Assessment of Oral Health Status and its association with Body Mass Index among Type 2 Diabetes Mellitus patients: A Case Control Study

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LIST OF ABBREVIATION

Sl. No.	Abbreviation	Expanded form
1.	WHO	World Health Organisation
2.	T2DM	Type 2 Diabetes Mellitus
3.	BMI	Body Mass Index
4.	DMFT	Decayed-Missing-Filled-Teeth
5.	DT	Decayed Teeth
6.	MT	Missing Teeth
7.	FT	Filled Teeth
8.	BOP	Bleeding on Probing
9.	PPD	Periodontal Pocket Disease
10.	LOA	Loss of Attachment

ABSTRACT

BACKGROUND: The incidence of Type 2 Diabetes Mellitus (T2DM) and obesity is fast growing, both of which affects the oral health seriously. Although diabetes and bad oral health are found to be associated in studies, few studies have compared the role of Body Mass Index (BMI) in oral health between diabetics and non-diabetics. This study examines this relationship in the Indian population.

AIM: To determine the association of oral health status and BMI in T2DM patients and controls.

METHOD: Case-control study was undertaken among 100 T2DM patients and 100 control participants by simple random sampling. Ethical clearance and informed consent were taken. Data collection included clinical oral examination, BMI measurement, and personal interview with the WHO Oral Health proforma (2013). Standardization, infection control, and proper recording of data were ensured by trained staff. Statistical analysis was done with descriptive statistics, Chi-square tests for association, Pearson/Spearman correlation for BMI and oral health measures, and logistic regression for odds ratio calculation. Statistical significance was established at $p \leq 0.05$.

RESULTS: The research demonstrated strong correlations between BMI and oral health in diabetics and non-diabetics. Diabetics presented with increased prevalence of dental caries, periodontal disease, and tooth loss, especially with BMI >25. Logistic regression indicated elevated odds of oral conditions with greater BMI, particularly tooth loss (OR = 5.26 in diabetics). Spearman correlation supported positive correlations between BMI and oral health indicators in both groups. Diabetics had poorer oral hygiene beliefs, more oral problems, and higher treatment demands.

Eating habits and dietary practices such as tobacco consumption were also more common in diabetics. These observations indicate that higher BMI aggravates oral health, particularly in diabetics.

CONCLUSION: This case-control study identified a significant correlation between increased BMI and worse oral health among both diabetics and non-diabetics, with more pronounced effects among diabetics. Diabetics had poorer oral health, higher treatment needs, and lifestyle-related risks, highlighting the importance of combined care and lifestyle interventions to enhance oral and systemic health.

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INTRODUCTION

"Health is like money, we never have a true idea of its value until we lose it"

Josh Billings

The International Diabetes Federation (IDF) highlights diabetes as one of the fastest-growing health challenges of the 21st century, reporting that the number of adults affected has tripled in the last 20 years. According to IDF projections 2021, the global diabetic population is expected to reach 643 million by 2030 and 783 million by 2045.[1] India, known as the "Diabetes Capital of the World," has more than 77 million diabetic adults accounting for one-fifth of all diabetics globally. The prevalence of affected persons is growing very rapidly year after year.[2,3] Diabetes Mellitus (DM) is a metabolic disorder marked by abnormalities in the metabolism of fats, carbohydrates, and proteins, leading to elevated blood glucose levels. The majority of diabetes cases fall into two main categories. One of these is type 1 diabetes, which results from a complete lack of insulin production. Individuals at higher risk for this form of diabetes can often be identified through serological markers of autoimmune activity in the pancreatic islets and specific genetic predispositions.[4] In the other, much more prevalent category, T2DM is a multisystemic, complex metabolic disorder that is caused by hyperglycaemia characterized by insulin secretion defect or tissue insensitivity to insulin.[1] β-cell dysfunction in type 2 diabetes begins with impaired first-phase insulin secretion, progresses to glucotoxicity, and ultimately leads to declining insulin secretion and β-cell failure. Insulin resistance in T2DM remains debated, as it also occurs in non-diabetic conditions, making its unique role in diabetes unclear.[5,6]

T2DM affects the oral cavity due to its highly vascularized and innervated nature, along with other organs and systems, leading to a higher incidence of various oral diseases.[7] A bidirectional relationship exists between PD and diabetes. PD not only adversely affects metabolic control in diabetes but also enhances the risk of acquiring the condition, whereas poor glycaemic control is linked to more severe PD.[8] A recent systematic review and meta-analysis suggests that T2DM may increase the risk of periodontitis by 34%. The severity of periodontitis appears to be influenced by glycaemic control in T2DM patients. Additionally, severe periodontitis has been linked to a 53% higher incidence of T2DM.[9] Studies on the link between poor oral health and T2DM among the Indian adult population have shown that diabetic individuals experience a higher burden of oral health issues in comparison with non-diabetic counterparts. The prevalence of dental caries was 78.9% among diabetic participants, indicating a more severe caries experience. Additionally, the prevalence of periodontitis was more in those with T2DM at 42.3%, compared to 31.3% in those without T2DM.[10]

T2DM often has poor quality of life when complications or comorbidities occur. Coronary artery disease has been the most severe complications, followed by renal failure, blindness, and vascular complications. Common comorbidities like obesity, hypertension also increase the negative impact of diabetes.[11] The rising global prevalence of obesity is a major factor in the type 2 diabetes epidemic. Obesity -induced chronic inflammation contributes to insulin resistance, which not only leads to diabetes development but also increases the risks of periodontal disease onset and progression. Dysfunction in adipose tissue, liver, and muscle plays a key role in this link. A positive causal relationship has been observed between BMI and T2DM, with a sharp increase in diabetes risk when BMI reaches 31 kg/m^2. [12,13,14] Additionally, the

occurrence of different oral diseases may be linked to an increased BMI, while better oral health could be related to a lower BMI.[15]

Existing studies have examined the link between oral health status and diabetes, as well as the relationship between BMI and diabetes, in individuals with T2DM and control groups separately. Research has consistently shown that individuals with diabetes tend to have poorer oral health outcomes compared to non-diabetic controls. Additionally, higher BMI has been more commonly associated with diabetes than with non-diabetic individuals. However, the specific impact of high BMI within control groups on oral health outcomes has not been extensively studied. This highlights the need for examining the impact of elevated BMI on oral health among non-diabetic individuals and to compare these findings with those observed in individuals with T2DM. Such a study could provide details about the interplay between BMI, diabetes status, and oral health. Thus, the rationale of this study is to assess the existence of any association of oral health status and BMI among T2DM patients and controls.

AIMS AND OBJECTIVES

AIM OF THE STUDY:

To determine the association of oral health status and BMI in T2DM patients and controls.

OBJECTIVES OF THE STUDY:

- To assess the oral health status and BMI of 30 to 60-year-old T2DM patients.
- To assess the oral health status and BMI of 30 to 60-year-old controls.
- To compare the oral health status and BMI of 30 to 60-year-old T2DM patients with controls.

REVIEW OF LITERATURE

1. Shrivastav et al. evaluated 75 diabetics and 75 non-diabetics on KAP about the relationship of diabetes and oral health used a standardized questionnaire and Chi-square test identified that 27.3% were unaware of the association. While 69.3% appreciated regular dental check-ups, 51.3% cleaned teeth once a day and 71.3% were not aware of flossing. The study emphasized the necessity for better oral health education in diabetic management.[8]
2. Wu et al. systematically reviewed 53 observational studies on the association between periodontitis and T2DM. Meta-analysis revealed T2DM was more prevalent among periodontitis patients (OR = 4.04) and that diabetics' periodontal health was poorer. T2DM increased periodontitis risk by 34%, whereas severe periodontitis elevated T2DM incidence by 53%. The results affirmed a robust bidirectional relationship, supporting combined management of the two conditions.[9]
3. Rawal et al. conducted a survey to investigate the link between DM and oral conditions in urban Delhi. Using WHO's Oral Health Assessment tools and clinical data, they assessed 2045 participants. Diabetes was ascertained from blood examination or drug use. Zero-Inflated Poisson regression showed that diabetics had more advanced dental caries (MCR = 1.07) and attachment loss (MCR = 1.10). Periodontitis prevalence was also higher among diabetics (42.3%) than non-diabetics (31.3%). At 85% of the population having at least one oral disease, the research underlined the need to integrate oral health in India's NCD programs.[10]

4. Chandrasekaran et al. carried out a review and elaborated that obesity was the foremost risk factor for T2DM and was the key cause of its development and worsening in all age groups. As both conditions had reached worldwide, the management of obesity was crucial in the prevention and control of T2DM. Clinical research revealed that moderate, long-term weight loss with diet, exercise, and behavioral modifications had the potential to enhance glycemic control as well as decrease medication reliance. The review discussed clinical concepts, prevalence, and pathophysiologic association between T2DM and obesity, and contemporary management approaches and in vivo models validating the creation of effective therapies.[12]
5. Guo et al. applied a study with regression discontinuity design (RDD) to find out the link between BMI and T2DM in 8550 subjects from the 2015 Survey. A model for predicting risk using variables such as age, gender, lifestyle, and hypertension was found to have good accuracy (AUC = 0.849). BMI was an independent risk factor, with a steep 5.03% rise in T2DM risk at BMI 31 kg/m² ($p = 0.006$), establishing a positive causal association. [13]
6. Miyazawa et al. examined large datasets to investigate the effects of diabetes and obesity on tooth loss, overcoming sample-size limitations of previous studies. Linear relationships between remaining teeth and such markers as fasting glucose, HbA1c, and BMI were discovered. Periodontal disease, exacerbated by hyperglycemia-induced inflammation, was a principal cause of tooth loss. Clinical trial evidence also revealed that periodontal disease management can enhance glycemic control or prevent the onset of T2DM, and it emphasizes a link on oral as well as general health.[14]

7. Issrani et al. carried out a review to study the link between BMI and oral health based on database information. Among 2839 articles found, 66 studies were included based on the inclusion criteria. The review revealed that the occurrence of different oral diseases may be linked to an increased BMI, while better oral health could be related to a lower BMI. The research focused on treating shared risk factors to enhance general as well as oral health concurrently.[15]
8. Nayak et al. carried out research to examine the correlation between oral health and obesity among Indians. A study group (BMI ≥25) and control group (BMI 18.5–24.99), with no patients with systemic diseases or bad habits were included. Oral health was measured in terms of indices of plaque, gingival, periodontal, and DMFT, along with diet and brushing habits. Statistical computation employing Chi-square and t-tests demonstrated that a positive link between higher BMI and lower oral health existed, where obese persons showed significantly poorer hygiene than people of normal BMI.[16]
9. Das et al. implemented a study in Muradnagar comparing oral health, SES and oral hygiene practices between 250 T2DM and 250 nondiabetic adults. The study revealed that diabetics had much higher decayed, missing, and filled teeth rates (10.23 ± 4.73 vs. 5.34 ± 3.32) and more severe periodontal conditions, such as deeper pockets and increased attachment loss (28.4% in diabetics vs. 18% in nondiabetics). The findings indicated a strong association between diabetes and oral health. [17]
10. Singh et al. examined the influence of salivary factors on dental caries in T2DM and non-diabetic controls. Glycemic factors were found to have a significant correlation with these salivary parameters that affected caries development in diabetes. Optimal flow rate, pH, could be protective measures in people with diabetes against dental caries, concluded the research. [18]

11. Malvania et al. performed a survey to evaluate the frequency of dental cavity among T2DM and controls in Ahmedabad. A total of 120 test group and 120 age- and sex-matched control group were included. The findings indicated that the frequency of dental caries was much more in the test group (73.33%) than the control group (33.33%). Furthermore, uncontrolled diabetic patients had a greater mean dental caries than those with controlled diabetes. The research concluded that the frequency of dental caries was much higher among diabetic patients and highlighted the requirement for enhanced cooperation between oral health workers and healthcare professionals to enhance the overall health status of diabetic patients. [19]
12. Latti et al. executed a study to examine the impact of diabetes mellitus on dental caries microorganisms that cause caries. The study was conducted on 60 subjects, with two groups: Group A (T2DM with decay) and Group B (non T2DM without decay). The study measured the DFS/dfs index and examined unstimulated saliva for Streptococcus mutans counts. Findings indicated that increased fasting blood sugar levels in Group A resulted in elevated Streptococcus mutans counts, leading to a greater caries index than in Group B. The research concluded that diabetes mellitus is linked with greater dental caries because of elevated blood sugar levels, indicating the connection between diabetes, oral microbiota, and dental caries. [20]
13. Khalifa et al. reported that there was no notable difference in total OHRQoL between T2DM and control but that diabetics experienced more clinical attachment loss. DMFT scores were associated with worse physical and psychological status in both groups, and CAL primarily impacted the handicap domain, particularly in diabetics. [21]

14. Apoorva et al. studied about periodontal disease among 408 T2DM patients and 100 non-diabetic controls in Bangalore. They used the Community Periodontal Index (CPI) and noted that diabetics had significantly greater CPI scores and more edentulous teeth than control (P = 0.000). Periodontal damage was positively associated with glycaemia and oral hygiene practices, whereas anti-diabetic treatment was negatively associated. The risk of periodontal damage increased as the glycaemic control worsened. Type 2 diabetics were found to have a severe periodontal disease compared to control. [22]

15. Natarajan et al. evaluated the association between missing posterior teeth and BMI by age and SES among 500 South Indian adults older than 40 years. Each participant had missing posterior teeth without prosthetic rehabilitation. Multivariate logistic regression indicated that those who had more tooth loss were also more likely to be obese. Obesity was particularly significant in females with high tooth loss in low socioeconomic status. Age, however, did not correlate significantly with obesity in the context of tooth loss. The research concluded that BMI and tooth loss are related, and integrated management is required to facilitate overall health.[23]

16. Bita Rohani stressed the significance of awareness regarding the oral complications and manifestations of diabetes mellitus. By reviewing recent literature, the article brought to the fore that diabetes, has a serious impact on oral health. Complications of various oral health related problems not only lower the QoL for patients with diabetes but can also compromise glycaemic control. Early control of these complications is thus vital to integral diabetic care.[24]

17. Deepa et al. measured diabetes awareness in four regions of India in 14,274 adults. 43.2% alone knew of diabetes by urban (58.4%) compared with rural (36.8%) (P < 0.001); men (46.7%) compared with women (39.6%) (P < 0.001).

Awareness of rising prevalence, prevention, and complications was greater in diabetics than the general population. Tamil Nadu had greatest knowledge among the general population; Maharashtra among diabetics. The report points to poor awareness of diabetes, particularly in rural communities, calling for mass education campaigns. [25]

18. Howard et al. performed a review of 32 studies to assess the effect of alcohol on diabetes in adults. Moderate drinking has reduced risk of developing T2DM and a 34–55% reduced risk of diabetes-associated heart disease. Heavy drinking (>3 drinks/day) raised the risk of diabetes by up to 43%. Moderate drinking did not have an acute effect on glycemic control. The research points out advantages of moderate drinking but suggests more research on long-term consequences. [26]
19. Sawane et al. implemented a review to determine the contribution of smokeless tobacco (ST) to T2DM in the South East Asia Region. In their analysis of 8 studies, they reported a non-significant correlation between T2DM and ST use (OR 1.39; 95% CI: 0.843–2.288). The pooled prevalence of ST use among T2DM patients was 24.08%. The research concludes that ST is not an important risk factor for T2DM, although evidence from a number of SEAR countries continues to be scarce. [27]
20. Pandey et al. examined 250 type 2 diabetic patients to evaluate oral hygiene habits. The majority of the participants were between 45–54 years (34%), with a greater proportion of males. Women with good or moderate glycemic control were brushing twice a day compared to men ($P < 0.001$). The research emphasizes the significance of oral hygiene in avoiding periodontal disease and aiding diabetes control. [28]
21. Ranfl et al. reviewed 2016 Slovenia CINDI Health Monitor data to evaluate poor oral hygiene habits (IOHH) in diabetic and general populations. In 7851

participants, IOHH was 34.7% overall and significantly more common among diabetics (50.9%) compared with non-diabetics (33.7%). Men had greatly increased odds of IOHH in both groups. Low education, unemployment, low social class, and rural dwelling were other risk factors highlighting the focused oral health measures, particularly for T2DM patients. [29]

22. Basu et al. implemented a study among 339 diabetic patients in Delhi to evaluate oral hygiene practices and attitude. Twice-daily brushing was practiced by merely 18.6%, but 47.5% and 20.3% have poor or very poor teeth and gum condition, respectively. A mere 15.2% knew that diabetes aggravates oral health, and only 15.6% underwent a dental check-up over the last one year. Poor oral hygiene and low awareness of diabetics are brought into focus by this study. [30]

23. Sanz et al. discussed the bidirectional relationship that periodontitis facilitates the risk of dysglycaemia and T2DM. Pathways are through inflammatory mediators and immunocompetent cells. Periodontal treatment among diabetics decreases HbA1C by 0.27–0.48% after 3 months. EFP and IDF suggest joint management for better outcomes in both diseases. [31]

24. Akherati et al. executed a study to analyze the frequency of prevalent periodontal pathogens in T2DM patients and their relationship with severity of periodontal disease. Periodontal disease severity, glycemic control, and BMI were measured in 55 T2DM patients and 55 controls. Aggregatibacter actinomycetemcomitans (Aa) was present significantly more in the test group than the control group. No notable variations were found for other bacteria between groups or by periodontitis severity in T2DM. Porphyromonas gingivalis (Pg) was more prevalent in overweight T2DM patients.[32]

25. Moles et al. have emphasized the global burden of DM as estimated to reach 642 million cases over the next two decades and related high annual health

expenditure. DM greatly impacts several organs, such as the oral cavity, thereby augmenting the occurrence of periodontitis, salivary dysfunction, fungal infection, oral cancer, and OPMDs. Periodontitis, specifically, compromises glycemic control and possibly enhances diabetes risk. Even with this, education among healthcare professionals—both doctors and dentists about the oral-systemic connection is still poor. The authors highlight the necessity of interdisciplinary care by dental practitioners for proper management of diabetes.[33]

26. Hessain et al., executed a study to identify the association between T2DM and poor oral health through self opinion. The study included 41,884 individuals from the 2020 Denmark survey. Poor oral health was reported by 37.0% of those with diabetes compared to 23.8% of the reference group. After adjusting for confounders, individuals with T2DM had a higher likelihood of poor oral health. A significance was found with education level ($p < 0.001$), with the association being stronger among those with lower educational attainment.[34]

27. Habashneh et al. conducted a study among Jordanians with a sample of 500 diabetic patients who had completed 405 questionnaire (81% response rate). Only 28% reported visiting the dentist for gum issues, 48% were aware of the link between DM and gum disease, and 38% recognized that glycaemic control based on periodontal health. Television and the internet were the primary sources of information (50%). Overall knowledge was low, highlighting the need for targeted educational programs, especially for patients with irregular dental and medical visits. The study emphasizes the role of healthcare providers in routinely assessing and advising diabetic patients on oral health.[35]

28. Allen et al. investigated diabetic patients' knowledge about periodontitis, their attitudes toward oral health, and OHRQL. Among 101 patients (aged 31–79) from a diabetic outpatient clinic, 33% were aware of periodontal disease risk,

compared to higher awareness of other diabetes-related complications. Only half of those aware of oral health risks had received information from a dentist, and 43% had visited a dentist within a year. OHRQL did not differ significantly from controls. The findings highlight the need to improve diabetic patients' awareness of oral-systemic health connections.[36]

29. Bakhshandeh et al. investigated oral health behaviors and smoking habits among diabetic adults in Tehran, Iran. Only 29% reported brushing twice daily, with women and those with moderately controlled diabetes (HbA1c 7.6–8.5%) showing higher frequencies. Dental visits within the past year were reported by 47%, more commonly among those without complications (52% vs. 41%) and those referred by physicians (OR = 4.4; CI = 1.9–10.2). The study highlights the need to enhance oral self-care and promote regular dental checkups in diabetic patients.[37]
30. Gupta et al. investigated oral health awareness, hygiene practices, and knowledge of the link between oral health and glycaemic control among T2DM patients and controls. A validated questionnaire was completed by 100 diabetics and 100 non-diabetics. Results showed 76% of test group and 73% of control group unaware of the connection. The study highlights a general lack of awareness in both groups and emphasizes the need for improved education among diabetic patients and healthcare providers.[38]

MATERIALS AND METHODS

Study Design and duration

The present study was a case control study conducted among patients with T2DM and controls. It aligned with the recommended standards outlined in STROBE guidelines. This survey was conducted for a six-month period, from November 2023 to April 2024.

Source of data

Cases were patients diagnosed with T2DM from the tertiary hospital, KLES Hospital, located in Belagavi city. Controls were patients from the same hospitals, their relatives or the general population.

Selection of cases:

Diagnostic criteria for cases:

- Cases were the individuals with known history of T2DM as per their medical records.
- To confirm this, guidelines given by American Diabetes Association (ADA) were assessed through an analysis of the patients' medical records.
- Any two abnormal test results from the given criteria of ADA were diagnosed as T2DM.

Inclusion criteria for cases:

- Based on diagnostic criteria, individuals aged 30 to 60 years with a documented history of T2DM for at least two years, as confirmed by

their medical records, and who are permanent residents of Belagavi city, were included.

- Participants taking only oral hypoglycaemic drugs were included.
- Participants who agreed to voluntarily provide consent.

Exclusion criteria for cases:

- Individuals with systemic conditions other than T2DM, as well as those who were bedridden or had mental impairments.
- Individuals who had undergone oral prophylaxis within the past year or had a history of antibiotic or steroid use.
- Participants who were on insulin therapy for diabetes.
- Pregnant or lactating women.

Selection of controls:

Diagnostic criteria for controls:

- Controls were the individuals with no previous medical history indicative of T2DM. They were confirmed by undergoing a confirmatory test measuring Random Blood Sugar level, which were in the range of < 140 mg/dl.

Inclusion criteria for controls:

- Based on diagnostic criteria, adults aged 30 to 60 years with no signs/symptoms/history of diabetes and who were providing written informed consent were included.

Exclusion criteria for controls:

- Participants with systemic diseases and who were on the medications for the same.
- Participants who were bedridden or had mental impairments.
- Participants with the history of oral prophylaxis in the past year and those with a history of antibiotic or steroid use.
- Pregnant or lactating women.
- Participants who are not willing to give informed consent.

Matching:

- Pairwise matching for age and gender was performed between the cases and controls.
- Allocation ratio for case and control were 1:1

Ethical Considerations, permissions, and informed Consent

- Ethical approval for the study, and all ethical standards were strictly followed.
- Permission was obtained from the relevant hospital.
- Written informed consent was secured from the study participants.

Sample size estimation:

- Based on the frequency of periodontitis among diabetic and non-diabetic population as per the study done by Akherati et al., 2021[32]

  95% confidence interval; 90% power

$$n = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 \ (p_1 q_1 + p_2 q_2)}{(p_1 - p_2)^2}$$

Where, p1= 90.9; p2=72.7

q1=100-p1; q2=100-p2

Z1-α/2=1.96; Z(1-β) =1.28

Estimated sample size for each group, n = 90; which were rounded off to 100

Thus, the final sample size were 100 cases and 100 controls.

Sampling technique

Simple Random Sampling: Participants were randomly selected from the list of eligible cases (T2DM patients) obtained from hospital records and the list of potential controls (non-diabetic individuals) compiled from hospital visitors, relatives, and the general population.

Organization of the study

1. Pilot study

A pilot study involving 20 cases and 20 controls was carried out to assess the feasibility and identify any potential challenges faced during the implementation of the study.

2. Training and calibration

A single investigator underwent a meticulous standardization and calibration process before to the start of the study at the Department of Public Health Dentistry, KLE V.K Institute of Dental Sciences, Belagavi to ensure consistent assessment under the guidance of a professor. The investigator then conducted clinical examinations on ten subjects using the WHO Oral Health proforma, five of them were randomly recalled for a repeated assessment. Intra-examiner reliability was assessed using

Kappa statistics, yielding a weighted Kappa coefficient of 0.86, which indicates a strong level of agreement. Calibration of glucometer were done for every 10 patients. (concentration: 50mg/dl). BMI was measured using a calibrated stadiometer and digital weight machine to obtain height and weight respectively. Regular checks were conducted to ensure accuracy and reliability of the measurements obtained.

3. Data collection

The survey was initiated at a tertiary hospital in Belagavi city for the cases. Controls were selected from the same hospital, their neighbours, or the general population. The clinical diagnosis of cases was confirmed if the patient had satisfied the ADA guidelines of clinical, as per their available medical records.

Estimation of random blood sugar of the controls using a glucometer kit as a confirmatory test was done. For each participant, the fingertip was cleaned with spirit and pricked with a lancet. The blood was loaded onto the test strip, which was then inserted into the glucometer's test slot. The glucometer showed the blood glucose level, which was noted down. The lancet was immediately discarded after use.

Data Collection includes,

a) Sociodemographic Details and Family History of Diabetes

This includes the collection of name, age, gender, and socioeconomic status based on the Modified Kuppuswamy Scale (2022). The diabetes history includes information on the duration of diabetes and family medical history of the condition.

b) Oral Health Problems which included the collection of details regarding mouth dryness, delayed healing in the mouth, gum bleeding on probing, mouth ulcers, bad

breath, fungal mouth infections, swollen or tender gums, loose teeth, taste problems, and oral skin diseases.

c) BMI Measurement included the height and weight assessment using a calibrated stadiometer and a digital weighing machine.

d) WHO Oral Health proforma (2013)

The present survey utilized the WHO Oral Health proforma (2013), which was obtained from the "Oral Health Survey – Basic Methods 5th Edition" and was distributed in printed form. This structured format is designed specifically to assess both the oral health condition and treatment needs of individuals. It furnishes essential data necessary for devising comprehensive oral healthcare initiatives. It recorded the dentition status, which included the assessment of DMFT, as well as the periodontal status, which involves evaluating Bleeding On Probing (BOP) and Periodontal Pocket Disease (PPD). Additionally, any oral mucosal lesions observed were documented, along with the type of dental treatment need.

e) WHO Oral Health Questionnaire for Adults (2013)

WHO Oral health Questionnaire for Adults (2013) was a pre-validated standard questionnaire taken from “Oral Health Survey – Basic Methods 5th Edition” was used in this study. It included 16 closed ended multiple choice questions in English. It was recorded in the form personal interview. It served to document the oral hygiene practices, including the frequency and methods of toothbrushing, as well as the frequency of dental visits. Additionally, the questionnaire captured sugar consumption frequency and documented any deleterious habits, such as tobacco use in any form and alcohol consumption.

4. Implementation of the survey

a) Scheduling:

The examination schedule for selected participants was organized and presented to the hospital administration. A total of 200 participants (100 cases and 100 controls) who provided consent underwent oral examinations, followed by personal interviews. Each day, a maximum of 5-10 participants were examined and interviewed. The examinations were conducted during daylight hours, specifically from 10:00 AM to 1:00 PM utilizing natural light. A consistent location within the hospital premises was used for the examinations.

b) Emergency care and referral:

Both cases and controls requiring emergency or additional treatment were appropriately referred to the KLE VK Institute of Dental Sciences for further assistance.

c) Personnel and organization:

1. Recording clerk: Five recording clerk underwent training to proficiently record the WHO Oral Health Assessment Forms and provided assistance to the examiner during the survey, fulfilling the role of recording clerks. To ensure seamless coordination and accuracy in coding, a preliminary session was conducted where the examiner and recording clerks jointly recorded a certain number of forms prior to the commencement of the survey. This preparatory step aimed to optimize workflow efficiency and precision of the collected data.

2. Organizing clerk: A hospital staff member was designated as the organizing clerk to oversee the smooth progression of participants for oral examinations and personal

interviews. The clerk ensured an orderly flow of activities and maintained the availability of necessary equipment in a sterile condition.

d) Infection control

Disposable gloves and mouth masks were utilized throughout the examination process. Gloves were replaced prior to examining each participant to maintain sterilization standards. Instruments were consistently sterilized during the survey. A total of 100 instruments were allocated for examinations, and they were sterilized at the end of each day. Additionally, 20 CPI probes were provided, and cold sterilization was conducted during the examinations to maintain the sterilization protocols. Single prick disposable lancets were used for blood sugar examination for controls and discarded after every use.

e) Examination area:

The examination site was established at a designated location within the hospital premises. All essential arrangements were meticulously organized to ensure smooth operations.

f) Examiner position:

The participants were positioned on chairs, while the examiner carried out the examination standing behind.

g) Lighting:

All examinations were carried out under natural daylight to ensure optimal illumination. In cases where additional light was necessary, a torch was utilized.

h) Seating of the recording clerk / intern:

The recording clerk was positioned strategically to ensure clear auditory reception of the codes and a clear view of the examination area. Simultaneously, the examiner had visibility of the codes being inputted into the form, minimizing the likelihood of recording errors. Following the oral examination, participants engaged in one-on-one sessions with the recording clerk and principal investigator for the personal interview, during which the contents of WHO Oral Health Questionnaire were recorded.

i) Instruments and supplies:

Adequate instruments were maintained at the time of examination, which included

1) For oral examination

- Mouth mirror
- Explorer
- CPI probe
- Williams periodontal probe
- Tweezers
- Kidney trays
- Cotton and gauze
- Mouth mask and gloves
- Antiseptic solution

2) For measuring BMI

- Stadiometer
- Weight scale

3) For measuring Random Blood Sugar for controls

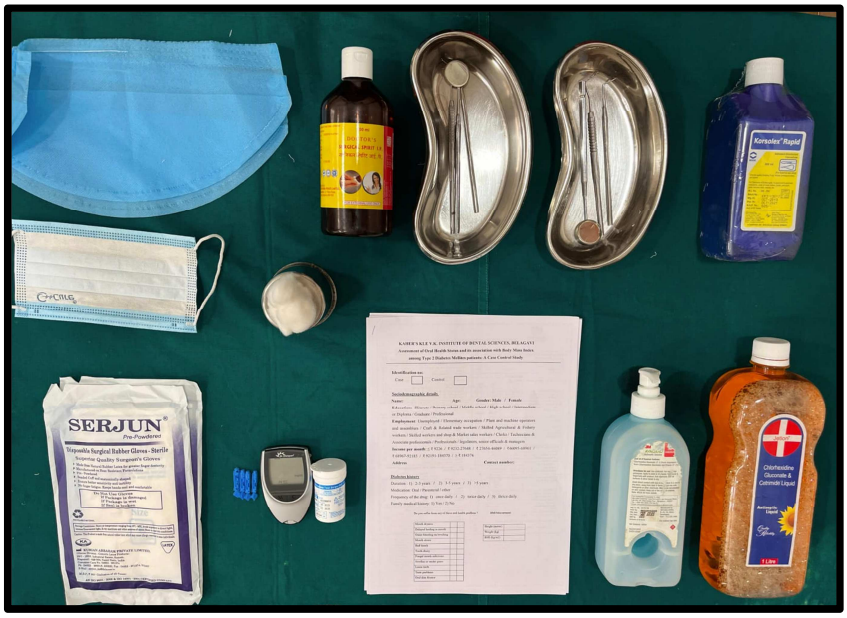
- Glucometer with test strips

Statistical analysis:

The data collected was entered into a Microsoft Excel spreadsheet and analyzed using SPSS version 25, IBM Statistics. The following statistical methods were applied in the study:

- Descriptive statistics were calculated to determine frequency, percentage, mean, and standard deviation.
- The Chi-square test was used to assess the association between study variables.
- Spearman's correlation coefficient was used to examine the relationship between BMI and oral health parameters.
- Logistic regression was performed to estimate the odds ratio.
- Statistical significance was set at $p \leq 0.05$.

Photographs illustrating the study progression and methodology



Photograph 1: Materials used for oral examination

Photograph 2 & 3: Stadiometer and Digital Weighing Machine

Photograph 4: Blood sugar estimation using Glucometer kit

Photograph 5: Interview of the participants

Photograph 6: Oral examination of the participants

Photograph 7 & 8: Measurement of height and weight for the assessment of BMI

RESULTS

This study was undertaken to evaluate the association between oral health status and BMI among diabetics and non-diabetics. Data collection involved oral examinations, BMI measurement and interviews utilizing the WHO Oral Health Assessment Form (2013) and the WHO Oral Health Questionnaire for Adults (2013) for both the cases and controls. Subsequently, the data were entered into Microsoft Excel 2013 and was analysed using SPSS for Windows (Version 25.0). The findings were organized and conveyed through tabulation, presenting frequencies, mean values, and standard deviations, accompanied by pertinent p-values for statistical significance.

Table 1, Figure 1, 2 & 3 depicts the demographic characteristics of the study participants, which comprised of 100 diabetics and 100 non-diabetics. Age and gender were equally distributed between both groups, with the majority being 40-49 years (50%) followed by 50-59 years (45%). Males constituted 54% of the participants while females accounted for 46%. Based on socioeconomic status, 18-19% belonged to the upper lower class, 45-46% to the lower middle class, and 36% to the upper middle class, with no participants in the lower or upper class. No statistically significant differences were observed between the groups. Among diabetics, majority were overweight (81%) or obese (2%), with only 17% falling within the normal weight range. In contrast, the non-diabetic group had a significantly higher proportion of individuals with normal weight (57%) and fewer overweight individuals (43%), with no cases of obesity. Statistically significant difference was observed between higher BMI and the presence of diabetes.

Table 2, Figure 4 & 5 illustrates the distribution of diabetics based on diabetes history. The majority of the participants had diabetes for 2-3 years (64%) followed by 4-5 years (29%) and more than 5 years (7%). Additionally, a positive family history of diabetes was found in 74% of the participants, while the remaining 26% had no family history of diabetes.

Table 3 and Figure 6 compares the mean dentition status between diabetic and non-diabetic participants. Diabetics exhibit significantly higher mean scores of decayed (3.59 ± 2.37), missing (4.01 ± 3.32), and filled teeth (1.13 ± 0.80), leading to a substantially higher DMFT index score (8.73 ± 4.03) compared to non-diabetics. Periodontal pocket depth is also significantly greater in diabetics, particularly in the 4-5 mm (5.57 ± 1.13) and ≥6 mm categories (3.95 ± 1.40). Regarding loss of attachment, diabetics show significantly higher values at 0-3 mm (2.26 ± 0.86), 4-5 mm (1.47 ± 0.51), and 6-8 mm (1.17 ± 0.98). However, differences in attachment loss at 9-11 mm and more than or equal to 12 mm are not statistically significant.

Table 4 & Figure 7,8 presents a comparison of oral health status with BMI among diabetic and non-diabetic individuals. Among diabetics, all oral health indicators including dental caries, gingival bleeding, periodontal pocket disease (PPD), loss of attachment (LOA), and tooth loss were significantly more prevalent in those with BMI > 25, with a significant association between poor oral health and higher BMI. Similarly, in non-diabetics, all five oral health conditions also showed a significant association with BMI > 25 ($p < 0.05$), though the distribution was relatively less pronounced than in diabetics. These findings suggest that higher BMI is significantly associated with poorer oral health, with the association being more marked in diabetic individuals.

Table 5 & Figure 9 depicts the comparison of various oral health-related problems among diabetics and non-diabetics. The occurrence of mouth dryness (74%), delayed healing (56%), bleeding on brushing (62%), mouth ulcers (35%), bad breath (60%), swollen gums (47%), loose teeth (61%) and taste problems (54%) was significantly higher among diabetics compared to non-diabetics.

Table 6, Figure 10 & Figure 11 presents the comparison of brushing habits and modes of teeth cleaning among diabetics and non-diabetics. Majority of the diabetics (86%) and non-diabetics (85%) brushed once daily. Regarding the mode of teeth cleaning, 77% of diabetics and 81% of non-diabetics used a toothbrush, while 23% of diabetics and 19% of non-diabetics used a finger or chewstick. No statistically significant differences were observed between the groups.

Table 7, Figure 12 & Figure 13 presents the comparison of the last dental visit and reasons for seeking dental care among diabetics and non-diabetics. Majority of diabetics (25%) had received dental care between 6-12 months, followed by 21% in more than one year but less than two years. Among non-diabetics, majority of participants had never received dental care (34%) followed by 20% who had visited within six months. Among diabetics, the primary reason for dental visits was pain or discomfort (35%), whereas most non-diabetics either did not remember the reason for their visit or had never visited a dentist (48%). Statistically significant differences were observed between the groups

Table 8 illustrates the analysis of sugar-containing food consumption between diabetics and non-diabetics. Fresh fruit intake was low in both groups, with most consuming it only once or several times a month. Similarly, the consumption of biscuits, cakes, jam, honey, and sugary chewing gum showed no significant

differences. However, a statistically significant difference was found in sweet consumption, as non-diabetics were more likely to consume sweets once or several times a week (25%) compared to diabetics (12%). A highly significant difference was observed in soft drink consumption with 50% of diabetics consuming these beverages once or several times a month, compared to 73% of non-diabetics. No significant differences were found in the consumption of tea or coffee with sugar.

Table 9, Figure 14 & Figure 15 represents the perception of oral health showed significant differences between diabetics and non-diabetics. None of the diabetics had rated their teeth as good, when compared to non-diabetics (46%). Instead, 69% of diabetics had described their teeth as fair, and 31% had rated them as poor, compared to 43% and 11% of non-diabetics, respectively. A similar pattern was observed for gum health, with no diabetics considering their gums good, when compared to non-diabetics (16%). Additionally, a significantly higher proportion of diabetics (39%) rated their gums as poor compared to 8% of non-diabetics. No significant difference was found in the use of fluoride toothpaste between diabetics and non-diabetics. Most participants were unaware of their toothpaste's fluoride content (89% of diabetics, 71% of non-diabetics).

Table 10 presents the alcohol consumption patterns between diabetics and non-diabetics. Among diabetics, 39% reported not drinking alcohol, compared to 41% of non-diabetics. Additionally, 11% of diabetics and 9% of non-diabetics consumed less than one drink per day. A similar proportion of both groups reported drinking one drink per day, while 15% of diabetics and 11% of non-diabetics consumed two drinks per day. No statistically significant difference is seen between the groups.

Table 11 & Figure 16 illustrates the statistically significant difference in the frequency distribution of tobacco chewing habits among diabetics and non-diabetics. Daily tobacco chewing was reported more frequently among diabetics (11%) compared to non-diabetics (7%). Similarly, a higher proportion of diabetics consumed tobacco once or several times a week (49%) and once or several times a month (31%) compared to non-diabetics (29% and 17%), respectively. However, fewer diabetics (9%) reported never or seldom using tobacco compared to non-diabetics (47%).

Table 12 & Figure 17 findings indicate significant differences in treatment needs between diabetics and non-diabetics. Diabetics (0%) had required no treatment, whereas 17% of non-diabetics had. A higher proportion of diabetics (41%) required immediate treatment compared to only 9% of non-diabetics. Similarly, 39% of diabetics needed a comprehensive evaluation, whereas only 1% of non-diabetics fell into this category. Preventive or routine treatment was more common among non-diabetics (57%) than diabetics (5%).

Table 13 presents the association between oral health conditions and BMI among diabetic and non-diabetic participants using binomial logistic regression. Among diabetics, individuals with higher BMI >25 were 4.81 times more likely to have dental caries compared to those with normal BMI ≤ 25 (95% CI: 1.61–14.36; p = 0.005), while in non-diabetics, those with higher BMI had 3.12 times higher odds of developing dental caries (95% CI: 1.37–7.11; p = 0.007). Similarly, diabetics with higher BMI had 4.38 times greater odds of experiencing gingival bleeding (95% CI: 1.44–13.32; p = 0.009), and non-diabetics had 2.78 times higher odds (95% CI: 1.23–6.30; p = 0.014). Higher BMI also significantly increased the likelihood of periodontal pocket depth in diabetics (OR = 3.32; 95% CI: 1.14–9.72; p = 0.028) and non-diabetics (OR = 2.67; 95% CI: 1.14–6.25; p = 0.034). For loss of attachment,

diabetics with higher BMI had 3.24 times the odds (95% CI: 1.09–9.64; p = 0.035), and non-diabetics had 2.45 times the odds (95% CI: 1.01–5.93; p = 0.046). Tooth loss was most strongly associated with higher BMI, with diabetics showing 5.26 times the odds (95% CI: 1.68–16.48; p = 0.004) and non-diabetics 3.01 times the odds (95% CI: 1.23–7.36; p = 0.016). These findings indicate that individuals with higher BMI have significantly increased chances of developing various oral health problems, especially among those with diabetes.

Table 14 represents the spearman correlation analysis between BMI and oral health status among both diabetics and non-diabetics. Among diabetics, significant positive correlation is obtained between BMI and dental caries (r = 0.297), gingival bleeding (r = 0.274), periodontal pocket depth (r = 0.227), loss of attachment (r=0.238) and tooth loss (r = 0.304), Similarly, among non-diabetics also significant positive correlation is obtained between BMI and dental caries (r = 0.275), gingival bleeding (r = 0.247), periodontal pocket depth (r = 0.224), loss of attachment (r=0.202) and tooth loss (r = 0.246), indicating that higher BMI is associated with poorer oral health outcomes among both the groups.

Table 1: Demographic distribution of study participants

Variable	Diabetics n (%)	Non- Diabetics n (%)	*p*-value
Age			
30-39 years	5 (5.0%)	5 (5.0%)	
40-49 years	50 (50.0%)	50 (50.0%)	1.000
50-59 years	45 (45.0%)	45 (45.0%)	
Gender			
Male	54 (54.0%)	54 (54.0%)	1.000
Female	46 (46.0%)	46 (46.0%)	
Socioeconomic status			
Lower class	0 (0.0%)	0 (0.0%)	
Upper lower class	18 (18.0%)	19 (19.0%)	
Lower middle class	46 (46.0%)	45 (45.0%)	0.981
Upper middle class	36 (36.0%)	36 (36.0%)	
Upper class	0 (0.0%)	0 (0.0%)	
Body Mass Index (BMI)			
Underweight (BMI < 18.5)	0 (0.0%)	0 (0.0%)	
Normal weight (BMI ≥ 18.5 to 24.9)	17 (17.0%)	57 (57.0%)	
Overweight (BMI 25 to 29.9)	81 (81.0%)	43 (43.0%)	<0.001*
Obese (BMI ≥ 30)	2 (2.0%)	0 (0.0%)	
Total	100 (100.0%)	100 (100.0%)	

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *p ≤ 0.05 indicates statistically* significant.

Table 2: Distribution of cases according to diabetes history

Variable	Diabetics n (%)
Duration of diabetes	
2-3 years	64 (64.0%)
4-5 years	29 (29.0%)
>5 years	7 (7.0%)
Family history of diabetes	
Yes	74 (74.0%)
No	26 (26.0%)
Total	100 (100.0%)

All values are expressed as frequency with percentages (in parentheses).

Table 3: Comparison of mean dentition status among diabetic and non-diabetic study participants

Variables	Diabetics Mean ± SD	Non diabetics Mean ± SD	Z value	*p*-value
Decayed, missing and filled teeth and mean DMFT status				
DT	3.59 ± 2.37	1.44 ± 1.87	-6.01	<0.001*
MT	4.01 ± 3.32	1.33 ± 2.23	-6.01	<0.001*
FT	1.13 ± 0.80	0.46 ± 0.50	-6.04	<0.001*
DMFT	8.73 ± 4.03	3.23 ± 3.88	-8.16	<0.001*
Periodontal pocket depth				
4-5 mm	5.57 ± 1.13	1.40 ± 0.50	-7.39	<0.001*
6 mm or more	3.95 ± 1.40	0.83 ± 0.98	-3.96	<0.001*
Loss of attachment				
0-3 mm	2.26 ± 0.86	1.19 ± 0.60	-4.37	<0.001*
4-5 mm	1.47 ± 0.51	0.75 ± 0.96	-1.67	0.039*
6-8 mm	1.17 ± 0.98	0.14 ± 0.35	-2.20	0.028*
9-11 mm	0.71 ± 0.95	0.12 ± 0.38	-1.38	0.199
12 mm or more	0.43 ± 0.79	0.11 ± 0.32	-0.71	0.620

DMF Decayed, Missing and Filled teeth; DT- Decayed Teeth; MT- Missing Teeth; FT- Filled teeth; SD- Standard deviation; All values are expressed as mean ± SD; Statistical test applied: Mann-Whitney U test; Level of significance: p value ≤ 0.05 is considered statistically significant.*

Table 4: Comparison of oral health status and BMI among diabetics and non-diabetics

Variables	Diabetics		X^2 value	*p*-value	Non-diabetics		X^2 value	*p*-value
	BMI < 25 n (%)	BMI ≥ 25 n (%)			BMI < 25 n (%)	BMI ≥ 25 n (%)		
Dental caries								
Present	7 (7.0%)	64 (64.0%)	8.848	0.003*	20 (20.0%)	27 (27.0%)		
Absent	10 (10.0%)	19 (19.0%)			37 (37.0%)	16 (16.0%)	7.551	0.006*
Gingival bleeding								
Present	9 (9.0%)	69 (69.0%)	7.495	0.006*	19 (19.0%)	25 (25.0%)	6.121	0.013*
Absent	8 (8.0%)	14 (14.0%)			38 (38.0%)	18 (18.0%)		
Periodontal Pocket Depth (PPD)								
Present	8 (8.0%)	62 (62.0%)	5.133	0.023*	14 (14.0%)	20 (20.0%)		
Absent	9 (9.0%)	21 (21.0%)			43 (43.0%)	23 (23.0%)	5.263	0.022*
Loss of Attachment (LOA)								
Present	6 (6.0%)	53 (53.0%)	4.758	0.029*	12 (12.0%)	17 (17.0%)		
Absent	11 (11.0%)	30 (30.0%)			45 (45.0%)	26 (26.0%)	4.066	0.044*
Tooth loss								
Present	5 (5.0%)	57 (57.0%)	9.232	0.002*	11 (11.0%)	18 (18.0%)		
Absent	12 (12.0%)	26 (26.0%)			46 (46.0%)	25 (25.0%)	6.060	0.014*

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 5: Comparison of various oral health related problems among diabetics and non-diabetics

Variables	Diabetics n (%)	Non diabetics n (%)	X^2 value	*p*-value
Mouth dryness				
Present	74 (74.0%)	24 (24.0%)	50.020	<0.001*
Absent	26 (26.0%)	76 (76.0%)		
Delayed healing				
Present	56 (56.0%)	23 (23.0%)	22.785	<0.001*
Absent	44 (44.0%)	77 (77.0%)		
Bleeding on brushing				
Present	62 (62.0%)	34 (34.0%)	15.705	<0.001*
Absent	38 (38.0%)	66 (66.0%)		
Mouth ulcers				
Present	35 (35.0%)	6 (6.0%)	25.802	0.002*
Absent	65 (65.0%)	94 (94.0%)		
Bad breath				
Present	60 (60.0%)	25 (25.0%)	12.531	<0.001*
Absent	40 (40.0%)	75 (75.0%)		
Swollen gums				
Present	47 (47.0%)	13 (13.0%)	12.659	<0.001*
Absent	53 (53.0%)	87 (87.0%)		
Loose teeth				
Present	61 (61.0%)	29 (29.0%)	20.687	<0.001*
Absent	39 (39.0%)	71 (71.0%)		
Taste problems				
Present	54 (54.0%)	9 (9.0%)	46.924	<0.001*
Absent	46 (46.0%)	91 (91.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *p ≤ 0.05 indicates statistically* significant.

Table 6: Comparison of brushing habit and mode of teeth cleaning among diabetics and non-diabetics

Variables	**Diabetics n (%)**	**Non diabetics n (%)**	**X^2 value**	***p*-value**
Brushing habit				
Once daily	86 (86.0%)	85 (85.0%)	0.040	0.841
Twice daily	14 (14.0%)	15 (15.0%)		
Mode of teeth cleaning				
Finger/chewstick	23 (23.0%)	19 (19.0%)	0.482	0.487
Toothbrush	77 (77.0%)	81 (81.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 7: Comparison of last dental visit and reasons for dental visit among diabetics and non-diabetics

Variables	Diabetics n (%)	Non diabetics n (%)	X^2 value	*p*-value
Last dental visit				
< 6 months	18 (18.0%)	20 (20.0%)		
6-12 months	25 (25.0%)	17 (17.0%)		
>1 years and < 2years	21 (21.0%)	6 (6.0%)	6.357	0.273
>2 years and < 5 years	7 (7.0%)	6 (6.0%)		
>5 years	9 (9.0%)	17 (17.0%)		
Never received dental care	20 (20.0%)	34 (34.0%)		
Reasons for dental visit				
Consultation/advice	6 (6.0%)	7 (7.0%)		
Pain/Trouble	35 (35.0%)	19 (19.0%)		
Treatment/follow-up	19 (19.0%)	9 (9.0%)	12.238	0.016*
Routine checkup	8 (8.0%)	17 (17.0%)		
Don't remember/Never visited	32 (32.0%)	48 (48.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 8: Comparison of food containing sugar among diabetics and non-diabetics

Food containing sugar	Diabetics	Non diabetics	X^2 value	*p*-value
	n (%)	n (%)		
Fresh fruit				
Everyday	5 (5.0%)	2 (2.0%)	1.713	0.425
Once / several times a week	17 (17.0%)	21 (21.0%)		
Once / several times a month	78 (78.0%)	77 (77.0%)		
Never / seldom	0 (0.0%)	0 (0.0%)		
Biscuits, cakes, cream cakes				
Everyday	0 (0.0%)	0 (0.0%)	1.776	0.412
Once / several times a week	8 (8.0%)	12 (12.0%)		
Once / several times a month	70 (70.0%)	72 (72.0%)		
Never / seldom	22 (22.0%)	16 (16.0%)		
Jam or honey				
Everyday	0 (0.0%)	0 (0.0%)	1.268	0.530
Once / several times a week	6 (6.0%)	8 (8.0%)		
Once / several times a month	16 (16.0%)	11 (11.0%)		
Never / seldom	78 (78.0%)	81 (81.0%)		
Chewing gum containing sugar				
Everyday	0 (0.0%)	0 (0.0%)	0.741	0.389
Once / several times a week	0 (0.0%)	0 (0.0%)		
Once / several times a month	19 (19.0%)	24 (24.0%)		
Never / seldom	81 (81.0%)	76 (76.0%)		
Sweets/candy				
Everyday	0 (0.0%)	0 (0.0%)	5.817	0.050*
Once / several times a week	12 (12.0%)	25 (25.0%)		
Once / several times a month	69 (69.0%)	61 (61.0%)		
Never / seldom	19 (19.0%)	14 (14.0%)		
Lemonade, Coca Cola or other soft drinks				
Everyday	0 (0.0%)	0 (0.0%)	21.669	<0.001*
Once / several times a week	9 (9.0%)	15 (15.0%)		
Once / several times a month	50 (50.0%)	73 (73.0%)		
Never / seldom	41 (41.0%)	12 (12.0%)		
Tea with sugar				
Everyday	5 (5.0%)	9 (9.0%)	5.026	0.170
Once / several times a week	26 (26.0%)	31 (31.0%)		
Once / several times a month	56 (56.0%)	41 (41.0%)		
Never / seldom	13 (13.0%)	19 (19.0%)		
Coffee with sugar				
Everyday	4 (4.0%)	8 (8.0%)	3.086	0.379
Once / several times a week	27 (27.0%)	28 (28.0%)		
Once / several times a month	54 (54.0%)	44 (44.0%)		
Never / seldom	15 (15.0%)	20 (20.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 9: Frequency distribution of perception of teeth and gums and knowledge on the presence of fluoride in their toothpaste among diabetics and non-diabetics

Questions	**Diabetics** n (%)	**Non diabetics** n (%)	**X^2 value**	***p*-value**
How would you describe the state of your teeth?				
Good	0 (0.0%)	46 (46.0%)		
Fair	69 (69.0%)	43 (43.0%)	61.560	<0.001*
Poor	31 (31.0%)	11 (11.0%)		
How would you describe the state of your gums?				
Good	0 (0.0%)	16 (16.0%)		
Fair	61 (61.0%)	76 (76.0%)	38.089	<0.001*
Poor	39 (39.0%)	8 (8.0%)		
Do you use a toothpaste that contains fluoride?				
Yes	2 (2.0%)	3 (3.0%)		
No	9 (9.0%)	18 (18.0%)	1.256	0.099
I don't know	89 (89.0%)	79 (79.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 10: Comparison of alcohol consumption among diabetics and non-diabetics

Alcohol consumption	Diabetics n (%)	Non diabetics n (%)	X^2 value	*p*-value
Did not drink	39 (39.0%)	41 (41.0%)		
Less than one drink/day	11 (11.0%)	9 (9.0%)	1.082	0.782
One drink/day	35 (35.0%)	39 (39.0%)		
Two drinks / day	15 (15.0%)	11 (11.0%)		
Total	100 (100.0%)	100 (100.0%)		

All values are expressed as frequency with percentages (in parentheses).
*Statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 11: Comparison of tobacco chewing habit among diabetics and non-diabetics

Tobacco chewing habit	Diabetics n (%)	Non diabetics n (%)	X^2 value	*p*-value
Everyday	11 (11.0%)	7 (7.0%)		
Once / several times a week	49 (49.0%)	29 (29.0%)		
Once / several times a month	31 (31.0%)	17 (17.0%)	35.886	<0.001*
Never / seldom	9 (9.0%)	47 (47.0%)		
Total	100 (100.0%)	100 (100.0%)		

All values are expressed as frequency with percentages (in parentheses).
*The statistical test applied: Chi- Square Test; *P ≤ 0.05 indicates statistically* significant.

Table 12: Comparison of treatment needs among diabetics and non-diabetic study particip

Treatment needs	Diabetics n (%)	Non diabetics n (%)	X^2 value	*p*-value
No treatment	0 (0.0%)	17 (17.0%)		
Preventive/routine treatment	5 (5.0%)	57 (57.0%)		
Prompt treatment	15 (15.0%)	16 (16.0%)	117.225	<0.001*
Immediate treatment	41 (41.0%)	9 (9.0%)		
Referred for comprehensive evaluation	39 (39.0%)	1 (1.0%)		
Total	100 (100.0%)	100 (100.0%)		

*All values are expressed as frequency with percentages (in parentheses). The statistical test applied: Chi- Square Test; *p ≤ 0.05 indicates statistically* significant.

Table 13: Association between oral health status and Body Mass Index (BMI) among study groups

Variables	Diabetics		Non-Diabetics	
	Odds ratio (95% CI)	***p*-value**	**Odds ratio (95% CI)**	***p*-value**
Reference category: BMI < 25				
Dental caries				
Absent	1 (ref)		1 (ref)	
Present	4.81 (1.61-14.36)	0.005*	3.12 (1.37-7.11)	0.007*
Gingival bleeding				
Absent	1 (ref)		1 (ref)	
Present	4.38 (1.44-13.32)	0.009*	2.78 (1.23-6.30)	0.014*
Periodontal Pocket Depth				
Absent	1 (ref)		1 (ref)	
Present	3.32 (1.14-9.72)	0.028*	2.67 (1.14-6.25)	0.034*
Loss of attachment				
Absent	1 (ref)		1 (ref)	
Present	3.24 (1.09-9.64)	0.035*	2.45 (1.01-5.93)	0.046*
Tooth loss				
Absent	1 (ref)		1 (ref)	
Present	5.26 (1.68-16.48)	0.004*	3.01 (1.23-7.36)	0.016*

*CI — confidence interval; The statistical analysis used: binomial logistic regression; level of significance: *p ≤ 0.05 is considered statistically significant.*

Table 14: Correlation of BMI with oral health status among diabetics and non-diabetics

Parameters	**Body Mass Index (BMI)**	
Diabetics	**rho**	***p*-value**
Dental caries	0.297	0.003*
Gingival bleeding	0.274	0.006*
Periodontal pocket depth	0.227	0.023*
Loss of attachment	0.238	0.029*
Tooth loss	0.304	0.002*
Non-Diabetics	**rho**	***p*-value**
Dental caries	0.275	0.006*
Gingival bleeding	0.247	0.013*
Periodontal pocket depth	0.224	0.022*
Loss of attachment	0.202	0.044*
Tooth loss	0.246	0.014*

*The statistical test used: Spearman correlation coefficient; *p- value ≤0.05 considered as statistically significant.*

Figure 1: Demographic distribution of study participants according to gender and age

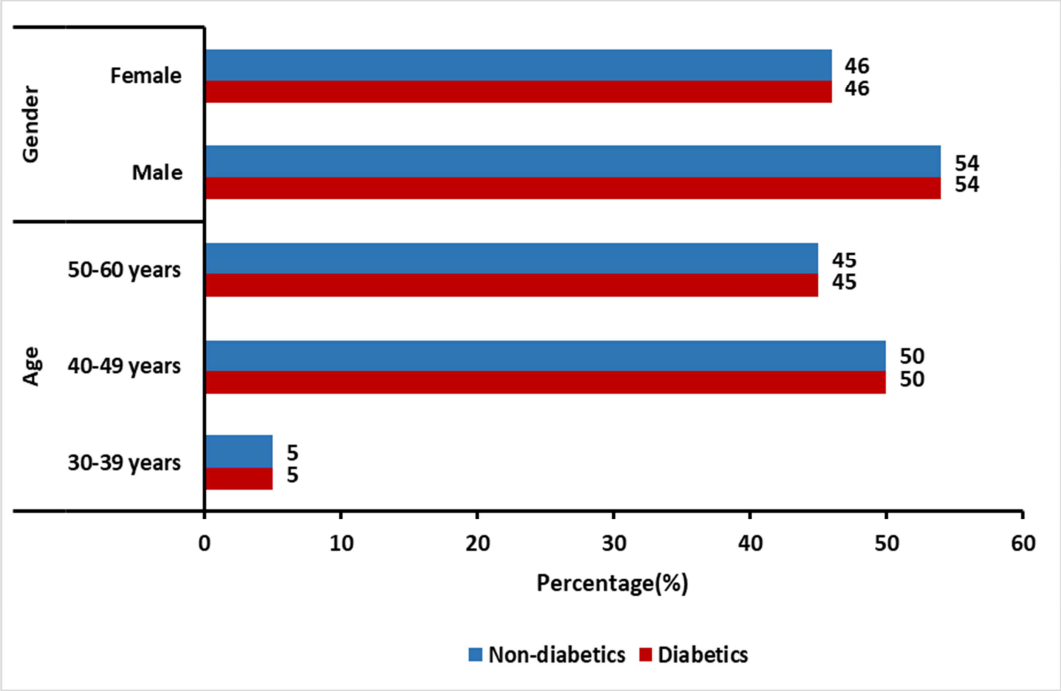


Figure 2: Demographic distribution of study participants according to socioeconomic status

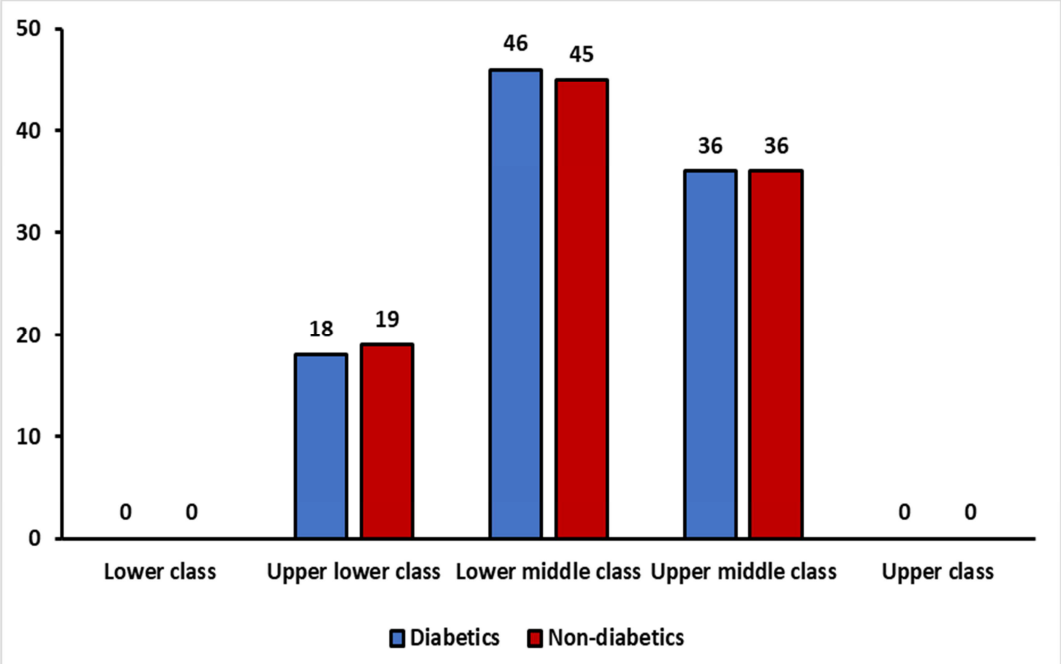


Figure 3: Distribution of BMI according to the study groups

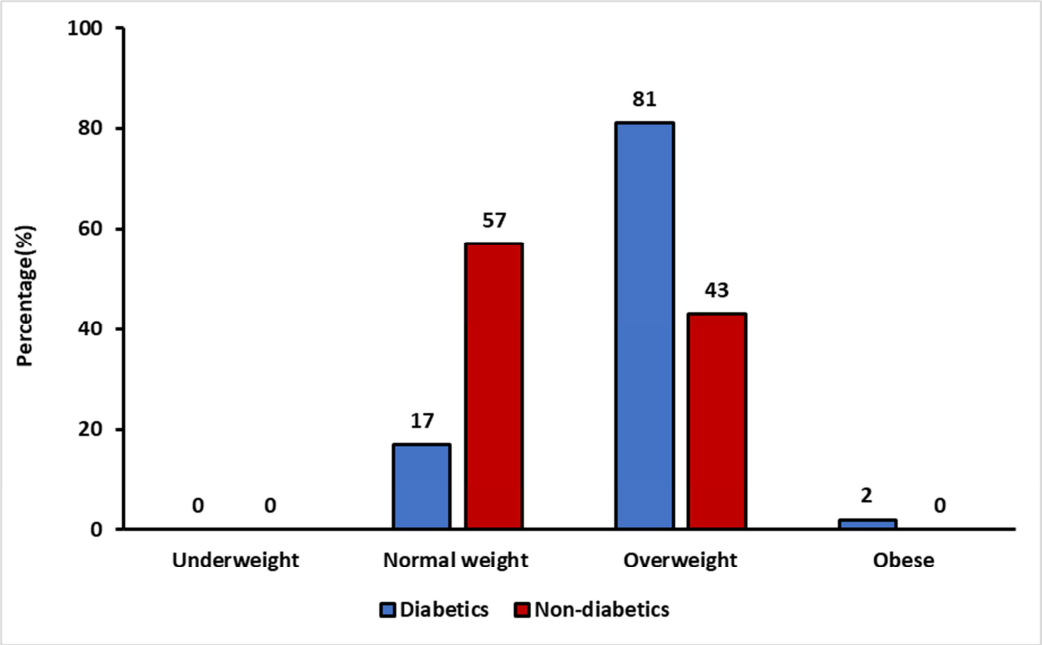


Figure 4: Distribution of diabetics' duration

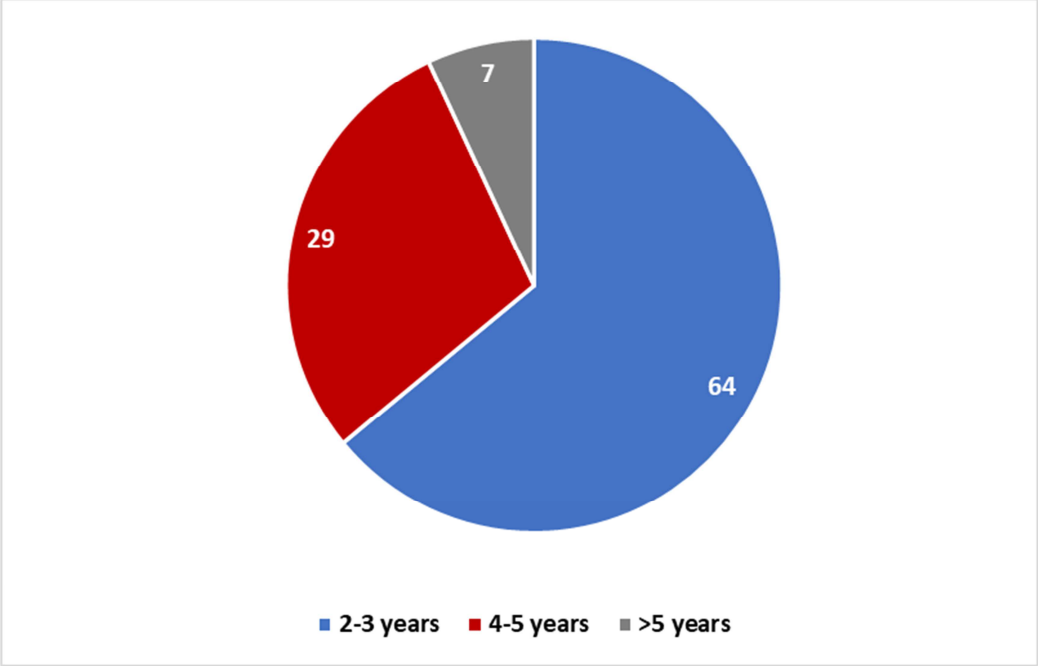


Figure 5: Distribution of cases according to the presence of family history of diabetics

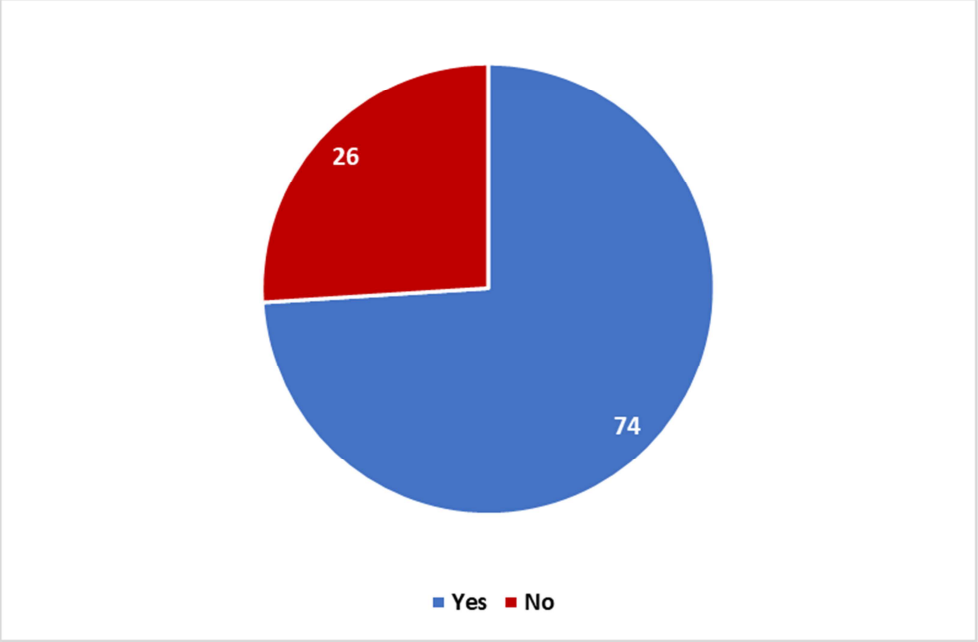


Figure 6: Distribution of mean DT, MT, FT and DMFT according to the study groups

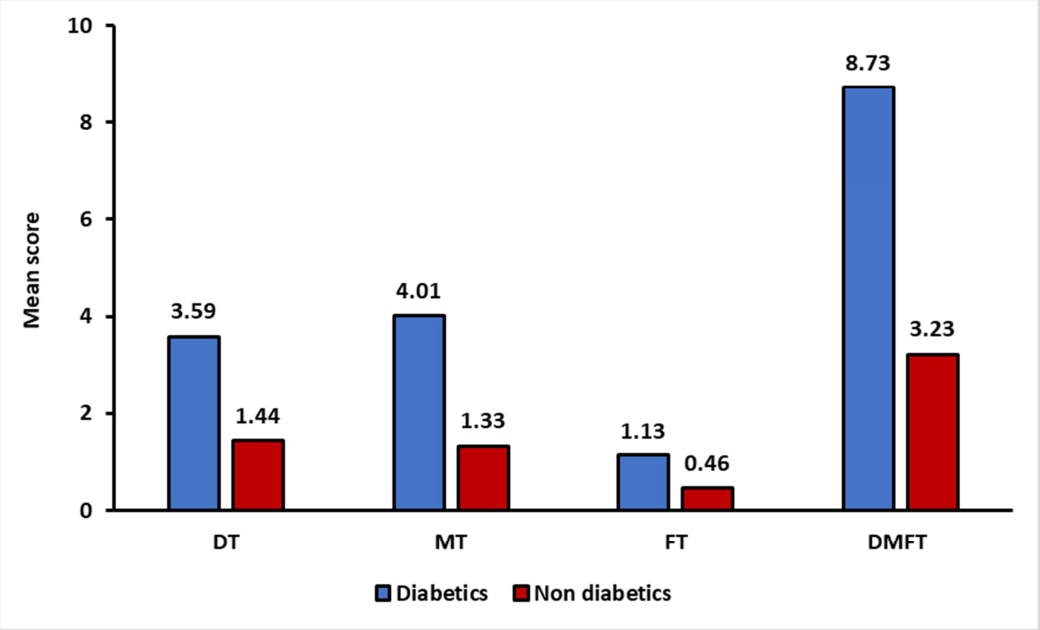


Figure 7: Distribution of mean periodontal pocket depth according to the study groups

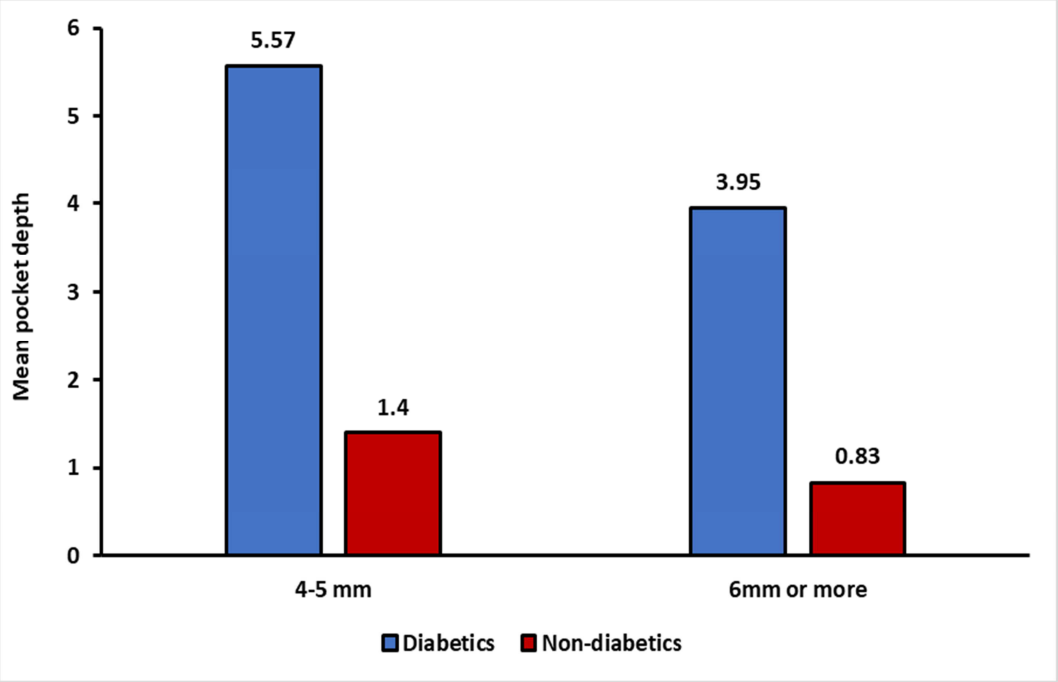


Figure 8: Distribution of mean loss of attachment according to the study groups

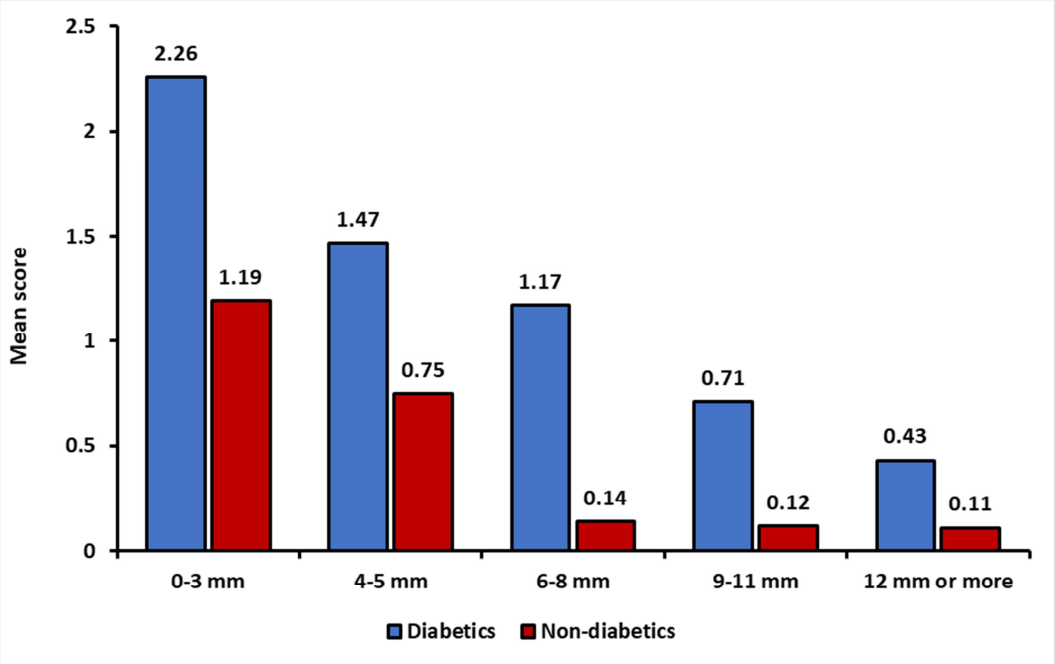


Figure 9: Distribution of oral health related problems according to the study groups

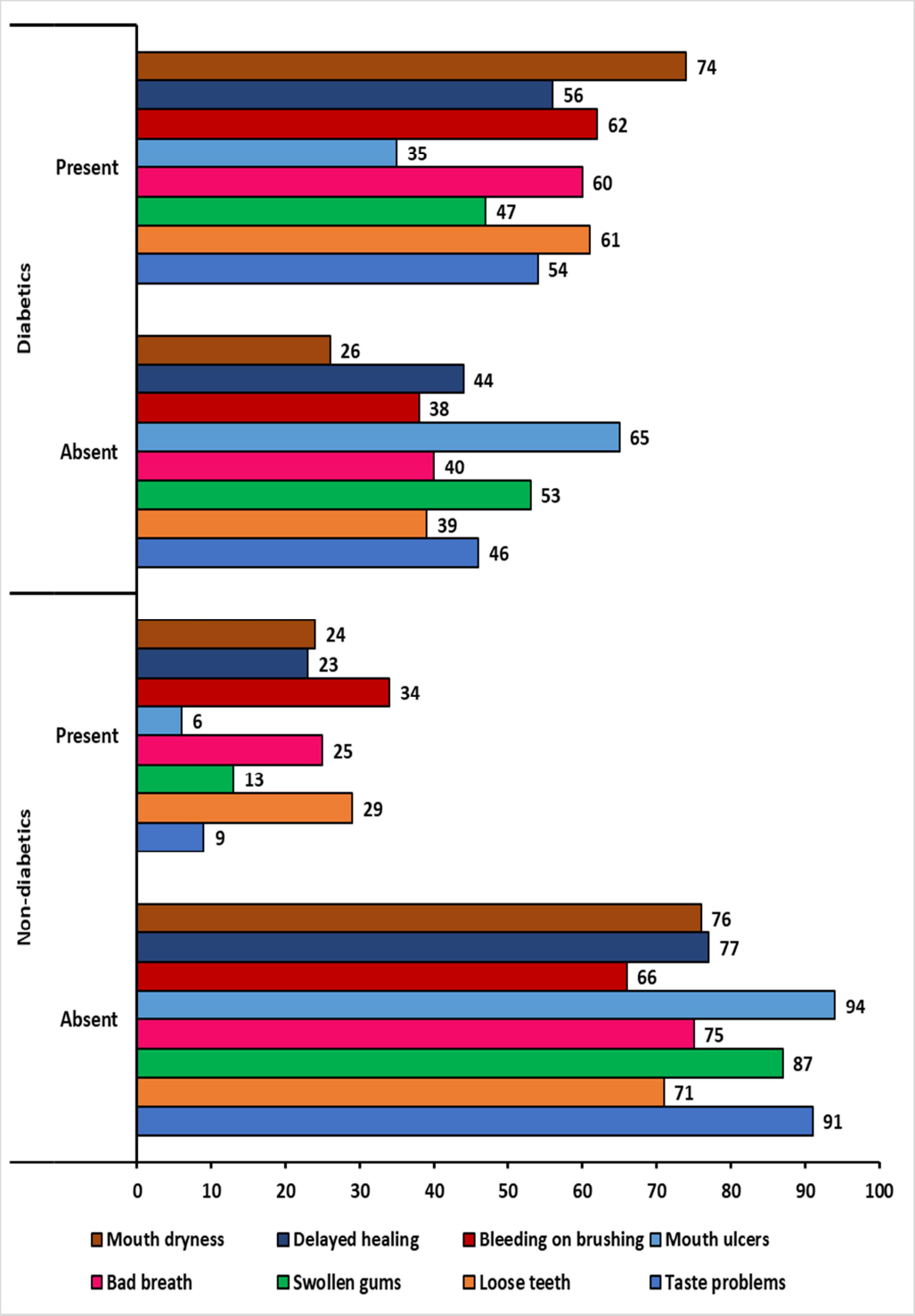


Figure 10: Distribution of frequency of tooth brushing according to the study groups

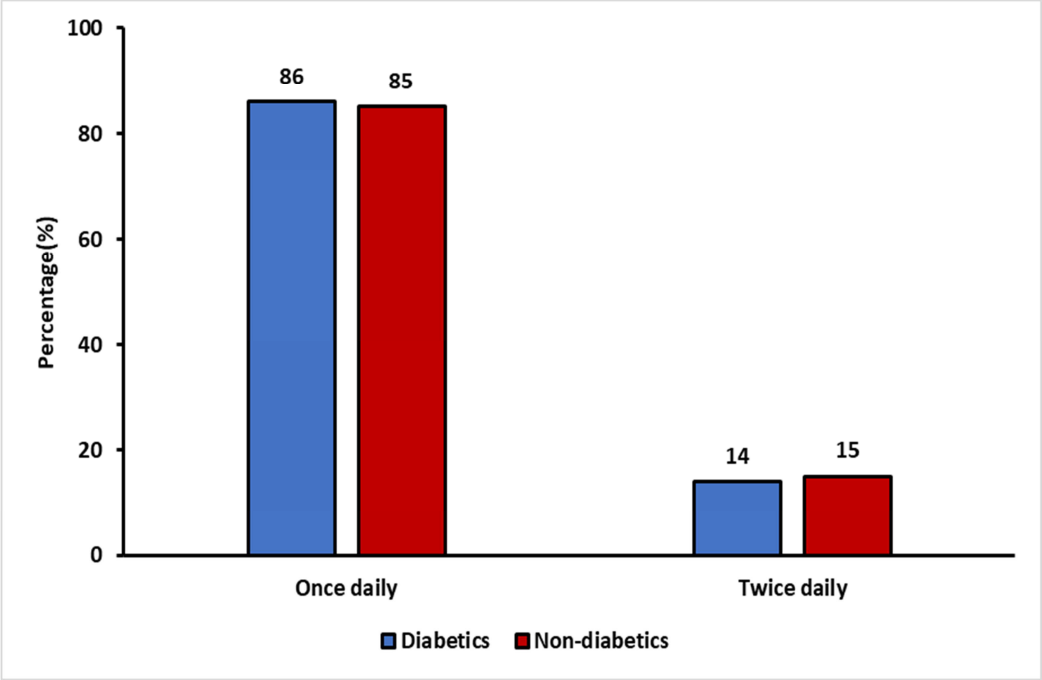


Figure 11: Distribution of mode of teeth cleaning according to the study groups

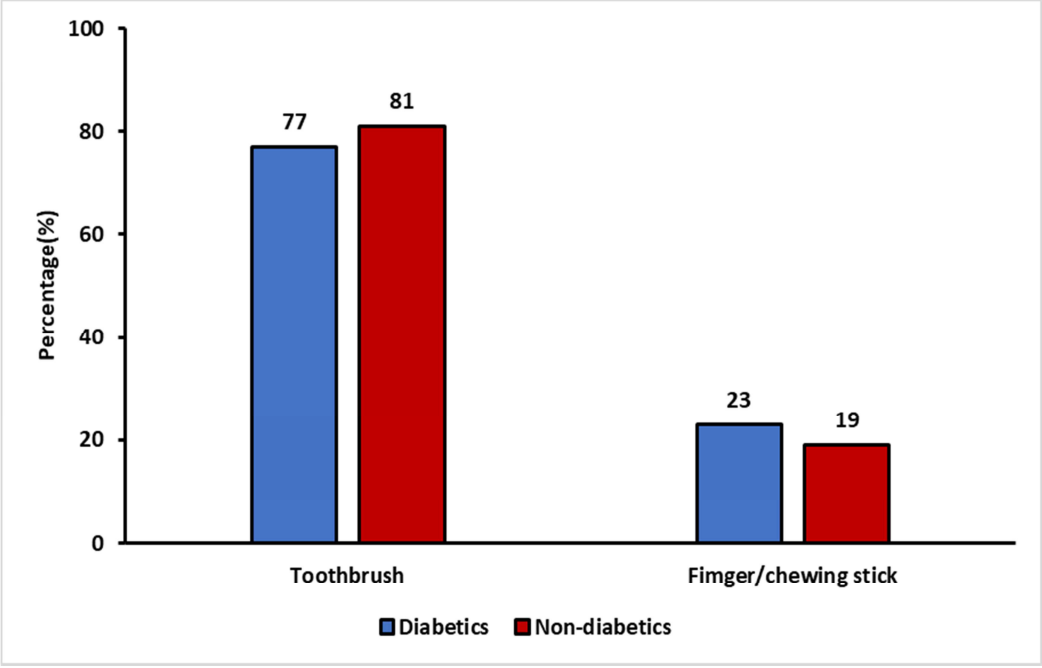


Figure 12: Distribution of last dental visit according to the study groups

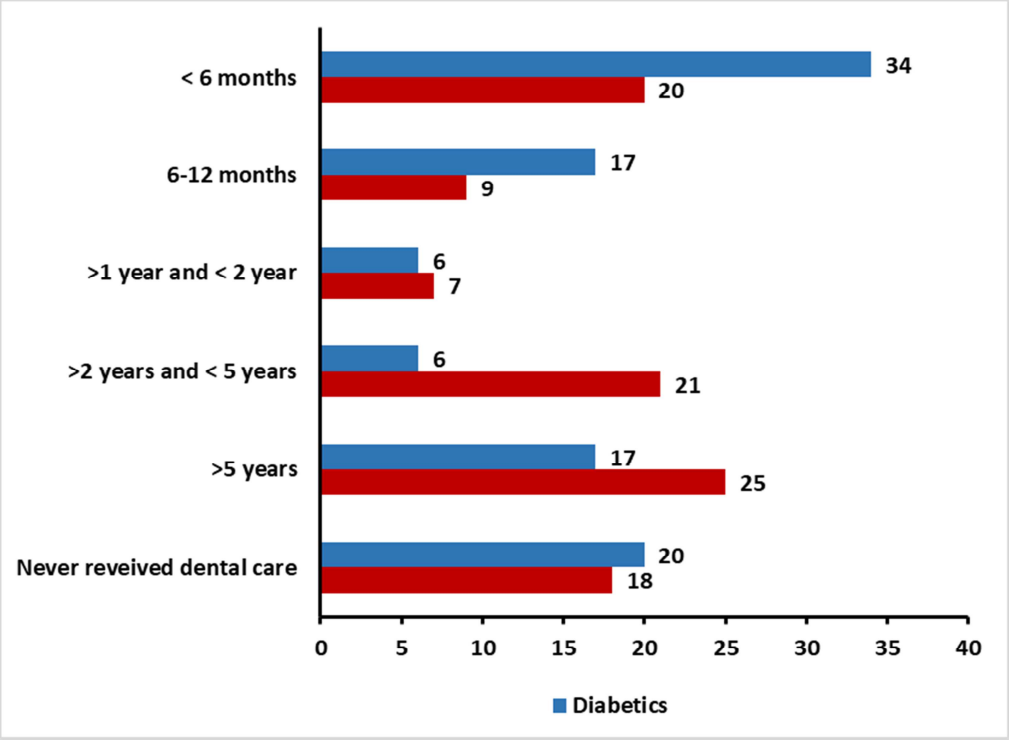


Figure 13: Distribution of reason for dental visit according to the study groups

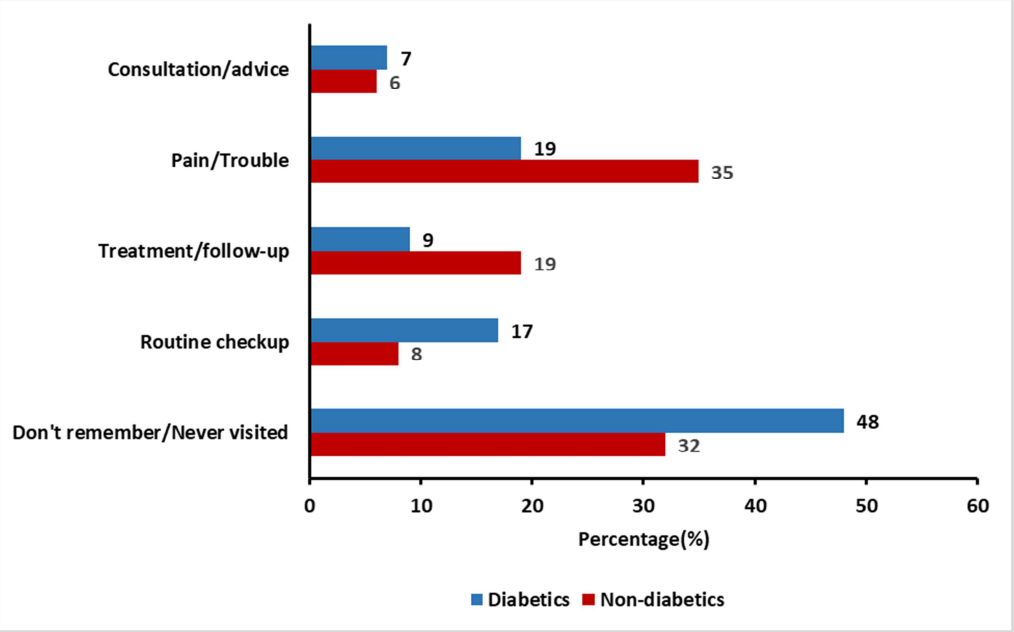


Figure 14: How would you describe the state of your teeth?

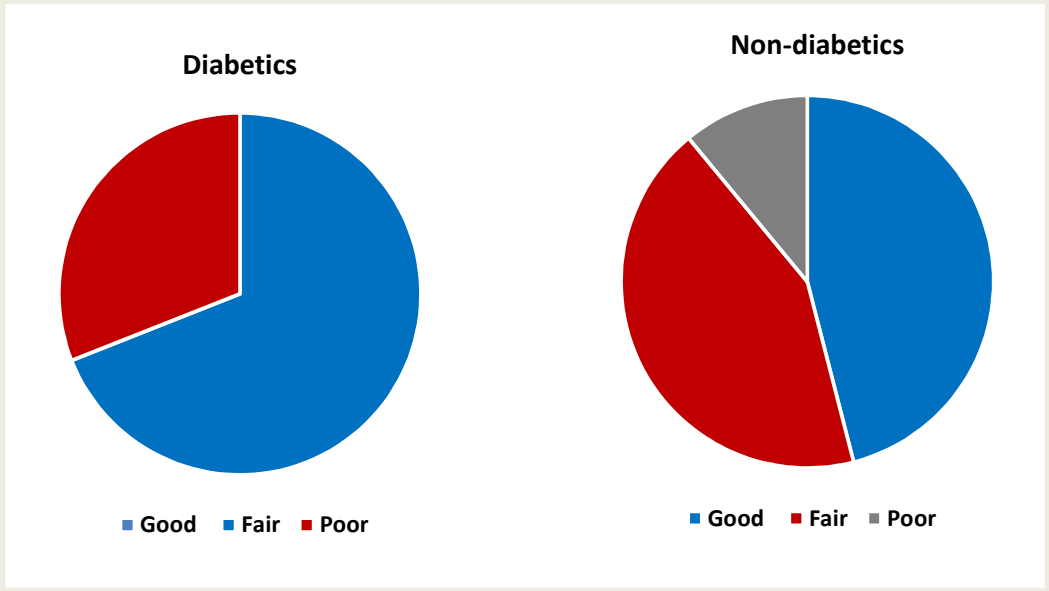


Figure 15: Do you use a toothpaste that contains fluoride?

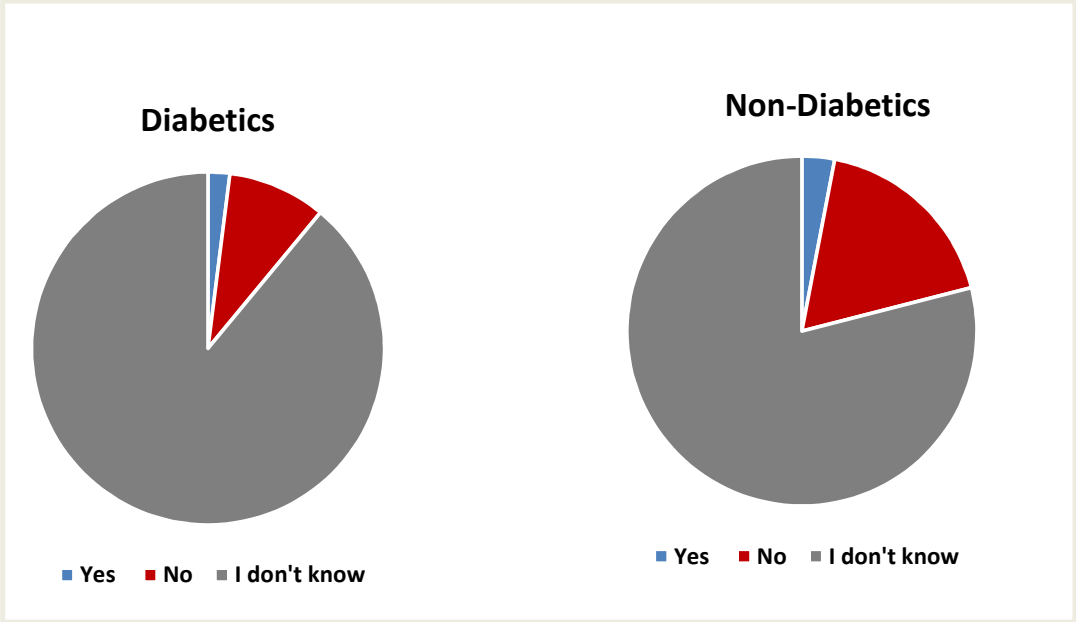


Figure 16: Distribution of tobacco chewing habit according to the study groups

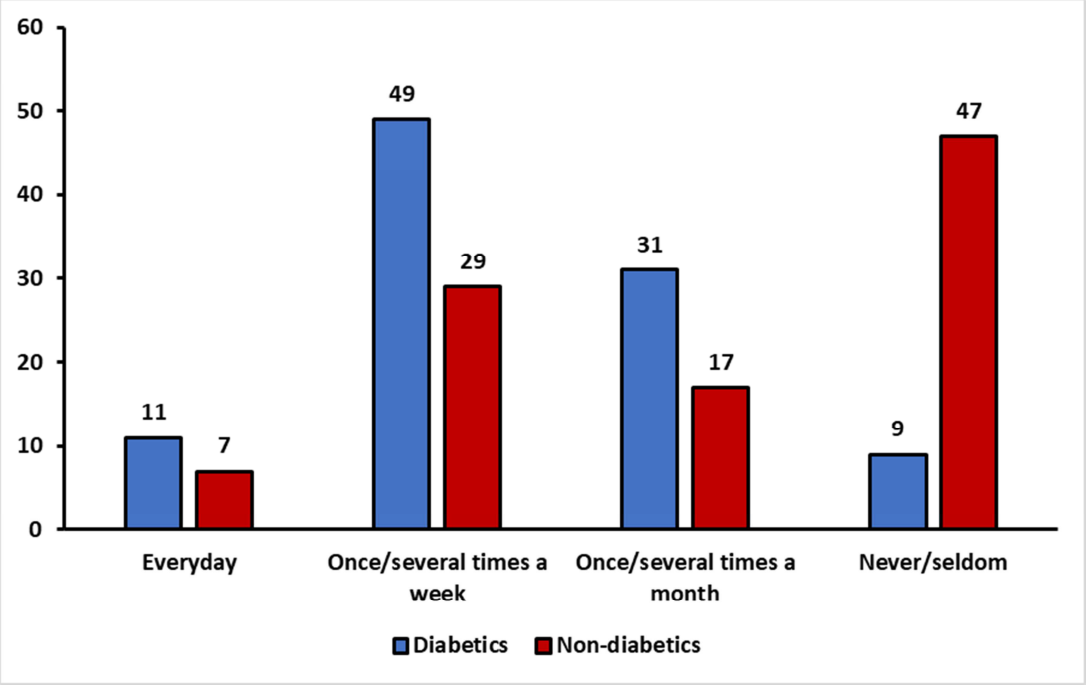
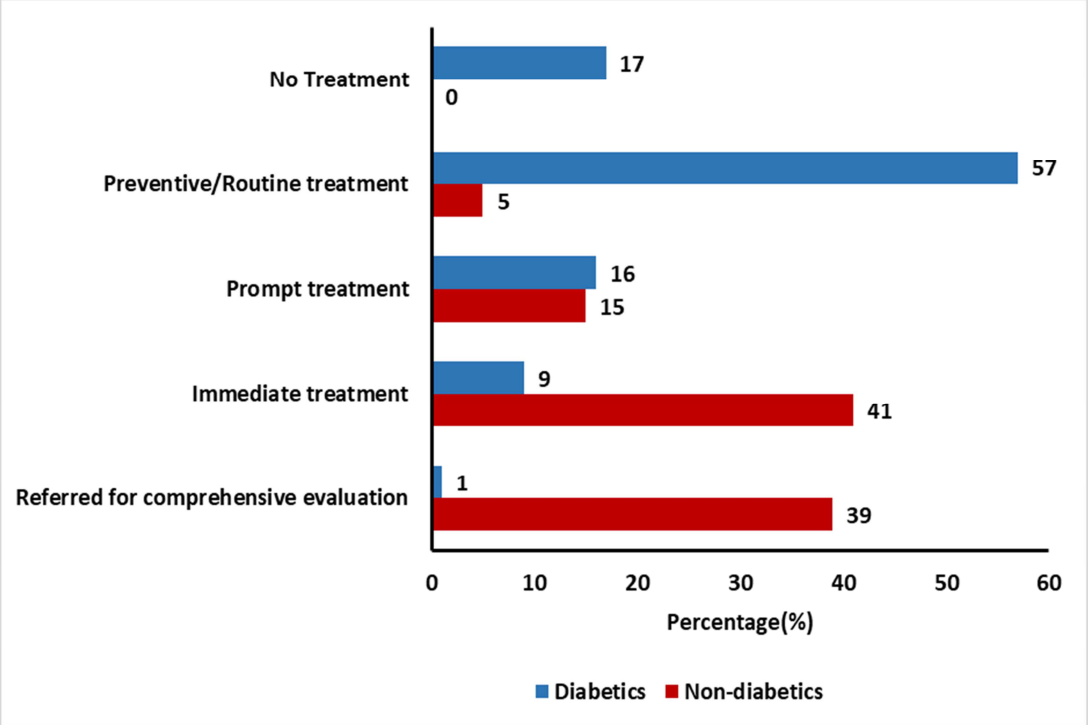


Figure 17: Distribution of treatment needs according to the study groups



DISCUSSION

The growing global burden of T2DM and obesity has made it crucial to explore their impact on various health parameters, including oral health. While previous studies have extensively examined the link between diabetes and oral health, as well as the link between BMI and diabetes, limited research has focused on how BMI influences oral health status in both diabetic and non-diabetic individuals. Given the rising prevalence of obesity and diabetes worldwide, understanding these interconnections is essential for developing comprehensive healthcare strategies. Hence, the current study was undertaken to evaluate the relationship between oral health status and BMI among diabetic and non-diabetic individuals.

General demographics

The higher prevalence of both T2DM and oral diseases is commonly observed among individuals aged 40–59 years, which aligns with the age distribution of participants in the present study.[39] Additionally, no significant differences were found across socioeconomic status (SES) groups in this study. However, SES remains an important factor in health disparities, as individuals from lower SES backgrounds may have limited access to healthcare services, including dental care, and are more vulnerable to chronic conditions due to lifestyle and dietary factors.[40,41]

The present study compared the oral health outcomes across similar socioeconomic distribution which supports the more reliable comparison between diabetics and non-diabetics. Most of the surveyed diabetics participants were obese as compared to non-diabetics which could be due to sedentary lifestyle and physical inactivity [42,43] Similar study findings reported that a higher BMI emerged as an independent risk factor for an increased risk of T2DM, confirming a positive causal

link.[13] Most diabetic participants had a relatively two to three years of history of diabetes and a strong familial predilection was seen which is consistent with evidence highlighting the hereditary nature of T2DM.[44]

Oral health status with BMI among diabetics and non-diabetics

The current investigation found a higher prevalence of oral diseases among the participants with higher BMI, in both diabetic and non-diabetic group. This may be attributed to the role of adipose tissue, which releases the pro-inflammatory adipokines such as TNF-α, IL-6, and IL-8 particularly in obesity. Obesity, often driven by poor diet and possibly linked to microbial imbalances, contributes to systemic inflammation and insulin resistance. These factors are associated with chronic conditions like diabetes and may explains the observed association between obesity and poor oral health, though the exact mechanisms remain under investigation.[16]

The mean DMFT scores was found to be more among diabetics as compared to non-diabetics. These findings are consistent with studies reported by Das *et al*.,[17]Singh *et al*.,[18] Taylor *et al*.,[45] Kanjirath *et al*.,[46] whereas they contradict the findings reported by Hawraa [47] and Gupta et al., [48] A majority of diabetics with higher BMI had a notably higher prevalence of dental caries than non-diabetics. These findings are in alignment with similar studies conducted by Aguilar et al., [49] Malvania et al.,[19] Rawal *et al*.,[10] and Issrani et al.,[15] as diabetes is linked to reduced salivary gland function and elevated levels of glucose in both blood and saliva, creating a favorable environment for oral bacterial growth. thereby increasing the risk of developing dental caries.[20,50,51] The present study has established a positive correlation between BMI and dental caries among both diabetics and non-diabetics. Similar

findings have been reported in other studies, which also showed that an increase in BMI is associated with an increase in dental caries.[52,53,54]

The present study found a higher prevalence of gingival bleeding, increased periodontal pocket depth, and greater loss of attachment among diabetics with elevated BMI compared to non-diabetics. This may be attributed to obesity-related inflammation, as adipose tissue produces pro-inflammatory cytokines which impair immune function in periodontal tissues. TNF-α also promotes fibroblast and osteoclast activity, leading to tissue breakdown and bone loss. Additionally, PAI-1 levels in obesity may reduce blood flow by thickening blood vessels, further aggravating periodontal disease.[55,56] The mean pocket depth and attachment loss were also higher among diabetics, consistent with findings from Das et al.[17] Singh et al.[57] and Khalifa et al.,[21] Previous literature have shown that occurence of periodontal disease is more severe in diabetic individuals due to altered immune responses.[58,59,60] The presence of periodontal pathogens in the bloodstream can elevate acute-phase proteins and oxidative stress markers. Furthermore, interactions between AGEs and their receptors, along with oxidative stress pathways, are believed to link diabetes with the progression of periodontitis.[61] The odds ratio of a diabetic with elevated BMI exhibiting periodontal destruction is higher compared to a non-diabetic. Similar studies have reported that diabetics have greater odds of developing periodontal disease than non-diabetics. [22,62,9] These findings reinforce the existing evidence that diabetes is a key risk factor for periodontal disease.

The present study findings indicate a higher prevalence and a positive correlation of tooth loss among diabetics with elevated BMI compared to non-diabetics.[15] Dental caries and periodontal disease are major contributors to tooth loss.[63,64] Studies have shown that obesity may influence periodontal health by altering

the oral microbiome. Research from the Forsyth Institute identified *Tannerella forsythia*, a known periodontal pathogen, as being more prevalent in obese individuals, suggesting obesity-related metabolic changes can disrupt microbial balance.[65] Additionally, Chitsazi et al. reported a strong association between obesity and elevated C-reactive protein an inflammatory marker produced by the liver, rises in response to periodontitis caused by gram-negative bacteria such as *P. gingivalis* and *T. forsythia*.[66] These factors collectively contribute to the severity of periodontal disease, ultimately leading to tooth loss.[23]

Oral health related issues in diabetics and non-diabetics

The perception of dryness of the mouth (xerostomia) is one of the typical symptoms in T2DM patients. [67] It happens because excess glucose is converted into sorbitol, which destroys nerve cells and interferes with normal functioning of salivary glands. [68] Xerostomia was also seen to be higher in the diabetics than in the non-diabetics in this study. The other conditions like delayed healing of wounds, bleeding on brushing, gum swelling, disturbances in taste, mouth ulcers, and bad breath are probably due to impaired immune system, vascular alterations, and underlying periodontal or metabolic disturbances.[24] These observations suggested that chronic oral complications in these patients were having an adverse effect on the control of blood glucose, thus emphasizing the prevention and management of such complications.

Frequency of sugar intake among diabetics and non-diabetics

The current research indicated that the intake of biscuits, cakes, jam, honey, and chewing gum with sugar did not vary significantly between the groups. The results indicate that although the general pattern of sugar intake was the same,

diabetics were more likely to exclude sweets and soft drinks from their diet, probably as a result of dietary changes to control diabetes. But to our surprise, the consumption of tea and coffee with added sugar continued to be significantly higher among diabetics than among non-diabetics. This pattern can be explained by poor knowledge and awareness of risk factors for diabetes and the effect of sugar intake on disease worsening, especially in rural India. [69,25] Tea and coffee rank among the most consumed drinks in the nation, [70] contributing greatly to day-to-day sugar consumption. A general absence of information about the damaging effects of sweetened drinks, such as tea and coffee, has led to health complications among patients who suffer from diabetes. It is important for diabetic patients to realize that adding sugar to these drinks can increase blood glucose levels. Rather, they are advised to drink unsweetened tea or take sugar substitutes in small amounts.

Harmful habits in diabetics and non-diabetics

Diabetics and non-diabetics have almost similar drinking habits in the current study, consistent with the earlier findings indicating that moderate alcohol consumption would not vary significantly among the two groups.[26] Nonetheless, the chewing of tobacco presented a statistically significant difference, and diabetics reported higher consumption in all frequency categories than the non-diabetic group. These findings are concerning, as tobacco use is a well-established risk factor for the development and progression of diabetes and its related complications.Tobacco uses adversely impacts glycaemic control, enhances insulin resistance, and worsens periodontal disease already a frequent comorbidity in diabetic individuals. [27] The strong history of tobacco use in diabetics in this survey could indicate an unfamiliarity with how it affects diabetes control, especially

among rural or disadvantaged communities. These findings support the development of health education initiatives targeted at the lifestyle risk factor of tobacco use. Incorporation of tobacco cessation into diabetes management would greatly enhance overall health and glycaemic control in diabetic patients.

Oral hygiene habits and oral health perception

Most of the participants in the present study reported toothbrushing as oral hygiene practice at least on a daily basis. These results coincide with research that was carried out by Apoorva et al.,[22] Shiferaw et al.,[71] Pandey et al.,[28] Ranfl [29] and Basu et al.[30] Again, use of a toothbrush was universal across both groups but with a limited number continuing with traditional techniques such as the finger or chewsticks. Daily brushing once, however, can be insufficient for diabetics, who are more prone to periodontal disease because of compromised immune function and glycemic control.[31] Twice-daily brushing with good technique is advocated to minimize oral disease risk. These results emphasize the necessity for increased oral hygiene education, particularly in diabetics.

The present research found that the majority of the diabetics had felt their oral health to be poor compared to non-diabetics whose perceived oral health was good. These results are consistent with the same study by Basu et al.,[30] Hessain et al.,[34] and Habashneh et al., [35] This result emphasizes that diabetics are more conscious or influenced by oral health problems, resulting in a worse self-assessment of their oral health than non-diabetics. It highlights the increased oral complication burden in diabetics and the necessity of specific oral health education, periodic dental checks, and coordinated management to enhance perception and outcomes.

Dental Treatment and Care Requirements

The current study revealed that there is a notable difference in dental care-seeking behaviour between diabetics and non-diabetics. A larger percentage of diabetics indicated visiting the dentist during the previous year, probably due to symptom presence, pain or discomfort, which is potentially associated with oral complications secondary to diabetes such as periodontitis or infection.[36,37] Conversely, a large percentage of non-diabetics had never been to a dentist, and about half were unable to state the reason or had never been, indicating a lack of awareness or perceived need. But these findings are in conflict with the results of a study by Gupta et al.,[38] in which diabetics and non-diabetics were both reported not to visit the dentist frequently or had not visited any dental clinic in the last year.

The current study results identify marked inequalities in dental treatment requirements among diabetics and non-diabetics. Of particular interest, no diabetics needed no therapy but with a significant percentage of diabetics needed urgent treatment, most probably for acute complaints like pain, infection, or severe periodontal disease, more frequent in patients with poorly controlled diabetes. Also, diabetics needed a complete assessment compared to non-diabetics, which indicates complicated oral health problems involving more than one carious lesion, periodontal pockets, or systemic associations impacting oral tissues.[10,39] Preventive or routine care needs were found to be higher in non-diabetics, reflecting relatively healthier oral health upkeep and fewer issues. The findings highlight the need for regular dental check-ups and early treatment, especially among diabetic patients, to avoid aggravation of oral conditions.

Limitation of the study

The conclusion from the findings of the current study could be biased by some limitations

1. Multiple variables such as host immune response, stress and saliva composition may influence the occurrence of oral diseases which were not accounted for.
2. This study may have been exposed to memory or recall bias since the participants replied to the questions from their memory of events.
3. Being an interview procedure, social desirability bias would have happened because the subjects would have attempted to provide more desirable responses.
4. Observer bias might have happened due to the tester's awareness of the subject's diabetic status as it could have affected the clinical evaluation of findings related to oral health.

Strengths of the study

1. The present study is the first in the Indian population to investigate the association between BMI and the oral health status of both T2DM patients and controls, filling an important gap in the literature.
2. By considering both diabetic and non-diabetic volunteers, the research provides a comparative view that enables a better appreciation of how BMI can affect oral health outcomes differently in these two groups.
3. The case-control study allowed the detection of potential patterns and risks that can be used to inform subsequent longitudinal or intervention studies.

FUTURE RECOMMENDATIONS

1. Oral health screening should become part of diabetes and obesity programs. Healthcare providers treating diabetic or obese patients should coordinate with dental providers for earlier detection and management of oral health.
2. Patients with a BMI $\geq$ 25, particularly diabetics, must be labeled high-risk and given priority for preventive dental treatment in the form of regular checks, oral hygiene instruction, and individualized nutritional guidance.
3. Public health education should stress the two-way interaction between systemic conditions (such as diabetes and obesity) and oral health. Oral hygiene education, lowering intake of sugars, and a healthy lifestyle must be advocated by community-based programs
4. Policymakers must aid the integration of oral health indicators into national diabetes and obesity surveillance systems. Medical, dental, and nutritional specialists should be encouraged to implement collaborative care models for holistic patient care.
5. Longitudinal and interventional studies in the future will be required to investigate the causal interactions between BMI and oral health. More studies should also investigate the effects of lifestyle and behavioral modifications on enhancing oral health outcomes in T2DM patients and controls.

CONCLUSION

The current study was a matched case control study undertaken to compare oral health status and its relationship BMI between patients with T2DM with controls.

1. The research showed a positive correlation between increased BMI and poorer oral health outcomes such as dental caries, gingival bleeding, PPD, LOA, and tooth loss in both diabetic and non-diabetic patients.
2. Diabetic subjects had worse oral health conditions than non-diabetics, especially in those with increased BMI, suggesting that diabetes can worsen the adverse effect of increased BMI on oral health.
3. The results emphasize BMI as a possible risk factor for poor oral health, further the need for combined medical and dental care strategies, particularly among people with T2DM.
4. Diabetics perceived their oral and gum condition to be much worse and had higher treatment needs than non-diabetics. Frequency and mode of brushing, however, did not differ significantly between groups, suggesting other underlying factors like systemic health status and BMI.
5. Non-diabetics had higher consumption of sweets and soft drinks, whereas diabetics had higher consumption of tea or coffee with sugar and tobacco. These were correlated with oral diseases and indicate the importance of lifestyle changes.
6. Binomial logistic regression and Spearman correlation testified to a statistically significant relationship between increased BMI and greater odds of oral health problems among both diabetics and non-diabetics, with more significant odds ratios among diabetics.

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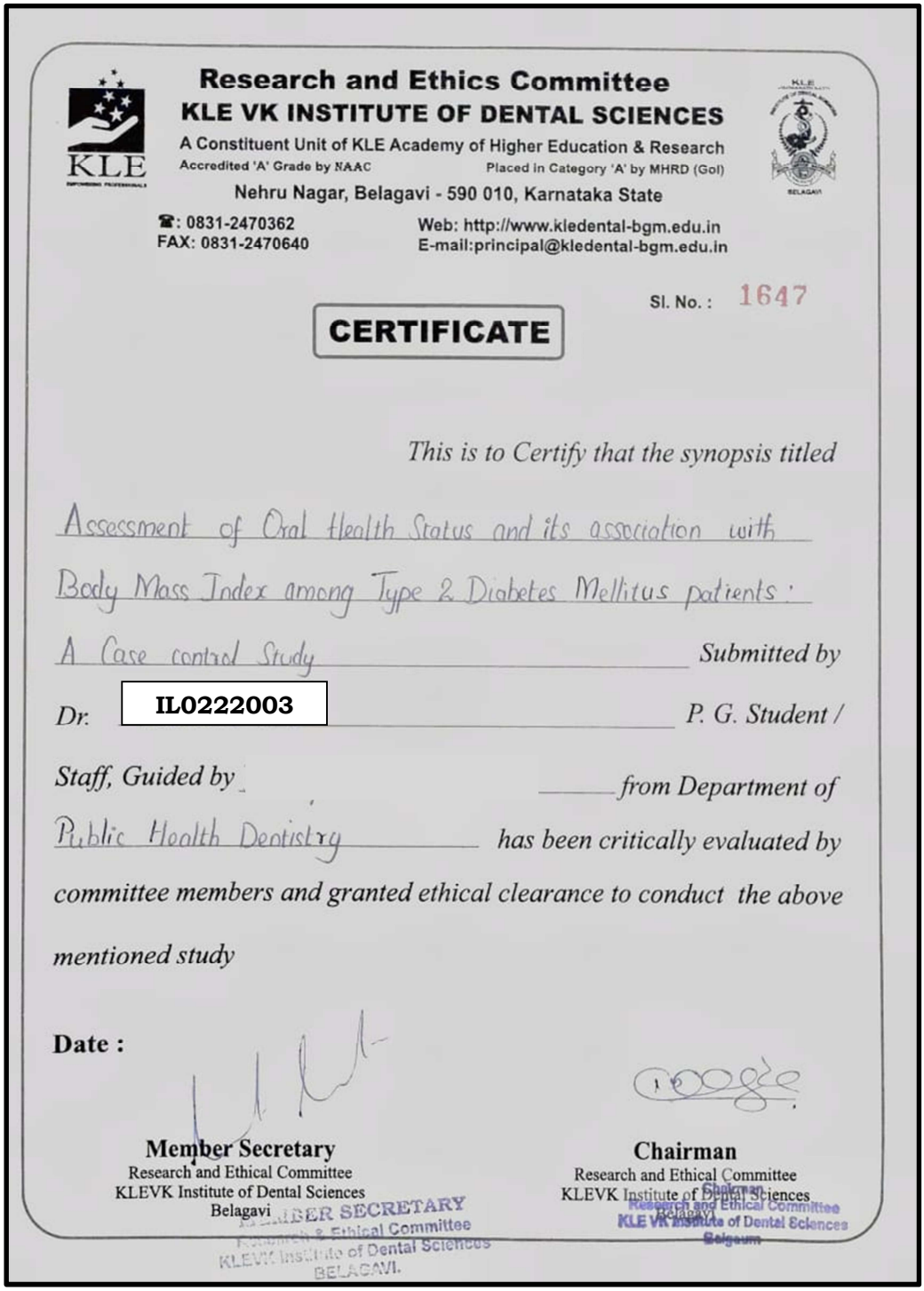
ANNEXURES I – ETHICAL CLEARANCE



Research and Ethics Committee
KLE VK INSTITUTE OF DENTAL SCIENCES
A Constituent Unit of KLE Academy of Higher Education & Research
Accredited 'A' Grade by NAAC — Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi - 590 010, Karnataka State
☎: 0831-2470362
FAX: 0831-2470640
Web: http://www.kledental-bgm.edu.in
E-mail:principal@kledental-bgm.edu.in

Sl. No. : 1647

CERTIFICATE

This is to Certify that the synopsis titled

Assessment of Oral Health Status and its association with Body Mass Index among Type 2 Diabetes Mellitus patients : A Case control Study *Submitted by*

Dr. IL0222003 *P. G. Student /*

Staff, Guided by _____ *from Department of* Public Health Dentistry *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date :

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

MEMBER SECRETARY
Research & Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI.

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLE VK Institute of Dental Sciences
Belgaum

ANNEXURES II – PERMISSION TO CONDUCT STUDY

KLES
DR.PRABHAKAR KORE HOSPITAL
&
MEDICAL RESEARCH CENTRE
NEHRUNAGAR, BELAGAVI 590 010
KARNATAKA-INDIA

ಕೆ. ಎಲ್. ಇ. ಸಂಸ್ಥೆಯ
ಡಾ. ಪ್ರಭಾಕರ ಕೋರೆ ಆಸ್ಪತ್ರೆ ಮತ್ತು
ವೈದ್ಯಕೀಯ ಸಂಶೋಧನಾ ಕೇಂದ್ರ
ನೆಹರುನಗರ, ಬೆಳಗಾವಿ-590 010 ಕರ್ನಾಟಕ, ಭಾರತ

Phone 0831-2473777 (16 lines)
Fax 0831-2470732
E-Mail medicaldirector@klehospital.org
Website www.klehospital.org

REF.NO: KLES/Dr.PK-HOSP/ADM-CS/GEN/23-24/ 921 Date: 28 April 2023

To

IL0222003
Postgraduate student
Department of Public Health Dentistry,
KLE VK Institute of Dental Sciences,
Belagavi

Sub: Reg.. Permission for conducting the study – information about medical records of diabetes patients at KLES Dr Prabhakar Kore Hospital & MRC, Belagavi

Sir,

1. Refer to your application dated 21st April 2023 on the above subject addressed to the hospital's Medical Director.

2. After perusal, the Medical Director has permitted you to collect data for research study on the topic titled 'Assessment of oral health status and its association with body mass index among type 2 diabetes mellitus: A Case – control study' under the guidance of Professor, Dept of Public Health Dentistry, KLE VKIDS and the co-guidance of Professor, Department of General Medicine, JNMC. The study would be entirely conducted in the Department of Medical Records of KLES Dr PK Hospital for a period of One year.

3. The hospital will not have any financial implications for the study.

This is for your information, and I wish you the best in your project.

Administrator - **Clinical Services (Academics)**
for Medical Director

Copy to:

- Guide, Professor, Dept of Public Health Dentistry, KLE VKIDS
- – co-guide, Professor, Department of General Medicine, JNMC
- Professor & Head, Dept of Public Health Dentistry, KLE VKIDS
- Incharge MRD - KLES Dr PK Hospital & MRC, Belagavi

Copy submitted to:
1. MD -- Sir, for your kind information.
2. Guard File

Sushma/D:ADM-CS/permission letters

ANNEXURES III – INFORMED CONSENT FORM

DEPARTMENT OF PUBLIC HEALTH DENTISTRY

CONSENT FORM

Assessment of Oral Health Status and its association with Body Mass Index among Type 2 Diabetes Mellites patients: A Case Control Study

I, have been informed about my involvement in the study in the language that I can understand. I agree to give my personal details like name, age, sex, address, previous dental and medical history and details required for the study to the best of my knowledge. I will co-operate with the dentist for my intra and extra oral examination. I will follow the instructions given by the doctor during the study. I permit the operator to utilize the information given by me and the results obtained from this study for presentation and publication. I will not claim any returns for my co-operation in the study, I am participating with my own will and wish. If for any reason I am unable to participate in the study, for reasons unknown, I can withdraw from the study. I have read, gone through and understand the above information given by the doctor about the study.

Dentist name: Participant's signature

Sign:

Date:

ANNEXURES IV – QUESTIONNAIRE PROFORMA

KAHER'S KLE V.K. INSTITUTE OF DENTAL SCIENCES, BELAGAVI

Assessment of Oral Health Status and its association with Body Mass Index among Type 2 Diabetes Mellites patients: A Case Control Study

Identification no:

Case ☐ Control ☐

Sociodemographic details

Name: **Age:** **Gender: Male / Female**

Education: Illiterate / Primary school / Middle school / High school / Intermediate or Diploma / Graduate / Professional

Employment: Unemployed / Elementary occupation / Plant and machine operators and assemblers / Craft & Related trade workers / Skilled Agricultural & Fishery workers / Skilled workers and shop & Market sales workers / Clerks / Technicians & Associate professionals / Professionals / legislators, senior officials & managers

Income per month: ≤ ₹ 9226 / ₹ 9232-27648 / ₹ 27654-46089 / ₹46095-68961 / ₹ 68967-92185 / ₹ 92191-184370 / ≥ ₹ 184376

Address **Contact number:**

Diabetes history

Duration : 1) 2-3 years / 2) 3-5 years / 3) >5 years

Medication: Oral / Parenteral / other

Frequency of the drug: 1) once daily / 2) twice daily / 3) thrice daily

Family medical history: 1) Yes / 2) No

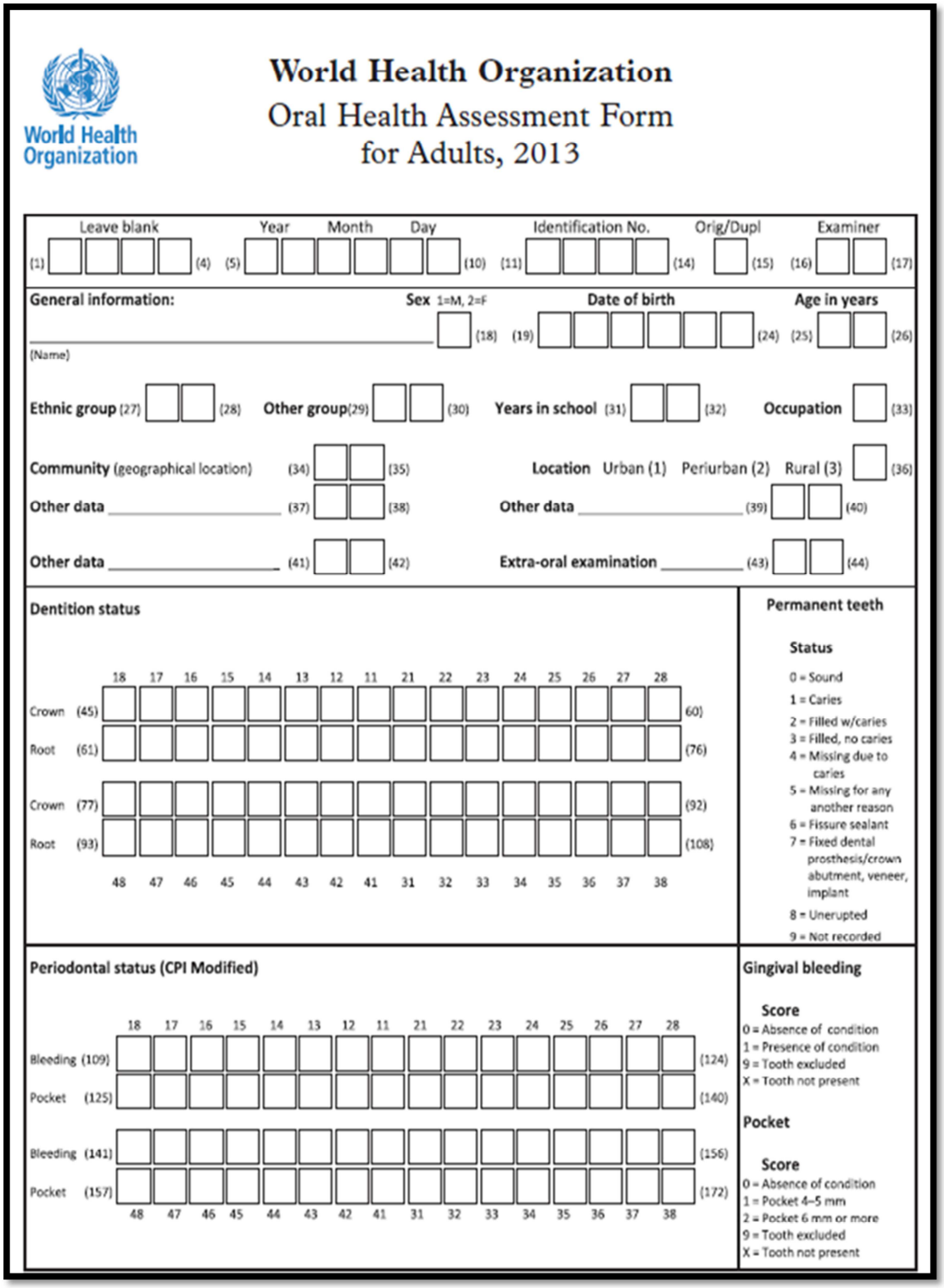
Do you suffer from any of these oral health problem ?

Mouth dryness		
Delayed healing in mouth		
Gums bleeding on brushing		
Mouth ulcers		
Bad breath		
Tooth decay		
Fungal mouth infections		
Swollen or tender gums		
Loose teeth		
Taste problems		
Oral skin disease		

BMI Measurement

Height (meter)	
Weight (kg)	
BMI (kg/m2)	

WHO ORAL HEALTH ASSESSMENT FORM (2013)



World Health Organization

Oral Health Assessment Form for Adults, 2013

(1) Leave blank (4) (5) Year Month Day (10) (11) Identification No. (14) Orig/Dupl (15) (16) Examiner (17)

General information: Sex 1=M, 2=F (18) (19) Date of birth (24) (25) Age in years (26)

(Name)

Ethnic group (27) (28) **Other group**(29) (30) **Years in school** (31) (32) **Occupation** (33)

Community (geographical location) (34) (35) **Location** Urban (1) Periurban (2) Rural (3) (36)

Other data (37) (38) **Other data** (39) (40)

Other data (41) (42) **Extra-oral examination** (43) (44)

Dentition status

	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Crown (45)																	(60)
Root (61)																	(76)
Crown (77)																	(92)
Root (93)																	(108)
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

Permanent teeth

Status

0 = Sound
1 = Caries
2 = Filled w/caries
3 = Filled, no caries
4 = Missing due to caries
5 = Missing for any another reason
6 = Fissure sealant
7 = Fixed dental prosthesis/crown abutment, veneer, implant
8 = Unerupted
9 = Not recorded

Periodontal status (CPI Modified)

	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Bleeding (109)																	(124)
Pocket (125)																	(140)
Bleeding (141)																	(156)
Pocket (157)																	(172)
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

Gingival bleeding

Score

0 = Absence of condition
1 = Presence of condition
9 = Tooth excluded
X = Tooth not present

Pocket

Score

0 = Absence of condition
1 = Pocket 4–5 mm
2 = Pocket 6 mm or more
9 = Tooth excluded
X = Tooth not present

Loss of attachment

Severity
0 = 0–3 mm
1 = 4–5 mm Cemento-enamel junction (CEJ) within black band
2 = 6–8 mm CEJ between upper limit of black band and 8.5 mm ring
3 = 9–11 mm CEJ between 8.5 mm and 11.5 mm ring
4 = 12 mm or more CEJ beyond 11.5 mm ring
X = Excluded sextant
9 = Not recorded

* Not recorded under 15 years of age

Index teeth

17/16 11 26/27
(173) (175)
(176) (178)
47/46 31 36/37

Enamel fluorosis (179)

Severity
0 = Normal
1 = Questionable
2 = Very mild
3 = Mild
4 = Moderate
5 = Severe
8 = Excluded (crown, restoration, "bracket")
9 = Not recorded (unerupted tooth)

Dental erosion

Severity (180)

0 = No sign of erosion
1 = Enamel lesion
2 = Dentinal lesion
3 = Pulp involvement

Number of teeth affected

(181) (182)

Dental trauma

Status (183)

0 = No sign of injury
1 = Treated injury
2 = Enamel fracture only
3 = Enamel and dentine fracture
4 = Pulp involvement
5 = Missing tooth due to trauma
6 = Other damage
9 = Excluded tooth

Number of teeth affected

(184) (185)

Oral mucosal lesions

(186)
(187)
(188)
(189)
(190)
(191)

Condition

0 = No abnormal condition
1 = Malignant tumour (oral cancer)
2 = Leukoplakia
3 = Lichen planus
4 = Ulceration (aphthous, herpetic, traumatic)
5 = Acute necrotizing ulcerative gingivitis (ANUG)
6 = Candidiasis
7 = Abscess
8 = Other condition (specify if possible)
9 = Not recorded

Location

0 = Vermillion border
1 = Commissures
2 = Lips
3 = Sulci
4 = Buccal mucosa
5 = Floor of the mouth
6 = Tongue
7 = Hard and/or soft palate
8 = Alveolar ridges/gingiva
9 = Not recorded

Denture(s)

Upper (192) **Lower** (193)

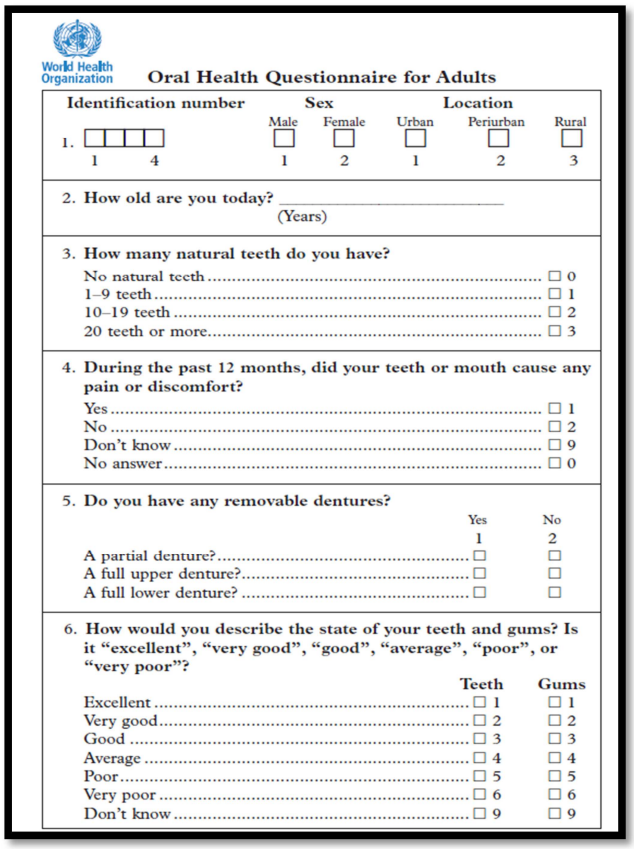
Status

0 = No denture
1 = Partial denture
2 = Complete denture
9 = Not recorded

Intervention urgency (194)

0 = No treatment needed
1 = Preventive or routine treatment needed
2 = Prompt treatment (including scaling) needed
3 = Immediate (urgent) treatment needed due to pain or infection of dental and/or oral origin
4 = Referred for comprehensive evaluation or medical/dental treatment (systemic condition)

ANNEXURES V – WHO ORAL HEALTH QUESTIONNAIRE FOR ADULTS (2013)



World Health Organization

Oral Health Questionnaire for Adults

Identification number	Sex		Location		
	Male	Female	Urban	Periurban	Rural
1. ☐☐☐☐	☐	☐	☐	☐	☐
1 4	1	2	1	2	3

2. How old are you today? _____ (Years)

3. How many natural teeth do you have?
- No natural teeth ☐ 0
- 1–9 teeth ☐ 1
- 10–19 teeth ☐ 2
- 20 teeth or more ☐ 3

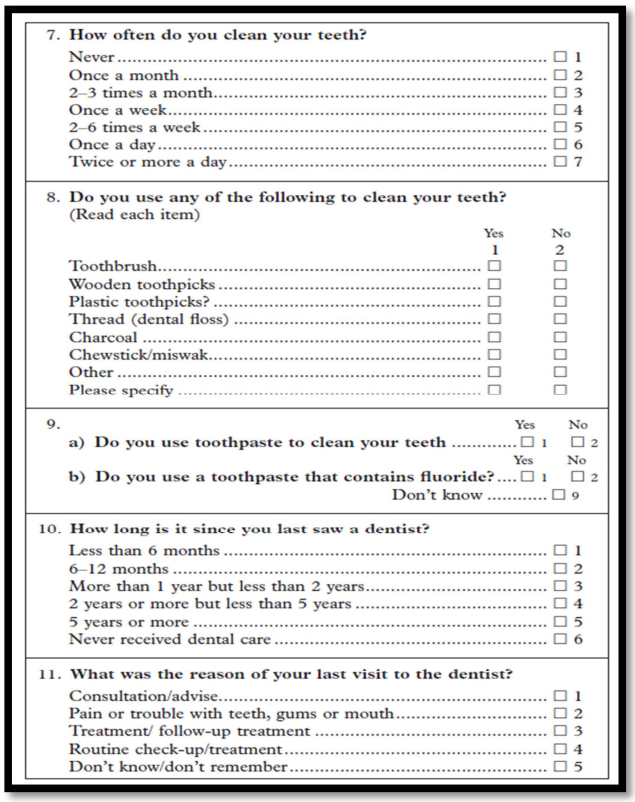
4. During the past 12 months, did your teeth or mouth cause any pain or discomfort?
- Yes ☐ 1
- No ☐ 2
- Don't know ☐ 9
- No answer ☐ 0

5. Do you have any removable dentures?

	Yes	No
	1	2
A partial denture?	☐	☐
A full upper denture?	☐	☐
A full lower denture?	☐	☐

6. How would you describe the state of your teeth and gums? Is it "excellent", "very good", "good", "average", "poor", or "very poor"?

	Teeth	Gums
Excellent	☐ 1	☐ 1
Very good	☐ 2	☐ 2
Good	☐ 3	☐ 3
Average	☐ 4	☐ 4
Poor	☐ 5	☐ 5
Very poor	☐ 6	☐ 6
Don't know	☐ 9	☐ 9



7. How often do you clean your teeth?
- Never ☐ 1
- Once a month ☐ 2
- 2–3 times a month ☐ 3
- Once a week ☐ 4
- 2–6 times a week ☐ 5
- Once a day ☐ 6
- Twice or more a day ☐ 7

8. Do you use any of the following to clean your teeth? (Read each item)

	Yes	No
	1	2
Toothbrush	☐	☐
Wooden toothpicks	☐	☐
Plastic toothpicks?	☐	☐
Thread (dental floss)	☐	☐
Charcoal	☐	☐
Chewstick/miswak	☐	☐
Other	☐	☐
Please specify	☐	☐

9.

	Yes	No
a) Do you use toothpaste to clean your teeth	☐ 1	☐ 2
b) Do you use a toothpaste that contains fluoride?	☐ 1	☐ 2
Don't know	☐ 9	

10. How long is it since you last saw a dentist?
- Less than 6 months ☐ 1
- 6–12 months ☐ 2
- More than 1 year but less than 2 years ☐ 3
- 2 years or more but less than 5 years ☐ 4
- 5 years or more ☐ 5
- Never received dental care ☐ 6

11. What was the reason of your last visit to the dentist?
- Consultation/advise ☐ 1
- Pain or trouble with teeth, gums or mouth ☐ 2
- Treatment/ follow-up treatment ☐ 3
- Routine check-up/treatment ☐ 4
- Don't know/don't remember ☐ 5

12. **Because of the state of your teeth or mouth, how often have you experienced any of the following problems during the past 12 months?**

	Very often 4	Fairly often 3	Some-times 2	No 1	Don't know 0
(a) Difficulty in biting foods	☐	☐	☐	☐	☐
(b) Difficulty chewing foods	☐	☐	☐	☐	☐
(c) Difficulty with speech/trouble pronouncing words	☐	☐	☐	☐	☐
(d) Dry mouth	☐	☐	☐	☐	☐
(e) Felt embarrassed due to appearance of teeth	☐	☐	☐	☐	☐
(f) Felt tense because of problems with teeth or mouth	☐	☐	☐	☐	☐
(g) Have avoided smiling because of teeth	☐	☐	☐	☐	☐
(h) Had sleep that is often interrupted	☐	☐	☐	☐	☐
(i) Have taken days off work	☐	☐	☐	☐	☐
(j) Difficulty doing usual activities	☐	☐	☐	☐	☐
(k) Felt less tolerant of spouse or people who are close to you	☐	☐	☐	☐	☐
(l) Have reduced participation in social activities	☐	☐	☐	☐	☐

13. **How often do you eat or drink any of the following foods, even in small quantities?**
(Read each item)

	Several times a day 6	Every day 5	Several times a week 4	Once a week 3	Several times a month 2	Seldom /never 1
Fresh fruit	☐	☐	☐	☐	☐	☐
Biscuits, cakes, cream cakes	☐	☐	☐	☐	☐	☐
Sweet pies, buns	☐	☐	☐	☐	☐	☐
Jam or honey	☐	☐	☐	☐	☐	☐
Chewing gum containing sugar	☐	☐	☐	☐	☐	☐
Sweets/candy	☐	☐	☐	☐	☐	☐
Lemonade, Coca Cola or other soft drinks	☐	☐	☐	☐	☐	☐
Tea with sugar	☐	☐	☐	☐	☐	☐
Coffee with sugar	☐	☐	☐	☐	☐	☐

(Insert country-specific items)

14. **How often do you use any of the following types of tobacco?**
(Read each item)

	Every day 6	Several times a week 5	Once a week 4	Several times a month 3	Seldom 2	Never 1
Cigarettes	☐	☐	☐	☐	☐	☐
Cigars	☐	☐	☐	☐	☐	☐
A pipe	☐	☐	☐	☐	☐	☐
Chewing tobacco	☐	☐	☐	☐	☐	☐
Use snuff	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐

Please specify _____

15. **During the past 30 days, on the days you drank alcohol, how many drinks did you *usually drink per day?***

Less than 1 drink	☐ 0
1 drink	☐ 1
2 drinks	☐ 2
3 drinks	☐ 3
4 drinks	☐ 4
5 or more drinks	☐ 5
Did not drink alcohol during the past 30 days	☐ 9

16. **What level of education have you completed?**

No formal schooling	☐ 1
Less than primary school	☐ 2
Primary school completed	☐ 3
Secondary school completed	☐ 4
High school completed	☐ 5
College/university completed	☐ 6
Postgraduate degree	☐ 7

(Insert country-specific categories)

That completes our questionnaire
Thank you very much for your cooperation!

Year	Month	Day	Interviewer	District	Country
☐☐	☐☐	☐☐	☐☐	☐☐	☐☐☐