cadaverine [6].

The majority of the bacteria that cause halitosis are connected to periodontitis. In this way, periodontitis and poor breath are positively correlated [12]. Furthermore, particularly in patients with Gastro-Esophageal Reflux Disease (GERD), there may be a connection between the microbiota of the mouth and probable bacterial overgrowth in the stomach and/or upper intestine.

In fact, it is well known that a prolonged suppression of gastric acid increases the likelihood of bacterial growth and the prevalence of faecal-type bacteria [13]. Proton Pump Inhibitors (PPIs), one of the most often prescribed drugs in the world, are the most efficient regulators of stomach acid output currently available on the market.

*Helicobacter pylori* infection risk is enhanced in patients receiving long-term acid-suppressant therapy. Furthermore, peptic ulcers may result from *H. pylori* colonization of the gastrointestinal

mucosa. According to research by Werdmuller et al. and Moshkowitz et al., there isn't a definitive link between these ulcers and halitosis [14, 15].

Studies conducted in vitro reveal that *H. pylori* produce a sizable amount of VSC [16]. According to studies that reveals *H. pylori* was discovered in participants with periodontitis, oral pathological halitosis following periodontitis may be indirectly associated to *H. pylori* infection. This implies that inflammation and the development of the periodontal pocket may encourage the colonization of this species.

### Relationships between bacterial and halitosis

According to Kinberg et al., halitosis is frequently included as one of the symptoms of *H. pylori* infection and gastroesophageal reflux illness [17]. The majority of halitosis complaints subsided once gastrointestinal pathology was addressed. In the treatment of children with halitosis with a positive *H. pylori* stool antigen test, eradication therapy was found to be helpful [18]. The treatment for bad breath can include:

- Mechanically decreasing intraoral nutrients and bacteria since microorganisms are what create bad breath in the mouth.
- Chemically reducing bacteria
- Turning volatile, scented gases into nonvolatile substances
- Hiding the malodor are examples of this [19].

Several experiments have recently been conducted to replace the bacteria that cause halitosis with specific probiotics, live microorganisms that are assumed to be advantageous to the host organism and, when provided in sufficient proportions, can help the host's health. The most popular microorganisms utilized as probiotics are bifidobacteria and lactic acid bacteria. Probiotics boost the immune system's ability to fight off allergies, stress, toxic material exposure, and other illnesses [20].

Recently, various research teams have become interested in the possible use of probiotics for dental health. The goal is to restrict the recurrence of oral malodor over an extended period of time by preventing the re-establishment of undesirable microorganisms. On the other hand, probiotics might be useful for both treating and preventing oral infections such dental caries, periodontal disease, and halitosis, according to a small number of clinical trials that have been done thus far [21, 22]. The oral administration of certain lactobacilli appeared to have beneficial effects on periodontal pocket bleeding in addition to physiologic halitosis [23].

This study set out to measure specific bacterial populations in the oral cavity flora and connects them with VSC levels in breath and Proton Pump Inhibitor (PPI) use. *Helicobacter pylori* infection in the stomach is known to cause halitosis, which is an issue in people who have low intragastric acidity in particular. The primary objective of the second section of the study was to quantify the potential benefits of a formulation containing the four selected lactobacilli (*L. rhamnosus*, *L. pentosus*, *L. plantarum*, and *L. delbrueckii* subsp. *delbrueckii*) in halitosis reduction and the restoration of a healthy oral flora.

### Terminology

Independent of the source, halitosis is the term for an

uncomfortable, disagreeable breath odor. The Latin word *halitus* means "breath, vapor." Throughout the literature, the words *halitosis*, *foetor ex ore*, foul breath, breath odor, offensive breath, and oral malodor has been used interchangeably [24-26].

The term "halitosis" should be used, with the distinction between intra-oral and extra-oral halitosis, according to the international consensus group. This covers all instances of true halitosis. True halitosis is defined as having bad breath that can be easily distinguished and that is worse than what is considered acceptable in society.

Extra-oral halitosis has its source outside the mouth, whereas intraoral halitosis has its source inside the mouth. Additionally, according to Seemann et al., there are two types of extra-oral halitosis: blood-borne and non-bloodborne. Psychogenic halitosis can also be diagnosed in addition to actual halitosis.

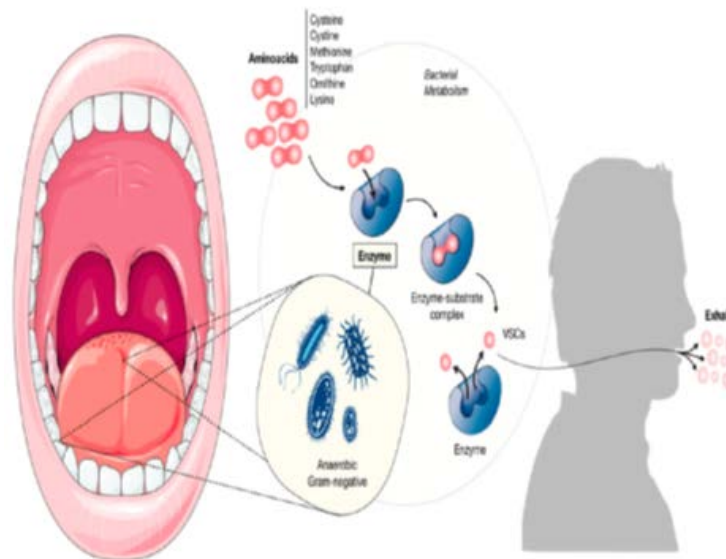
The patient typically detects a smell that is neither measured nor provable objectively. Those with pseudo-halitosis experience improved conditions following professional evaluation and diagnosis, in contrast to those with halitophobia. Patients with halitophobia still think they have terrible breath even after receiving extensive information and education. According to Seemann et al., momentary or transient halitosis refers to halitosis brought on by dietary components such as garlic and onions. The International Classification of Halitosis published by Yaegaki and Coil, Coil et al., and Miyazaki et al., served as the foundation for this classification, which has been slightly simplified [27-30].

## Epidemiological studies

The prevalence of halitosis is estimated by epidemiological studies to be between 2.4 and 78%, while the American Dental Association believes that close to 50% of Americans has oral malodor [30-32]. The causes for such large variances in prevalence rates include the vast range of halitosis evaluation procedures, whether the outcomes are based on self-reporting or objective measures of oral malodor, the geographical location, and the year the study was developed.

The origin and patient-reported outcomes of this condition are of interest because of its high incidence. The prevalence of halitosis is estimated to range between 2.4 and 78%, and the American Dental Association stated that close to 50% of American adults experience oral malodor. Halitosis is well documented to have a detrimental effect on patients' quality of life, despite the "disease mongering" that surrounds it.

The wide range in halitosis evaluation techniques, the location of the study, the year it was conducted, and the reasons for the significant levels of heterogeneity in the prevalence rates depend on whether the results are based on self-reporting or objective measurements of oral malodor. Given its high frequency, researchers are interested in learning more about the etiology and patient-reported outcomes (Figure 1). Despite the "disease mongering" that surrounds halitosis, it is well known that it negatively affects patients' quality of life, particularly in interpersonal relationships Kizhner et al. [33, 34]. Furthermore, when patients feel embarrassed in front of others, they are more likely to seek professional help [5].



**Fig. 1.** Shows the pathophysiology of halitosis. Bacteria present in gingival crevices and on the tongue's, dorsum produce volatile sulphur compounds from amino acids through the use of enzymes

In addition to reviewing conventional and cutting-edge alternative treatments, this study seeks to give a quick overview of the genesis and classification of halitosis as well as therapeutic management options.

## Risk factors for halitosis behavioral factors

Smoking, eating patterns and alcohol use is some behavioral factors that raise the likelihood of acquiring halitosis [33]. According to Bornstein et al, and Setia et al., smoking is associated with a rise in the frequency and severity of halitosis. According to Khaira et

al., this is mostly a result of the high concentration of VSCs found in cigarettes. Furthermore, smoking cigarettes actively disrupts the subgingival microbial environment's delicate balance, increasing the absolute numbers of bacteria that make VSC [35-38].

Smoking causes hyposalivation and a dry mouth as well. Dietary VSCs-enriched foods, such as garlic, onions, durians, and spices, may momentarily cause an offensive mouth odor. The bearable breath odor threshold of individuals, nevertheless, has an impact on how frequently this is not acknowledged as an odor problem [33]. Chronic alcohol consumption is yet another potential risk factor for halitosis, maybe as a result of oral and hepatic alcohol

oxidation, which produces acetaldehyde and other offensive by-products, or as a result of a secondary association with hyposalivation and dry mouth [39].

### Classification of extra-oral halitosis

Extra-oral halitosis refers to bad breath originating from outside the mouth, such as the upper respiratory tract or the digestive system [40, 41]. The classification of extra-oral halitosis can be divided into three main categories based on their different etiologies:

- Upper Respiratory Halitosis: Normally caused by respiratory tract infections, postnasal drip, chronic sinusitis, or inflammation of the tonsils.
- Gastrointestinal Halitosis: Caused by digestive system disorders such as Gastro-Esophageal Reflux Disease (GERD), gastritis, ulcers, and colonic fermentation.
- Systemic Halitosis: Caused by diseases such as liver failure, kidney failure, and certain types of cancers.

These can be classified into the following categories:

- Respiriophasic Halitosis: This type of halitosis develops in the respiratory tract and is linked to illnesses of the respiratory system, including sinusitis, bronchitis, and pneumonia. The respiratory tract's breakdown of germs and their byproducts is what causes the offensive odor [42].
- Gastrointestinal halitosis is a type of bad breath that is associated with medical diseases such as gastritis, Gastro-Esophageal Reflux Disease (GERD), and infection with the bacterium *H. pylori*. The production of Volatile Sulphur Compounds (VSCs) during food breakdown in the stomach is responsible for the odor emission. Square brackets surround the number [43].
- Renal halitosis is a disorder characterized by a foul odor that is caused by renal failure and the accumulation of uremic toxins in the body. One specific description of this odor is its characteristic fishy smell. The user's text is [44].
- The decomposition of several compounds, such as ketones and aldehydes, which have been associated with ailments like diabetes and liver diseases, causes metabolic halitosis [45].

### Dry mouth/xerostomia

Saliva possesses several advantageous characteristics, such as its lubricating effect that facilitates speech and swallowing, its ability to counteract acids produced by bacteria, and its role in the self-cleansing of oral tissues. Saliva also remineralizes enamel. Additionally, saliva includes microbes, desquamated epithelial cells, lysed leukocytes, hemopoietic cells, and food particles [46, 47].

Hyposalivation, or decreased salivary flow, is a symptom of dry mouth that impairs the aforementioned processes while increasing anaerobic bacterial putrefaction of food debris that is left in the oral cavity after meals [35, 48]. The decrease in antimicrobial activity caused by the lack of salivary flow encourages the growth of cariogenic bacteria [47]. As a result, VSC production rises, which is the primary cause of halitosis [49].

Anticholinergics, antihistaminics, antipsychotics, anxiolytics, antidepressants, antihypertensives, diuretics, and opioids are the most often prescribed medications that produce hyposalivation [50].

Additionally, autoimmune illnesses such systemic lupus erythematosus, Sjögren's syndrome, rheumatoid arthritis, and scleroderma, as well as radiation, dehydration, vitamin deficiencies, menopause, emotional problems, and scleroderma might reduce salivation. Thyroid dysfunction, nephritis, and Diabetes Mellitus (DM), among other systemic illnesses, can also have similar effect. According to Pajukoski et al., about 25% of older people experience dry mouth. Additionally, as people age, changes in the mouth might affect the growth of bad odor. These changes include a rise in salivary pH brought on by ingesting amino acids and a shift in oxygen depletion.

As a result of these modifications, Gram-negative bacteria produce more VSC [50-52]. Although xerostomia is linked to aging, numerous studies have demonstrated that healthy old persons still have functioning salivary glands. As a result, systemic or extrinsic causes are likely to be involved in dry mouth. The most frequent cause of hyposalivation is medication, specifically anticholinergics, antihistaminics, antipsychotics, anxiolytics, antidepressants, antihypertensives, diuretics, and opioids [50].

Additionally, autoimmune illnesses such systemic lupus erythematosus, Sjögren's syndrome, rheumatoid arthritis, and scleroderma, as well as radiation, dehydration, vitamin deficiencies, menopause, emotional problems, and scleroderma might reduce salivation. According to Pajukoski et al., 25% of older people experience dry mouth. Additionally, as people age, oral alterations including an increase in salivary pH brought on by ingesting amino acids and a shift in oxygen depletion might affect the development of mal-odor.

These modifications increase the production of VSC by stimulating the metabolism of Gram-negative bacteria [50, 52]. Even though xerostomia is linked to aging, numerous studies have demonstrated that healthy old persons still have functioning salivary glands. Dry mouth is therefore likely a systemic or extrinsic disease.

### Periodontal disease

Another common disorder of the tongue is halitosis, which is a nonstop inflammatory disease. It causes damage to the bone holding the teeth's roots and gums, respectively. Plaque and bacteria on the teeth and gums may make tissue inflamed, causing the disorder. The trash on the tongue may cause halitosis. The tongue is known for its trash and germs that cause halitosis. Bacteria found on the tongue generate with or without a film coat and volatile sulphur compounds which generate biogenic amines, keto acid, cadaverine, and putrescine that cause halitosis. In addition, the bacteria and plaque in the oral cavity may make lately inflame gum tissue. Recent research has found how closely related the two disorders are with one another. Individuals with periodontal disease had higher levels of volatile sulphur compounds on their tongues than the healthy group and there was also a strong correlation between the intensity of the disease severity and the degree of halitosis, further emphasizing that improving periodontal bad breath is a possibility [3, 53].

A study of patients with chronic periodontitis found that scaling and root planing treatment significantly reduced levels of Volatile Sulphur Compounds (VSCs) and markedly improved halitosis [54].

Periodontal disease strongly correlates with halitosis, a disorder characterized by the accumulation of germs and debris on the tongue. Effective periodontal disease therapy can improve both

halitosis and overall dental health. Halitosis, commonly known as malodorous breath, can be caused by various extrinsic factors that originate outside the mouth. Extra-oral variables encompass conditions caused by systemic disorders or dietary habits.

Various factors, including diseases outside of the mouth, can cause halitosis, also known as bad breath. These factors encompass extrinsic impacts, such as those associated with systemic disorders or dietary habits [55].

### Extra-oral causes of halitosis

Tonzetich, Aylkc et al., and Durham et al. conducted research suggesting that sources beyond the mouth account for approximately 10%-20% of cases of halitosis. The causes of extra-oral halitosis include gastrointestinal disorders, endocrine and hematologic system abnormalities, as well as respiratory tract infections [56]. Dimethyl sulphide is the main Volatile Sulphur Compound (VSC) associated with bad breath outside the mouth, while methyl mercaptan and hydrogen sulphide are the main VSCs responsible for bad breath inside the mouth [55, 57]. The subsequent analysis focuses on the most widespread sources, categorized by system.

- Respiratory illnesses such as sinusitis, bronchitis, and pneumonia can cause halitosis due to the production of Volatile Sulphur Compounds (VSCs) by bacteria in the respiratory system [58].
- Diabetes mellitus: Unregulated diabetes can lead to the production of ketones, which can cause the breath to have a fruity smell [59].
- Due to the buildup of toxins in the body that the breath can expel, liver diseases like cirrhosis and hepatitis can cause halitosis [60].
- Kidney diseases, such as renal failure, can cause halitosis due to urea accumulation in the body, resulting in a breath that smells like fish [61]. According to Al-Ansari et al. [62].
- Illnesses of the digestive system, such as acid reflux, gastritis, and peptic ulcers, can cause halitosis. This is because these diseases release acidic gases such as sulphur dioxide and carbon disulfide.

### Infection and treatments of extra-oral halitosis

Several external factors, such as bacterial infections, poor dental hygiene, respiratory infections, and gastrointestinal illnesses, can cause halitosis, or foul breath [63]. This reply will focus on external factors that cause halitosis and correlate with bacterial infections. Halitosis is frequently caused by bacterial infection, which arises when malodorous breath emanates from the respiratory and digestive tracts. Beiraghi et al. state that the dominant anaerobic bacteria in the mouth and throat belly cells travel to the lower respiratory region by inhalation or aspiration. As a result, the first signs and symptoms of sickness occur, and the pathogenic processes of halitosis develop. The second reason is that too much bacterial growth and division in the gastrointestinal system cause the oral cavity to exude malodorous gases.

Respiratory infections from several bacterial strains including *Haemophilus influenza*, *Streptococcus pneumonia*, and *Mycoplasma pneumonia* can cause respiratory distress [64]. Halitosis is medically associated with gastrointestinal diseases such as gastritis, Gastro Esophageal Reflux Disease or GERD, and *Helicobacter pylori* infection [65]. Meanwhile, the expression extra-oral

halitosis describes an unpleasant odor from beyond the mouth's boundaries, such as the nasal passages, sinuses, throat, and respiratory tract. The extra-oral halitosis variant therapeutic approach is determined by its underlying etiology.

Treatments for extra-oral halitosis include the following:

- The treatment often prescribes medication for bacterial infections in the nasal and respiratory systems, which can be a source of bad breath. Results from using nasal decongestants have been describe as favorable because they reduce congestion and with it the discomfort.
- Targeted therapies for gastro-esophageal reflux, which is frequently related to extra-oral halitosis, can be effective. For example, targeted therapies include such lifestyle modifications as giving up certain foods and beverages, quitting smoking, and losing weight. Treatment options include the administration of proton pump inhibitors. This has proven to be effective in reducing the production of stomach acid.
- The problem of tonsil stones should be resolved to prevent the occurrence of halitosis. Tonsil stones are hard formations that develop in the crypts of the tonsils. The patient is encouraged to use one of the following to resolve the bacterial infection: gargling with a saltwater gargle, oral irrigator, or antibiotics.
- Extra-oral halitosis that leads to foul breath can be treated with chronic lung and liver diseases. Several treatments might be considered based on the identified pathology.

Extra-oral halitosis stands for bad breath that emanates from the source beyond the mouth. Many medical conditions might the chances of getting this condition. First, it could be affecting the stomach and the any other organ in the liver are Cheung is defined as one of the conditions might originate from certain pathogenic products such as tobacco, alcohol beverages, among others.

## DISCUSSION

Bad breath is a particularly demoralizing social problem since even typical prescribed dental solutions and mouthwashes provide only a transient respite. Foul breath, halitosis, is caused by the metabolic activity of bacteria and is distinct from the short-lived distressing odors arising from particular foods and beverages. Hundreds of bacterial varieties living in the mouth generate numerous springy chemicals following breaking down of protein. The existence of bacteria that consume oral tissues and discharge volatile sulfur compounds has been associated with halitosis.

The etiology of oral malodor is complex and includes both extrinsic and intrinsic mechanisms. Tobacco, alcohol, and some foods like onions, garlic, and some spices are examples of extrinsic causes. The circulatory system may release substances as volatile odoriferous chemicals obtained from food in the pulmonary air or saliva. The easiest way to manage extrinsic mouth odor causes is to stop consuming irritating substances. Bad breath has oral and systemic factors that are intrinsic in nature. In average, around 10% of these instances have a systemic cause, while 90% of them have an intraoral cause [25]. The oral microbiota has not yet been entirely defined, despite extensive research into the microbiology of the human mouth cavity. The majority of research was on cultivable microorganisms, which made up just 1 to 10% of all microbial species. Therefore, these studies have been predisposed to favor "what grows" while ignoring "what does not grow".

Since there is no conclusive connection between oral malodor and any specific bacterial disease, it is probable that halitosis is brought on by complex interactions between several oral bacterial species. In addition to the anterior dorsal tongue, oral malodor can also arise from this area, which helps to explain why even those with adequate dental hygiene may occasionally experience it. In the periodontal pockets and gingival fissures, these bacterial interactions are more likely to occur [64].

According to study, varieties of gram-negative bacteria as well as a few gram-positive bacteria are commonly found in periodontal pockets or on the dorsum of the tongue. These bacteria are responsible for producing  $H_2S$  and  $CH_3SH$ . Gram-negative anaerobic bacteria are usually to blame for this symptom in the oral cavity. These bacteria produce sulfur compounds (methyl mercaptan and hydrogen sulfate) as well as certain volatile fatty acids, both of which have disagreeable odors. The oral pathogens that are most likely to be to blame for foul breath are gram-negative bacteria, which include *Prevotella melaninogenica*, *Treponema denticola*, *Porphyromonas gingivalis*, *P. endodontalis*, *Prevotella intermedia*, *Bacteroides loescheii*, *Enterobacteriaceae*, *Tannerella forsythensis* (*Bacteroides forsythus*), *Centipeda periodontii*, *Eikenella corrodens*, *Fusobacterium nucleatum vincentii*, *F. nucleatum nucleatum*, *F. nucleatum polymorphum*, *F. eriodonticum*, *Veillonella* species, *Actinomyces* species and *Streptococcus* species [40, 64]. Oral malodor is mostly produced on the tongue, with periodontal disease and other variables only contributing to a small portion of the overall issue.

In the oral cavity, the papillary structure of the dorsum provides a distinct biological niche by providing a substantial surface area that encourages the collection of bacteria and oral detritus. The

characteristics of tongue biofilm microflora and its relationship with oral malodour remains unclear due to the complexity of the tongue's bacterial composition, which has been implicated as a major source of odor production in subjects with halitosis but has not yet been well characterized [40]. Since the majority of the microorganisms that cause oral halitosis are non-cultivable, we recommend identifying those using Polymerization Chain Reactions (PCR).

## CONCLUSION

Oral infection and extra-oral causes are both possible causes of bad breath, and the relationship between the two is complex. Oral infections such as gum disease, tooth decay, and oral thrush can lead to bad breath due to the bacteria that cause these infections releasing sulfur compounds in the mouth. Extra-oral causes such as diet, smoking, medication use, and systemic diseases like diabetes can also lead to bad breath. A potential association may exist between oral infection and some environmental conditions that contribute to halitosis. Thus, smoking might lead to oral infections, which may further cause halitosis. Systemic diseases, including diabetes, may similarly predispose an individual to oral infections, meaning that such processes may eventually result in bad breath. To conclude, halitosis can be caused by both oral diseases and other factors. However, proper oral hygiene in terms of brushing, flossing, and regular dentist visits can efficiently prevent oral infections and, thus, halitosis. Additionally, dietary choices and smoking cessation may also help manage the problem. It is best to consult physicians or dentists if a person has issues with halitosis.

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