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Diabetes Mellitus and Its Influence on Dental Health: Evidence-Based Approaches to Treatment and Care

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Abstract

Background: Maintaining good oral health and metabolic control is crucial for living a long and fulfilling life. Many developing and disadvantaged nations are experiencing a rise in oral disorders. As a developing country, Bangladesh faces significant challenges in meeting the oral health care needs of its population, as well as other health sector demands. Preventive measures are always a better approach to avoiding oral diseases. Good metabolic control and proper oral hygiene practices can help prevent oral diseases and unhealthy oral conditions. **Method:** A cross-sectional observational study was conducted between December 2022 and May 2023 using convenience sampling, involving 44 patients with diabetes mellitus. The study consisted of two phases: 1) a questionnaire survey and 2) an intraoral clinical examination. Descriptive statistics were used to analyze the data. Data screening and entry were performed using SPSS version 25.00, with all analyses conducted through the SPSS software. **Results:** A total of 44 participants made up the analyzable sample, with 51% male and 49% female. The largest proportions were in the 18 - 36 years and 51 - 70 years age groups. A substantial 77.3% of individuals reported a family history of diabetes mellitus, while 15.9% did not. The dataset includes information from these participants, revealing diverse demographics and health-related variables. It highlights a significant proportion of individuals with strong oral health awareness, regular blood sugar monitoring, and concerns about oral complications related to diabetes. However, there is room for improvement in diabetes management, as a notable percentage exhibited poor metabolic control in the oral health evaluation. **Conclusions:** A population-based cross-sectional study exploring the association between glycemic control in diabetes mellitus and severe oral lesions and periodontal diseases in adults aged 25 and older found that individuals with poorly controlled diabetes mellitus have a significantly higher prevalence

of severe oral lesions and periodontitis than those without diabetes, after controlling for age, education, smoking status, and calculus.

Keywords

1. Introduction

Diabetes is a common condition with oral symptoms that affect dental hygiene. High blood sugar is linked to both diabetes and dental health concerns. If blood sugar is poorly controlled, oral health issues are more likely to occur (Cleveland Clinic, 2020). This is because uncontrolled diabetes reduces the effectiveness of white blood cells, the body's primary defense against bacterial infections in the mouth. Controlling blood sugar levels has been demonstrated in several studies to reduce the risk of serious organ complications associated with diabetes, such as eye, heart, nerve damage, and oral health issues.

Diabetic patients experience a variety of oral and dental issues. The most common oral issues include halitosis, delayed wound healing, dental caries, salivary dysfunction, lichen planus, tongue abnormalities, oral infections, periodontal disease, and more (Rohani, 2019; Ahmad & Haque, 2021). Small artery damage and elevated glucose levels are the causes that lead to oral and dental issues in uncontrolled diabetic patients. According to one study, more than 90% of individuals with diabetes experience oral problems. Another study found that diabetic individuals have a higher prevalence of oral mucosal diseases than non-diabetic patients (Ahmad & Haque, 2021).

Diabetes mellitus patients are much more likely to develop oral complications. Diabetes mellitus is a chronic metabolic disease that affects approximately 8.5 percent of the world's adult population (Nazir et al., 2018). Oral manifestations of diabetes mellitus (DM) can be divided into two categories:

- Those that affect the hard tissues of the oral cavity.
- Those that affect the soft tissues.

The most significant issue now is that oral infections can have a substantial impact on diabetes metabolic regulation. As a result, it is critical for all healthcare practitioners to have a thorough understanding of the numerous oral symptoms of diabetes mellitus (DM) so they can recognize, treat, and take proactive measures to regulate their patients' glycemic status. Diabetic patients should also be educated about these issues, encouraged to maintain good dental hygiene, and regularly seen by both diabetic care providers and dentists (Al Amassi & Al Dakheel, 2020).

Maintaining good dental health is essential for leading a healthy lifestyle. Oral

problems negatively affect the quality of life for diabetic patients (Ahmad & Haque, 2021). Many people with diabetes have insufficient knowledge about the oral consequences of diabetes mellitus (DM) and oral hygiene. Therefore, it is crucial to raise awareness among diabetics about the connection between diabetes and dental health. A multidisciplinary approach is required to prevent oral complications, recognize them early, and manage them effectively.

In order to ensure optimal oral health and avoid complications, dental surgeons and physicians must collaborate efficiently to provide the best possible care for those with diabetes mellitus (Ahmad & Haque, 2021).

This paper aims to shed further light on the subject and provide baseline data for future research in the field. It will examine the frequency and pattern of oral problems among diabetic patients in Bangladesh.

2. Justification of the Research

In Bangladesh, diabetic patients have limited knowledge about the relationship between periodontal disease and diabetes mellitus. They have a narrow understanding of dental complications (Al Amassi & Al Dakheel, 2020; Poudel & Arora, 2018). Several studies have been conducted in Bangladesh in recent years to examine the factors associated with oral complications in diabetic patients.

A recent study on the knowledge and practices of diabetes care providers in dental health care revealed several challenges, including a lack of guidelines and oral health screening devices, as well as an inadequate medical appointment system, which prevents caregivers from providing effective oral health care management (WHO, 2014).

However, several studies have indicated that receiving oral health information from healthcare professionals, as well as relatively high education levels in this area, leads to better oral health knowledge among diabetic patients (Poudel & Arora, 2018). Patients who have a good understanding of the relationship between diabetes and dental health are more diligent than those with a poor understanding of oral health. Therefore, increasing diabetic patients' knowledge of oral problems can help reduce the risk of poor oral health (ADA, 2013). The goal of this study is to investigate the awareness and knowledge of diabetic patients in Bangladesh regarding oral health and its associated problems (ADA, 2013).

3. Operational Definitions:

1) Diabetes Mellitus: It's a chronic non-communicable metabolic condition in which insulin action, secretion, or both are disrupted. Insulin deficiency causes glucose, protein, and fat metabolism to become messed up. Diabetes Mellitus develops as a result of a combination of genetic and environmental factors.

2) Oral Complication: A range of soft tissue problems have been connected to diabetes. Some of the issues that might arise are oral fungal, salivary dysfunction, dental cavities, bacterial infections, tongue anomalies, halitosis, lichen planus, periodontal disease, etc. The prevalence and risk of developing oral mucosal lesions

are higher when diabetic patients are compared to non-diabetic patients.

- Periodontal Disease: Another problem of diabetes is that it thickens blood arteries, in addition to weakening white blood cells. The passage of nutrients to and waste products from bodily tissues, including the mouth, is slowed as a result. When this sequence of events occurs, the body's capacity to fight infections is compromised. People with uncontrolled diabetes may encounter more frequent and severe gum disease since periodontal disease is a bacterial infection.
- Dental Caries: A disintegration of the tooth enamel causes dental caries or cavities, more often known as tooth decay. This breakdown is caused by bacteria on the teeth breaking down meals and producing acid, which dissolves tooth enamel and causes tooth decay.
- Salivary Dysfunction: Diabetes that is not well managed can cause a reduction in saliva (spit) flow, leading to salivary dysfunction or dry mouth. It can also cause discomfort, ulcers, infections, and tooth decay.
- Delayed Wound Healing: Because blood flow to the treatment site might be disrupted in people with uncontrolled diabetes, oral surgery and other dental treatments recover slowly. Delayed wound healing is the term for this condition.
- Tongue Abnormalities (Geographic Tongue): Geographic tongue is a condition in which the tongue develops a map-like layout. On their tongues, people with this disease have smooth, reddish areas with white borders. The red patches lack the small bumps (papillae) that normally develop on the tongue's surface.
- Lichen Planus: Lichen planus is a common skin or oral inflammatory condition that produces swelling and discomfort. Lichen planus is characterized by an itchy rash on the skin. It might produce burning and pain in the mouth.
- Halitosis: One of the early diabetes symptoms is halitosis, or foul breath, which is a common ketone smell in diabetics. Oxidative stress is caused by high quantities of fatty acids and methyl nitrate in the blood, which leads to halitosis.
- Thrush: People with diabetes who take antibiotics often to treat a variety of diseases are more likely to develop a fungal infection of the mouth and tongue. The fungus flourishes in persons with uncontrolled diabetes who have high glucose levels in their saliva. Dentures can also cause fungal infections, especially if they are worn all of the time.

People with diabetes who smoke are at an even higher risk of developing thrush and periodontal disease, since they are up to 20 times more probable than non-smokers. Smoking also appears to reduce blood flow to the gums, perhaps affecting wound healing in this area.

4. Literature Review

Diabetes mellitus (DM) is a group of metabolic disorders characterized by hyperglycemia due to defects in insulin production, insulin action, or both (WHO,

2016). The global prevalence of diabetes was estimated to be 9% in 2014, and DM was directly responsible for about 1.6 million deaths worldwide in 2015 (Fowler, 2008). Retinopathy, nephropathy, neuropathy, and cardiovascular disease are all associated with increased morbidity in people with diabetes (Ship, 2003; Lamster et al., 2008). Preventing and managing these complications has become an essential part of modern diabetes treatment. Oral complications in DM are also possible, in addition to these well-known issues (D'Aiuto et al., 2017; Lang & Bartold, 2018).

As a result, in 2009, the International Diabetes Federation (IDF) issued a "guideline on dental health for individuals with diabetes," encouraging the integration of oral care into diabetes treatment (Poul, 2005). For successful implementation of the guideline, it is critical to know which oral problems to expect, how frequently they occur in patients with DM, and to understand the underlying pathophysiology.

4.1. Periodontal Disease in Diabetes Mellitus

Periodontal health can be described as a condition devoid of inflammatory periodontal disease that permits an in-dividual to function properly and not suffer any effects (mental or physical) as a result of previous disease. Periodontal health may be classified into four categories:

1) The lack of clinical inflammation and physiological immune surveillance on a periodontium with appropriate support (no attachment or bone loss (Kuo et al., 2008)) is regarded as pristine periodontal health.

2) The absence or presence of a low level of clinical inflammation in a periodontal pocket with adequate support is classified as clinical periodontal health (Kuo et al., 2008).

3) Periodontal disease is associated with a periodontium that is less stable, as well as (Kuo et al., 2008).

4) Remission/control of periodontal disease in a periodontium that has been decreased (Kuo et al., 2008).

Periodontitis is one of the most common oral disorders worldwide, affecting both industrialized and developing nations (Irwin et al., 2007). It's a bacterial-caused chronic inflammatory condition that affects the gingivae and periodontal tissue (Katz et al., 1991). This inflammatory process is caused by the microflora in dental plaque, which accumulates every day next to the teeth. The toxins produced by the bacteria in dental plaque might eventually cause gingival inflammation if they are not removed on a regular basis (Kibayashi et al., 2007). The gingivae separate from the tooth surface once gingival inflammation develops, causing a periodontal pocket. In this periodontal pocket, bacteria and their toxins are numerous. The periodontal pocket and tooth plaque will be deepened as the disease progresses until it reaches the alveolar bone. Periodontal tissue degradation, alveolar bone loss, and tooth loss all are situations caused by this disease. A vulnerable host is one of the variables that contribute to this form of inflammation in addition to

the presence of bacteria in dental plaque.

Diabetic Patients are more likely to develop periodontal disease, according to several researches (Calsina et al., 2002; Dietrich et al., 2007; Moore et al., 2000). This is especially true for individuals who have poor dental hygiene, poor metabolic management, have had diabetes for a longer time, and are smokers. According to many researches, smoking is a major preventable risk factor for periodontal disease and tooth loss for both diabetic patients and general population (Berlin, 2008; Beziaud et al., 2004; Chestnut, 2010; Darr et al., 2008; Preshaw, 2009). Diabetic Patients might benefit from the advice and assistance of their dentist and physician when it comes to quitting smoking. The dentist should be involved in advising these individuals and directing them to a smoking cessation specialist organization (Ritchie, 2009).

The therapy of periodontal disease has an impact on diabetes glycemic management. The efficacy of periodontal therapy on diabetes glycemic control could result in a significant reduction in HbA1c according to a recent meta-analysis evaluation (Moore et al., 1999). As a result, bigger studies are needed to establish the impact of periodontal therapy on glycemic management, as periodontitis and diabetes are linked.

The medical profession does not acknowledge the relationship between diabetes and periodontal disease. Diabetes has been linked to an increased prevalence and severity of periodontal disease (Teeuw et al., 2008). The exact method by which hyperglycemia might cause periodontal damage is unknown. Many ideas, however, suggest that advanced glycation end products and changes in collagen stature are to blame, and impaired polymorphonuclear leukocyte function, which may facilitate bacterial persistence in the tissue and the accumulation of advanced glycation end products caused by prolonged and chronic hyperglycemia and Increased release of proinflammatory cytokines such as TNF- and prostaglandin E-2 (Pihlstrom et al., 2005; de Silva et al., 2006).

Collagen metabolism will be harmed by an increase in collagenase activity combined with a decrease in collagen production. As a result, wound healing would be hampered, and periodontal tissue would be destroyed. Periodontitis has a bi-directional influence on glycemic management in diabetic individuals, according to recent research (Tsai et al., 2002). A slew of research findings back up the idea that periodontitis is more common in diabetics with poor glycemic control. Furthermore, there is sufficient data to support the concept that poor periodontal health might exacerbate glycemic control. According to several studies, for gingivitis and periodontitis, diabetes is a risk factor and it is worsened by poor glycemic management (Lin et al., 2002). Diabetes patients have a three-fold increased risk of developing periodontitis compared to the general population (Khan, 2018).

4.2. Salivary Dysfunction

Saliva plays an important function in the oral cavity's health. Saliva is generated by the parotid, submandibular, and sublingual salivary glands, as well as a number

of smaller salivary glands throughout the oral cavity. In individuals with diabetes, salivary dysfunction has been documented (Tsujimoto et al., 2016; Cicmil et al., 2018). Salivary dysfunction reveals itself in a variety of ways, including taste impairment, changes in saliva content and decreased salivary flow (Cicmil et al., 2018).

4.3. Taste Disorder

A variety of variables have been linked to changes in taste perception in the oral cavity. Salivary dysfunction can cause a change in sense of taste or an increase in detection thresholds (Al-Maskari et al., 2011; Cicmil et al., 2017). Salivary dysfunction can contribute to altered taste sensation or elevation of detection thresholds when endocrine diseases and metabolic have been proposed as causal factors for this disturbance. However, Patients with poorly managed diabetes have been found to have a higher rate of taste impairment than healthy controls. 5.7 percent of diabetes or prediabetic patients had a sweet taste issue, and 8.6 percent had a salt taste disorder, according to cross-sectional research. The taste thresholds of diabetic individuals with neuropathy are greater. A change in taste experience or a rise in detection thresholds can be caused by salivary malfunction. This sensory malfunction can make it difficult to stick to a healthy diet and cause problems with glucose management (Sudarshan et al., 2015).

4.4. Dry Mouth or Xerostomia

Salivary dysfunction is common in diabetics, and it can result in reduced salivary flow and a change in saliva composition.

To find out the link between salivary dysfunction and diabetic complications and the prevalence of hyposalivation and xerostomia (dry mouth), some researchers conducted a cross-sectional epidemiological study in 2001. Diabetics and non-diabetic patients were included in this investigation. Diabetes patients, particularly those with acquired neuropathy, reported xerostomia symptoms and reduced salivary flow rate more frequently than healthy controls. Xerostomia and hyposalivation are also more common in those with diabetes, according to other studies. The stimulated parotid gland flow rate is lower in diabetic patients than non-diabetic patients. There was also an increase in salivary pathogens in these people. Because of the constant dryness, the soft tissues of the mouth are feeling irritated and discomfort. Gum disease and tooth decay are more common in diabetics and xerostomia patients. The origin of this in diabetics is unknown; however, it could be related to polydipsia and polyuria, as well as a change in the salivary glands' basement membrane (Hsu et al., 2019). Diabetes mellitus is known to create chronic issues such neuropathy, microvascular abnormalities, and endothelial dysfunction.

4.5. Tongue Abnormalities

Tongue anomalies are common among diabetic patients. Fissured tongue is a common deformity among diabetics. In this case, the dorsal tongue surface has

grooves of various depths and sizes. When material becomes trapped in these cracks, symptoms appear (Villa et al., 2014; Erriu et al., 2016). It was discovered in a study of 2015 that reported fissured tongue was linked to Diabetes Mellitus. Xerostomia and a reduced salivary flow rate can cause fissured tongue development (Dotiwala & Samra, 2021). Another research published in 2019 discovered a bluish tongue with thick yellow hairs in diabetics and recommended tongue screening for early identification of Diabetes Mellitus (Bihari et al., 2014).

A Candida infection in the oral cavity induces rhomboid glossitis in a diabetic patient (Khan, 2018). Glossitis can be defined as an erythematous tongue lesion anterior to the circumvallate papillae. It is found on the dorsal surface of the tongue along the midline (Al Mubarak et al., 2013). Patients with Diabetes Mellitus might also develop Benign Migratory Glossitis (Buranasin et al., 2018). This benign disorder is characterized by redness (erythema), atrophy of the filiform papillae, and a serpiginous, whitish, and hyperkeratosis border (Huang et al., 2005).

4.6. Bacterial Infections

Diabetics, on the other hand, are more susceptible to bacterial infections in the mouth. Immunodeficient patients are those who have a weaker immune system (Utkarsh & Srinath, 2007; Rao et al., 2010). To spread and recurrence of bacterial infections, Diabetic patients are more vulnerable. Diabetes patients are more likely than non-diabetic individuals to have a deep neck bacterial infection, according to several studies (Abiko & Selimovic, 2010; Rathee & Sapra, 2021). The submandibular region was shown to be the most prevalent site of bacterial infection in both patients and controls, with the buccal space coming in second (Lima et al., 2017). Both groups had a higher percentage of *Streptococcus* species isolated. Diabetic patients are required to admit in the hospital for longer periods to control their blood glucose levels for avoiding any kind of serious infection.

4.7. Oral Wound Healing Problem

Patients with uncontrolled diabetes have been found to have poor oral wound healing, as well as long-term consequences (Jeong & Park, 2017). Poor oral wound healing is a documented hazard for diabetes people undergoing oral surgery. As a result, diabetes individuals having oral surgery require more extensive care and therapy. Delay in vascularization, reduced blood flow, a loss of innate immunity, decreased growth factor production, and psychological stress have all been associated to prolonged oral wound healing in diabetic patients.

4.8. Dental Caries and Tooth Loss

It is an infectious disease of the teeth in which the tooth structure is demineralized and bacteria stick to the tooth and produce acid from sugar, primarily *Streptococcus mutans*. The common factors that contribute to dental caries are microbial flora: cariogenic, fermentable sugar, and environmental variables etc. (Sampaio et al., 2011). In Diabetes Mellitus, lower saliva flow, impaired salivary buffering

function, high glucose levels in saliva, changes in the molecular composition of saliva, cariogenic food, poor oral hygiene and existing dental plaque have all been linked to dental caries formation (Moin & Malik, 2015). Diabetic patients are more prone to develop dental caries than non-diabetic patients (Seetha Lakshmi et al., 2016). Caries in the cementum of teeth become more common as people get older, and diabetic patients have been identified with caries in the radicular portion of the tooth. Hyposalivation is identified as a cause of poor oral hygiene in diabetic patients (Abikshyeet et al., 2012). Sugar-free toothpaste lowered salivary glucose levels and enhanced salivary pH in people with Diabetes Mellitus, indicating that blood glucose levels should be closely monitored to preserve oral hygiene (Hariharavel et al., 2017).

Patients with Diabetes Mellitus are more likely to develop dental caries due to reduced salivation and high glucose levels in saliva, which may be the result of an Insulin deficit (Latti et al., 2018). Saliva in diabetics loses its protecting, buffering, and cleaning functions (Cicmil et al., 2018). Damage to the microvasculature causes alterations in the basement membrane of the salivary gland. As a result, glucose leakage from duct cells increases, causing glucose levels in saliva and crevicular space to rise.

The activity of fibroblasts diminishes as a result of this shift, leading in greater plaque development. Dental plaque converts glucose in saliva into lactic acid, reducing salivary pH (Al-Maskari et al., 2011). The low pH leads to the growth of aciduric bacteria, while the expansion of acidogenic bacteria suppresses the defense bacteria in the mouth. The natural environment's equilibrium has shifted in favor of the bacteria that cause tooth decay. The pH is subsequently reduced even further, and the cycle continues. Diabetic people are more likely to acquire new or recurring dental caries. Increased levels of oral yeasts, mutans streptococci, and lactobacilli, as well as decreased saliva cleaning and buffering ability, can contribute to an increase in the prevalence of tooth decay (Ship, 2003). Chronic hyperglycemia can also lead to permanent pulpitis and pulp necrosis (Khan, 2018). Apical periodontitis and radiolucent periapical lesions are more prevalent in diabetics than in non-diabetics, according to several studies (López-López et al., 2011).

Diabetics, on the other hand, are more likely to develop oral infections, which can result in tooth decay and loss (Kamala et al., 2016). New and recurrent dental caries, as well as tooth loss, have all been associated to salivary secretory dysfunction, periodontal disease, and sensory issues. The link between diabetes and dental caries development is currently unknown (Nada et al., 2020). The cleaning and buffering ability of saliva is known to be reduced in people with diabetes mellitus, leading to an increased prevalence of dental caries, particularly in those with xerostomia.

4.9. Burning Mouth Syndrome

According to the International Association for the Study of Pain, it is a neuropathic oro facial sensory disease. Burning mouth syndrome is characterized by oral

mucosal burning pain involving the anterior 2/3rd of the tongue without evident mucosal pathology (Costa et al., 2019). There is no obvious reason to experience a tingling, burning sensation in the mucosa of the oral cavity (Colak, 2013). In type 2 diabetes, substantial predictors of burning mouth syndrome are found. Increased excitability of the trigeminal nerve in diabetic peripheral neuropathy is found in the oral cavity of patients with diabetic peripheral neuropathy and healthy people comparing the nociceptive activity of the Trigeminal nerve (Khandelwal et al., 2013). Hyperesthesia and discomfort in the oral cavity in diabetics with peripheral neuropathy can be caused by burning mouth syndrome. Long-term searing discomfort in the mouth makes it difficult to maintain oral hygiene, which can lead to additional deterioration in diabetic patients' oral health.

4.10. Halitosis

Halitosis or foul breath is one of the early diabetes symptoms which is a common ketone smell in diabetics. Sulfide compound odor can also be caused by periodontal disease. Methyl nitrate in the blood promote oxidative stress and high levels of fatty acids are the common factors of halitosis (Atefi et al., 2012). 23.3 percent of diabetic patients have developed halitosis.

4.11. Oral Lichen Planus

Lichen planus is a long-term skin inflammatory disorder (Iqbal et al., 2020). In the oral cavity, white raised lines appear, forming a lace-like pattern that is symmetrical and bilateral (Uma Maheswari & Chaudhary, 2020). Diabetes patients have oral lichen planus (Gupta & Jawanda, 2015; Irwin et al., 2007). Another mucosa-related modification has a negative impact on diabetes patients. Oral hypoglycemic drugs are the oral lichenoid reaction (Katz et al., 1991; Kibayashi et al., 2007).

Mouth lichen planus is an autoimmune disease in which cytotoxic T lymphocytes kill the oral epithelium's basal cells (Calsina et al., 2002). Patients with oral lichen planus may have discomfort and a burning sensation in their mouth, making eating and swallowing difficult. Because oral lichen planus can turn malignant, it's vital to diagnose it early and treat it to avoid developing oral squamous cell carcinoma.

4.12. Diabetic Patient with Periodontal Disease and Smoking

Diabetes patients are more likely to develop periodontal disease as a result of a number of risk factors, including poor dental hygiene, poor metabolic management, diabetes over a longer period of time, and smoking (Dietrich et al., 2007; Moore et al., 2000; Berlin, 2008). Smoking is a major preventable risk factor for periodontal disease and tooth loss in the general population as well as diabetes patients (Beziaud et al., 2004; McIntyre, 2001; Samaranayake, 1990; Akpan & Morgan, 2002). Counseling and aiding diabetes patients who want to quit smoking should be a priority for dentists and physicians (Lamey et al., 1988). The dentist should help these patients quit smoking by counseling them and referring them to a smoking cessation expert.

4.13. Oral Infection

4.13.1. Fungal Infections

Candida albicans species cause oral candidiasis, which is an opportunistic infection. Smoking, xerostomia, and endocrine and metabolic illnesses are also risk factors for this infection (Willis et al., 1999). Old age, drugs, Cushing's syndrome, malignancies, and the usage of dentures have all been implicated (Hill et al., 1989). Oral candidiasis is divided into two types: primary and secondary. Acute (pseudomembranous and erythematous), chronic (pseudomembranous, erythematous, and hyperplastic), and candida-related lesions are the three kinds of primary oral candidiasis (Khosravi et al., 2008).

Angular cheilitis appears as an erythematous crusting lesion in the lip commissures. Diabetics with inadequate glycemic control have been found to develop the lesion. On the dorsal surface of the tongue, median rhomboid glossitis appears as a depopulated erythematous diamond-shaped region near the midline.

For many years, it has been known that people with diabetes mellitus are more likely to develop fungal infections (Soysa et al., 2006). Candida infection is more common in diabetic patients, particularly those who smoke, wear dentures, have poor glycemic control, and take steroids and broad-spectrum antibiotics (Huang et al., 2005). Furthermore, salivary dysfunction in diabetic individuals might lead to greater fungus carriage in this group of patients.

4.13.2. Oral Thrush

Oral thrush is another name for Pseudomembranous candidiasis. When wiped, it leaves a creamy white surface with underlying erythematous and bleeding oral mucosa (Khosravi et al., 2008). The most commonly affected areas are the soft palate, cheek, tongue, and gingivae. In immune-compromised people, it may be persistent. Erythematous candidiasis is a kind of infection that can be acute or persistent. It is caused by long-term use of steroid and broad-spectrum antibiotics, and it primarily affects the tongue.

4.13.3. Bacterial Infections

Oral bacterial infections are more common in diabetic patients. They are referred to as immunocompromised since they have a weaker immune system. Diabetics with diabetes problems and poor metabolic control are more susceptible to bacterial infection spreading and recurrence. According to several studies, Diabetes patients are more prone to have a deep neck bacterial infection than non-diabetic patients (Vernillo, 2003; Lamster et al., 2008). In both patients, diabetic and non-diabetic, the common location is the submandibular region and the second most common location is the buccal space (Lalla & D'Ambrosio, 2001). In both groups, *Streptococcus* species were isolated more frequently. Diabetes patients are required to stay longer in the hospital to avoid more severe infections and to control their blood glucose levels.

As a result, it is critical to raise diabetes patients' understanding of mouth cleanliness and oral health care. Dentists can also help diabetic individuals become more conscious of their condition. The purpose of this study is to find out how common oral problems are among diabetes patients in Bangladesh.

## 5. Research Methodology

5.1. Study Objectives

5.1.1. General Objective

To assess the prevalence and pattern of oral complication among diabetic patient in Dhaka city.

5.1.2. Specific Objectives

- To assess the socio-demographic factors for oral complication among diabetic mellitus patient.
- To assess the lifestyle and behavioral factors for oral complication among diabetic mellitus patient.

5.2. Conceptual Framework
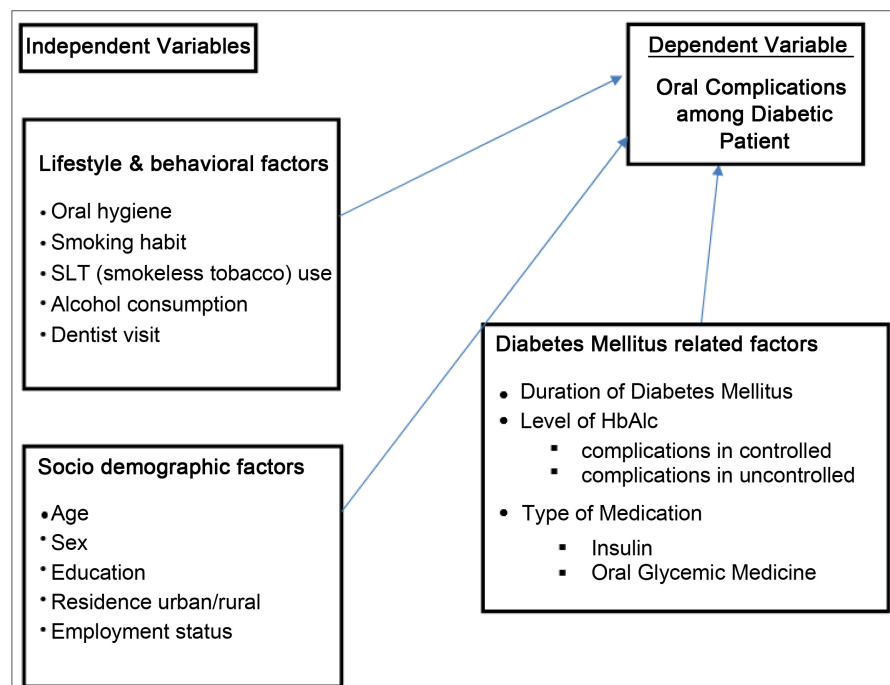
5.3. Study Design

A hospital-based cross-sectional study will be conducted at selected Dhaka hospitals from December 2021 to March 2022.

5.4. Target Population & Sample Population

Target population are dental patient attending tertiary level diabetes hospital; both male and female above 18 years old with diabetes mellitus.

5.5. Study Site & Area

The study will be conducted in tertiary hospital in Dhaka City having dental department:

- Diabetes Hospital in Bashundhara R/A Branch.

5.6. Study Period

December 2022 to May 2023.

5.7. Sample Size

Calculation of sample size:

$$n = \frac{z^2 \times pq}{d^2} = \frac{(1.96)^2 \times (0.80)(1-0.80)}{0.0064} = 96$$

Here,

n = desired sample size (when the population > 10,000).

Z = standard normal deviation; usually set at 1.96, which corresponds to 95% confidence level p = level of oral complication among DM Patients 80%/0.80.

$q = 1 - p$.

d = degree of accuracy required, usually set at 8% level.

By calculating the sample size is 96 and considering 20% will be non-responsive, so it will be 115.

Finally, we were able to collect 44 samples.

5.8. Inclusion Criteria

The study participants will be selected according to the following inclusion criteria:

- Patients older than 18.
- Patient with diabetes mellitus.
- Both male and female.
- Willing to permit consent.

5.9. Exclusion Criteria

Unable or not interested in participating in the study.

5.10. Sampling Technique

Convenience sampling will be used to collect data.

5.11. Data Collection Tools

A pretested and validated structured face-to-face questionnaire will be used to collect data. The study's questionnaire will be divided into three pieces (A, B, C). Section A will cover socio demographic characteristics (C1 - C8), section B will cover lifestyle and health characteristics (L1 - L10) and section C will cover diabetes mellitus related factors with oral complications (D1 - D24).

5.11.1. Socio-Demographic Factors

Socio-demographic characteristics (C1 - C8) such as age, sex, education, residence, employment status, and working location will be collected using a structured questionnaire.

5.11.2. Life Style Factors

Characteristics of a person's lifestyle and behavior (L1 - L10) furthermore, they are prone to oral infections, and taste abnormalities cause them to consume more sugar and salt, causing their glycemic control and, as a result, the health of their oral cavities to deteriorate further.

5.11.3. Diabetes Mellitus Related Factor

Diabetes Mellitus related factor (D1 - D24) includes duration of Diabetes Mellitus, level of HbA1c (complications in controlled or complications in uncontrolled), type of Medication—(Insulin/Oral Glycemic Medicine).

5.12. Data Management & Analysis Plan

The questionnaire will include 45 closed-ended questions aimed at increasing people's awareness, understanding, and practice of oral complications of diabetic patients, their signs and symptoms, and risk factors. As socio-demographic data, age, sex, employment, and educational level will be collected. Editing and data entering will be part of the recorded response. For data entry, processing, and analysis, Microsoft Word, Microsoft Excel, and SPSS will be used.

5.13. Quality Control & Quality Assurance

The supervisor will provide frequent assistance and direction to achieve quality control and assurance. Before collecting data from the field, the chosen questionnaire will be pre-tested to determine its usefulness. In both English and Bangla, the questionnaire will be conducted in easy language. To ensure the greatest possible quality of data, the researcher will gather it themselves. Before any data is collected, all reports will be made with the respondents. Data will be cross-checked for accuracy.

5.14. Ethical Considerations

Because the researchers' goal is to improve society, they will not force anybody to complete the questionnaire and will ensure that all personal information is kept private. The North South University officials will provide its approval to the study procedure. The study participants will also get a full consent form.

5.15. Limitation of the Study

Although frantic effort was made to reduce bias and errors in the research however there were some limitations that was always be there despite all the effort. Some of the limitation of this type of research included non-response by some of the respondents. Some of them were not able to respond because of their medical

condition, fragility, cognitive deficit and general weakness among others. Apart from non-response another limitation was that some respondents misinterpret ed the questions and this might have influenced their response and subsequently the result. However, subjecting the questionnaire to reliability and validity test minimized this.

6. Results

This was a descriptive cross-sectional survey of 44 patients. All data was collected, maintain and evaluated.

Table 1. Socio demographic status of the participants.

Variables		Frequency (Number)	Percentage (%)
Age	18 - 30 years	14.0	31.8%
	31 - 40 years	7.0	15.9%
	41 - 50 years	5.0	11.4%
	51 - 60 years	6.0	13.6%
	61 - 70 years	9.0	20.5%
Sex	Male	24.0	51%
	Female	20.0	49%
Education	High school	5.0	11.4%
	College	6.0	13.6%
	Higher education (Bachelors, Masters)	30.0	68.2%
Employment Status	Employed	18.0	40.9%
	Unemployed	18.0	40.9%
	Self-Employee	8.0	18.2%
Residence	Rural	11.0	25%
	Urban	33.0	75%
Family History of Diabetes Mellitus	Yes	34.0	77.3%
	No	7.0	15.9%

The dataset Table 1 includes various demographic and health-related variables from 44 participants. The age distribution is diverse, with the largest proportion falling in the 18 - 30 years and 51 - 70 years age groups, accounting for 31.8% and 20.5%, respectively. The gender distribution slightly favors males, constituting 51% of the dataset. Education levels vary, with 68.2% of individuals having higher education (Bachelors, Masters), while 11.4% completed high school and 13.6% attended college. Employment status is evenly spread, with 40.9% employed, 40.9% unemployed, and 18.2% self-employed. A notable difference in residence is observed, with 75% living in urban areas and 25% in rural areas. A substantial 77.3% of individuals have a family history of diabetes mellitus, while 15.9% do not.

Table 2. Lifestyle and behavioral factors.

Variables		Frequency	Percentage (%)
Consciousness of oral health	Yes	38.0	86.4%
	No	6.0	13.6%
Regular checking of sugar level	Yes	27.0	61.4%
	No	17.0	38.4%
Dentist visit	Regular	21	50%
	Irregular	21	50%
Maintain oral hygiene regularly	Yes	36	81.8%
	No	8	18.2%
How many times brush your teeth in a day	Once	18	40.9%
	Twice	25	56.8%

The majority of individuals (86.4%) in the dataset exhibit a strong consciousness of their oral health, while a smaller percentage (13.6%) do not share the same level of awareness. A significant portion (61.4%) of individuals reported regular checking of their sugar levels, while 38.4% do not engage in this practice. The dataset Table 2 is evenly split between individuals with regular dentist visits (50%) and those with irregular dentist visits (50%). Additionally, 81.8% of individuals maintain their oral hygiene regularly, while 18.2% do not follow regular oral hygiene practices. Among the surveyed individuals, 40.9% brush their teeth once a day, while a significant majority (56.8%) brush their teeth twice daily.

Table 3. Health Habits and personal safety.

Variables		Frequency	Percentage (%)
Dieting	Yes	27.0	41.7%
	No	17.0	58.3%
Smoking Habit	Yes	12.0	27.3%
	No	32.0	72.7%
Smokeless tobacco (SLT) habit	Yes	12.0	13.6%
	No	32.0	86.4%
Alcohol consumption	Yes	6.0	13.6%
	No	38.0	86.4%

In terms of dietary habits, 41.7% of the surveyed individuals adhere to dietary restrictions, while the majority, comprising 58.3%, do not follow a specific diet. When it comes to smoking habits, the dataset Table 3 reveals that 72.7% of individuals do not smoke, in contrast to the 27.3% who reported having a smoking habit. A significant proportion, totaling 86.4% of individuals, do not use smokeless tobacco (SLT), while a smaller segment, constituting 13.6%, engage in this

habit. In the context of alcohol consumption, the majority, at 86.4%, abstain from alcohol, while 13.6% do consume it. Regarding dentist visits, the dataset is evenly split, with 50% of individuals having regular visits and an equal 50% having irregular dentist visits.

Table 4. Diabetes mellitus related practice.

Variables		Frequency	Percentage (%)
Duration of diabetes	Less than 5 years	28	63.5%
	More than 5 years	16	36.4%
Regularly monitoring blood level	Yes	29	65.9%
	No	15	34.1%
Anti-diabetic medication	Yes	32	75%
	No	12	25%
Oral completion with diabetes mellitus is a major complication	Yes	32	75%
	No	12	25%
Family history of diabetes mellitus	Yes	37	83.3%
	No	7	16.7%
Type of anti-diabatic medication	Insulin	21	47.7%
	OAD	23	52.3%
Maintain any guideline to control diabetes	Yes	38	86.4%
	No	6	13.6%

Among the individuals, 63.5% have had diabetes for less than 5 years, while 36.4% have been managing the condition for more than 5 years. A significant 65.9% of those surveyed regularly monitor their blood levels, whereas 34.1% do not engage in this practice. The majority, totaling 75%, use anti-diabetic medication, while 25% do not. The dataset Table 4 shows that 75% of individuals have experienced oral complications related to diabetes mellitus, with 25% reporting no such complications. A significant 83.3% of those surveyed have a family history of diabetes mellitus, while 16.7% do not. When it comes to the type of anti-diabetic medication, 47.7% use insulin, and 52.3% use oral anti-diabetic drugs (OAD). Maintain guideline to control 86.4% of 38 persons and 13.6% of 6 persons.

Nearly half of the individuals, specifically 47.7%, experience a dry mouth sensation, while 52.3% do not report this symptom. A significant 61.4% of those surveyed consider gum bleeding as a sign of oral complications, while 38.6% do not associate it with such issues. It is reported that 38.6% of individuals experience a burning sensation in the mouth, while 61.4% do not have this symptom. Among the individuals, 36.4% feel difficulty in chewing or swallowing, while 63.6% do not encounter such issues. A minority, 20.5%, report feeling abnormal swelling in the mouth, while the majority, 79.5%, do not experience this symptom. Take protection to prevent periodontal disease in 75% of 33 persons and 25% of 11 persons (Table 5).

Table 5. Types of oral complication.

Variables		Frequency	Percentage (%)
Dry mouth feeling	Yes	21	47.7%
	No	23	52.3%
Gum bleeding is a sign of oral complications	Yes	27	61.4%
	No	17	38.6%
Burning sensation in the mouth	Present	17	38.6%
	Absent	27	61.4%
Feeling difficulty chewing or swallowing	Yes	16	36.4%
	No	28	63.6%
Feeling abnormal swelling in mouth	Yes	9	20.5%
	No	35	79.5%
Take any protection to prevent periodontal disease	Yes	33	75%
	No	11	25%

Among the individuals, 42.5% believe that poor glycemic control can cause oral lesions, while 54.5% do not share this belief. A substantial majority, specifically 86.4% of those surveyed, consider poor oral hygiene as a risk factor for oral health issues, while a smaller proportion, 13.6%, do not view it as a significant risk factor. Lifestyle changes and reduced risk of oral lesions apply to 95.5% of 42 persons and 4.5% of 2 persons. Uncontrolled diabetes and major organ complications affect 93.2% of 41 persons and 6.8% of 3 persons (Table 6).

Table 6. Impact of uncontrolled diabetes on oral health.

Variables		Frequency	Percentage (%)
Poor glycemic control can cause oral lesions	Yes	19	42.5%
	No	24	54.5%
Poor oral hygiene is a risk factor	Yes	38	86.4%
	No	6	13.6%
Lifestyle Changes and Reduced Risk of Oral Lesions	Yes	42	95.5%
	No	2	4.5%
Uncontrolled Diabetes and Major Organ Complications	Yes	41	93.2%
	No	3	6.8%

In Table 7, the data illustrate the percentage of oral complications in diabetic patients with different metabolic control levels, using a cut-off point of 6.5. Among patients with a cut-off point ≤ 6.5, 44% exhibited oral complications, whereas 58% of those with a cut-off point > 6.5 experienced similar complications. Conversely, 56% of patients with better metabolic control (≤ 6.5) did not show oral complications, compared to 42% in the higher cut-off group.

Table 7. Percentage of oral complications in diabetic patients with different metabolic control levels (Cut-off Point: 6.5).

Oral Complication status	Cut point ≤ 6.5 (N = 18)	Cut point > 6.5 (N = 26)
Oral Complication Positive	8 (44%)	15 (58%)
Oral Complication Negative	10 (56%)	11 (42%)

Table 8. Socio demographic, behavioral and diabetes mellitus related factors associated with oral complication (n = 44).

Variables	Categories	≤6.5 (%)	>6.5 (%)	p-value	
		N %	N%	Chi-Square	p-value
Sex	Male	10 (22.7%)	15 (34.1%)	0.0198	0.89
	Female	8 (18.2%)	11 (25%)		
Duration of Diabetics	≤5 years	12 (27.3%)	16 (36.4%)	0.0033	0.95
	>5 years	7 (15.9%)	9 (20.5%)		
Oral complication with diabetes mellitus	Yes	12 (27.3%)	20 (45.5%)	0.0639	0.80
	NO	5 (11.4%)	7 (15.9%)		
Dentist Visit	Regular	9 (20.5%)	14 (31.8%)	0.0050	0.94
	Irregular	8 (18.2%)	13 (29.5%)		
Smoking Habits	Yes	5 (11.4%)	7 (15.9%)	0.2005	0.65
	No	11 (25%)	21 (47.7%)		
Use of anti-diabetic medication	Yes	14 (31.8%)	18 (40.9%)	0.0154	0.90
	No	5 (11.4%)	7 15.9%)		
Maintain oral hygiene regularly	Yes	13 (29.5%)	23 (52.3%)	0.0055	0.94
	No	3 (6.8%)	5 (11.4%)		
Number of brushing everyday	Ones	9 (20.5%)	9 (20.5%)	0.0000	1.00
	Twice	13 (29.5%)	13 (29.5%)		
Maintain any guideline to control diabetes	Yes	12 (27.3%)	26 (59.1%)	0.0074	0.93
	No	2 (4.5%)	4 (9.1%)		
Take any protection to prevent periodontal disease	Yes	12 (27.3%)	21 (47.7%)	0.0000	1.00
	No	4 (9.1%)	7 (15.9%)		

Table 8 presents the association between socio-demographic, behavioral, and diabetes-related factors and oral complications in diabetic patients. While factors such as sex, diabetes duration, and oral hygiene practices showed variations in oral complication rates, none of the associations reached statistical significance, as evidenced by p-values all exceeding 0.05. For instance, 27.3% of patients with better glycemic control (≤6.5) reported oral complications, compared to 45.5% of those with poorer control (>6.5), though the association was not statistically

significant ($p = 0.80$). Similarly, no significant differences were found based on dentist visits, smoking habits, or brushing frequency.

Evaluating oral complications among diabetic patients:

The below pie Chart 1 illustrates that among diabetic patients, 40% show good metabolic control, while the remaining 60% have poor metabolic control in the evaluation of oral complications.

Oral complication among diabetic patient
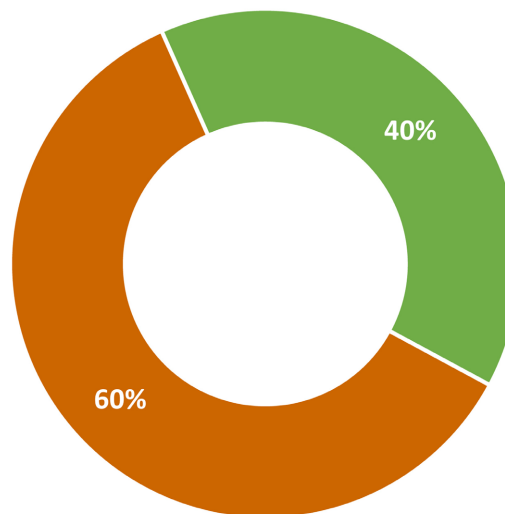
■ Good Metabolic Control (≤ 6.5) ■ Poor Metabolic Control (>6.5)

Chart 1. Showing frequency of level of oral complications among diabetic patients.

7. Discussion

This evaluation revealed a high prevalence of oral complications among patients with diabetes mellitus. A preliminary study in the literature, involving diabetic patients, reported a prevalence of 80%. This finding, which closely aligns with the results of the current study, underscores the importance of dentists closely monitoring the oral health of patients with diabetes mellitus. A high incidence of oral lesions indicates a pressing need for immediate treatment.

In this study, the most common oral mucosal lesions observed were ulcerative lesions. A case-control study similar to this one reported a prevalence of 22% for ulcerative lesions in the oral cavity among diabetes patients. The literature also indicates that alterations in the oral mucosa associated with diabetes can lead to symptoms such as salivary dysfunction, taste disorders, dry mouth (xerostomia), tongue abnormalities, and bacterial infections. Consequently, these oral complications can cause pain, discomfort, and a burning sensation, significantly affecting the oral health of patients. In some cases, these complications may even hinder patients from engaging in their professional activities.

The results also highlight that while most of the population is concerned about

maintaining dental hygiene, they are not as inclined to visit the dentist, despite being aware of the elevated risk of oral problems associated with diabetes. Surprisingly, over 50% of the population seems to lack awareness of oral health issues.

It's noteworthy that the age group between 41 - 60 years comprises the majority of diabetes patients (25%). The gender distribution in the samples is nearly equal. Given the elderly age group, about 81.8% of the patients are unemployed. The majority of patients (36.4%) have been suffering from diabetes for more than 5 years, followed closely by those with less than 5 years of diabetes history (63.5%).

Regarding dental hygiene, all the samples reported regularly brushing their teeth, with 56.8% brushing twice or more daily, 40.9% brushing once a day, and only a few not doing so regularly. Notably, the data reveals that most of the sample population has the habit of rinsing after every meal. Surprisingly, 50% of the population had not visited a dentist in the past year, while 34.1% reported visiting once a year, 11.4% had not visited yet, and 9.5% visited once every 6 months. Those who had visited the dentist did so primarily due to tooth loss.

Regarding lifestyle and dietary choices, all the patients had abstained from alcohol, but more than half of the samples (68.2%) believed that all diabetes patients should follow a diet rich in fruits and vegetables. However, the data suggests that around half of the sample does not adhere to any specific diet, 27.3% occasionally follow such a diet, and approximately 9% never do.

8. Conclusion

The study reveals a higher prevalence of oral complications in patients with diabetes mellitus, emphasizing the importance of dentists monitoring the oral health of diabetic patients. An assessment of health knowledge among adults with diabetes found that only 47% answered critical oral health questions correctly, indicating a lack of awareness about oral health complications associated with diabetes. A study on glycemic control and severe oral lesions in adults over 40 demonstrated that poorly controlled diabetes significantly increased the risk of severe oral complications. These findings underscore the significance of dental care for diabetic patients, particularly those with uncontrolled diabetes, and high-light the potential for collaborative care between physicians and dentists to enhance oral health in these patients. In conclusion, proactive oral health management is essential for individuals with diabetes, and interdisciplinary healthcare collaboration can contribute to improved outcomes in oral health for this patient population.

9. Recommendation

There is a need for more studies with a solid longitudinal design in the future to provide stronger evidence, as these studies are cross-sectional in nature. More research is needed to determine the precise components that influence people's oral health awareness.

To address the high prevalence of oral complications in diabetic patients, we

recommend:

- Launching an extensive patient education campaign.
- Encouraging regular dental check-ups for diabetics.
- Continually emphasizing the importance of daily oral hygiene.
- Implementing targeted awareness initiatives for the 41 - 60 age group.
- Promoting interdisciplinary collaboration between physicians and dentists.
- Providing comprehensive guidance on diet and lifestyle management.

These measures will help reduce oral complications in diabetic patients and improve their overall well-being.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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