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Xerostomia and fissured tongue in Libyan patients with type 2 diabetes: An evaluation of their relationship

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Abstract
Background: Type 2 diabetes mellitus (T2DM), a common metabolic disorder, involves reduced insulin secretion and tissue sensitivity. About 95% of diabetes cases are T2DM, mainly affecting adults. Measuring HbA1c in blood is key for assessing diabetic Control treatment. Diabetic patients (DPs), especially those with poor glycemic control, are more prone to suffering from xerostomia (dry mouth). Fissured tongue (FT) is often linked to DM. Xerostomia, a common condition among DPs, can affect the development of FT.
Aim of the work: The goal of this study is to assess the relationship between xerostomia and FT in individuals with T2DM.
Materials and Methods: This cross-sectional study assessed 426 Libyan participants with T2DM. Medical and dental histories, age, gender, and HbA1c levels were evaluated to determine diabetes control. Questionnaires were utilized to identify xerostomia along with analyses of demographic data. Chi-square assessed tests the relationship between xerostomia and FT, with a p-value < 0.05 considered significant.
Result: In a study of 426 patients with T2DM, 226 (53.1%) had xerostomia, and 327 (76.8%) had FT. Among those with xerostomia, 82.7% had glycemically uncontrolled diabetes, while 79.2% of those with FT were also glycemically uncontrolled. A strong, significant relationship was established between xerostomia and FT in Libyan individuals with T2DM.
Conclusion: Many uncontrolled DPs had a high prevalence of xerostomia and fissured tongue. Our research reveals a strong correlation between these conditions in Libyan patients with type 2 diabetes mellitus (T2DM).

Keywords: Libyan T2DM, HbA1c, xerostomia, FT, controlled and uncontrolled glycemia.

Introduction
Diabetes mellitus (DM) is an assortment of metabolic disorders identified by high blood glucose levels attributed to insulin insufficiency, resistance, or both [1]. DM includes type 1 diabetes (T1DM), type 2 diabetes (T2DM), gestational diabetes, and monogenic diabetes [2]. The International Diabetes Federation (IDF) predicts that by 2040, more than 640 million people worldwide will have DM [3]. T1DM, or insulin-dependent diabetes, is defined by an absolute deficit of insulin due to the loss of pancreatic β-cells, accounting for around 10% of all cases [4]. T2DM is a prevalent metabolic condition characterized by decreased insulin secretion and diminished insulin sensitivity in tissues. It is the most common form of DM [5]. Approximately 95% of all cases with diabetes are T2DM [6]. It affects individuals of all ages, but is most commonly seen in adults [7]. As a retrospective indicator of metabolic control, the measurement of glycated haemoglobin (HbA1c) in blood is a crucial sign for evaluating the efficacy of diabetic treatment [8].
DM is associated with high morbidity due to various complications, such as retinopathy, nephropathy, neuropathy, and cardiovascular illnesses [9].
The most common oral complications seen in T2DM include periodontitis, carious lesions, xerostomia, angular cheilitis, FT, burning sensations, gingivitis, and oral ulceration [10]. DPs, especially those with poor glycemic control, are more prone to suffering from xerostomia [11]. Xerostomia is the subjective sense of dry mouth, while hyposalivation reveals a lower salivary

flow rate [12]. The onset of autonomic diabetic neuropathy is due to nerve fiber demyelination, which is frequently the cause of salivary gland dysfunction in DPs [13]. Its prevalence ascends with age, affecting approximately 30% of those over 65 years old [14]. Xerostomia occurs more frequently in females than in males [15]. Patients suffering from xerostomia frequently experience dry mouth, burning in the mouth, difficulties swallowing, and a diminished or changed sense of taste [16]. The Sialometry test is the most widely used clinical tool for diagnosing salivary malfunction. However, hyposalivation occurs when salivary flow rates fall below 0.1 mL/min at rest [17]. A thorough examination, including questions concerning dry mouth in various situations, extra and intraoral examination, and measurement of salivary flow rates, helps in the diagnosis [18]. Patients are definitively diagnosed with xerostomia when they experience a dry mouth for a continuous period of six months [19]. Management of xerostomia should focus on alleviating symptoms, controlling oral diseases, and enhancing salivary function [20]. According to previous studies, xerostomia is a common condition in DPs that may influence the development of the FT [21]. The FT has been frequently associated with DM and is more prevalent in males than in females [22]. FT is an asymptomatic benign condition that presents with several shallow to deep grooves or furrows on the dorsal surface of the tongue [23]. It has been identified as the most common lingual disorder, affecting 5-11% of the population, and is frequently associated with ageing [24]. Although no definitive etiology has been established, it is speculated that the disorder may be inherited in a polygenic manner [25]. FT usually refers to an acquired disorder caused by chronic glossitis, xerostomia, trauma, or vitamin deficiencies [26]. Numerous grooves up to 6 mm deep are observed in the anterior tongue dorsum and do not require treatment [27]. The diagnosis of fissured tongue depends primarily on clinical examination; biopsies are seldom performed [28]. The dentist plays a crucial role in the detection, diagnosis, and management of oral disorders, as well as identifying any underlying systemic diseases [29].

Materials and Methods

The current cross-sectional study was conducted on a sample of the Libyan population diagnosed with T2DM, based on their medical files at a tertiary care hospital, from July 2023 to August 2024. Ethical clearance and informed written consent were obtained from all patients. All participants underwent a thorough assessment of their medical history, dental history, age, and gender. Oral medicine specialists and a pathologist examined the oral mucosa for dry mouth and FT, following WHO guidelines to establish a final diagnosis. HbA1c levels were measured for each patient to identify those with controlled and uncontrolled glycemic status. HbA1c was considered controlled if it was ≤ 7.0 and uncontrolled if > 7.0. Numerous questionnaires have been proposed to determine patients with genuine xerostomia. Each patient was asked about their experience of dry mouth during the day over the previous 6 months, followed by additional questions: 1- Does your mouth feel dry? 2- Do you have difficulty swallowing? 3- Do you need to sip water to swallow food? All responses to these questions were recorded. Xerostomia was evaluated when the dental mirror adhered to different parts of the oral mucosa, along with the presence of oral ulcerations and speech difficulties. The tongue dorsum was examined for evidence of FT conditions. Xerostomia, FT condition, and demographic data were analyzed using IBM SPSS 26. Chi-square tests assessed the relationship between xerostomia and FT in T2DM, as well as other variables such as age, gender, and HbA1c. A p-value < 0.05 was considered statistically significant.

Result

The study was conducted on 426 Libyans with T2DM, comprising 222 males (52.1%) and 204 females (47.9%) (Fig. 1). The participants in this study ranged in age from 23 to 95 years, with a mean age of 58.6 years and a standard deviation of 10.46 years. Based on their ages, the participants were divided into four groups (Fig. 2).

The glycemic state of the entire study sample consisted of 95 (22.3%) controlled DPs and 331 (77.7%) uncontrolled DPs (Table 1).

Among 426 DPs, 226 (53.1%) were diagnosed with xerostomia (Fig. 3), and 327 (76.8%) were diagnosed with FT (Fig. 4) in the entire study sample.

In the current study, 125 cases (55.3%) of xerostomia were observed in females, and 101 cases (44.7%) in males, which was statistically significant (p = 0.001), resulting in a male-to-female ratio of 1:1.2 (Table 2). Meanwhile, 157 cases (48.0%) of FT were detected in females, and 170 cases (52.0%) in males, which were not statistically significant p =0.925, with a male-to-female ratio of 1:1 (Table 3).

In patients with xerostomia, the most commonly affected age group was 60-79 years old (Fig. 5), whereas the age group most impacted by FT cases was 60-79 (Fig.6).

In the analysis of HbA1c values, it was found that among patients with xerostomia, 39 (17.3%) maintained glycemic control, while 187 (82.7%) were classified as having glycemically uncontrolled diabetes. This finding suggests a significant relationship, with a p-value of less than 0.001 (Fig. 7). Conversely, among patients exhibiting a FT, 68 (20.8%) were under glycemic control, while 259 (79.2%) were not. This data also revealed that the prevalence of FT in uncontrolled DPs was significantly greater than that in controlled diabetic patients, with a p-value of less than 0.001 (Fig. 8). Our study evaluated the relationship between xerostomia and the presence of a FT. After adjusting for factors such as age, sex, glycemic status, and the prevalence of these conditions, we found a strong and significant correlation between xerostomia and FT, with a p-value of less than 0.001 (Fig. 9 and Table 4).

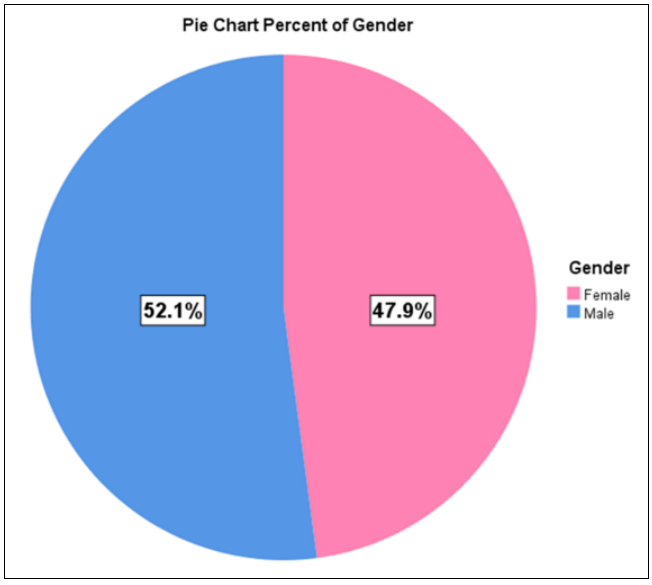

Fig 1: The pie chart shows the gender percentage within the entire study sample

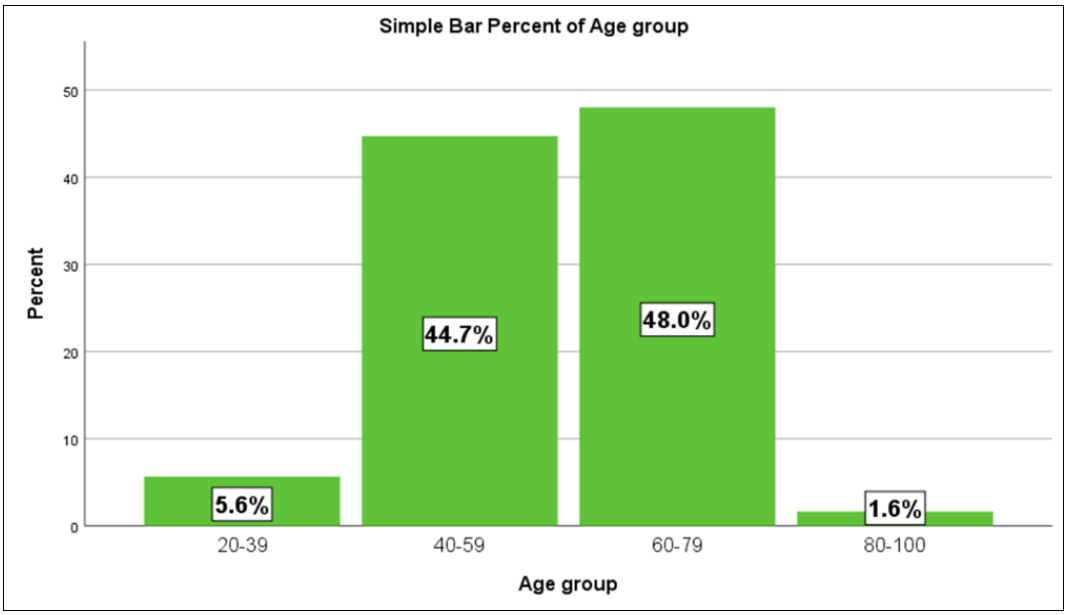

Fig 2: The Bar graph shows the percentage of different age groups

Table 1: Demonstrates the frequency and percentage of glycemic states of the patients

Glycemic state		Frequency	Percent	Cumulative Percent
Valid	uncontrolled	331	77.7	77.7
	controlled	95	22.3	100.0
	Total	426	100.0	

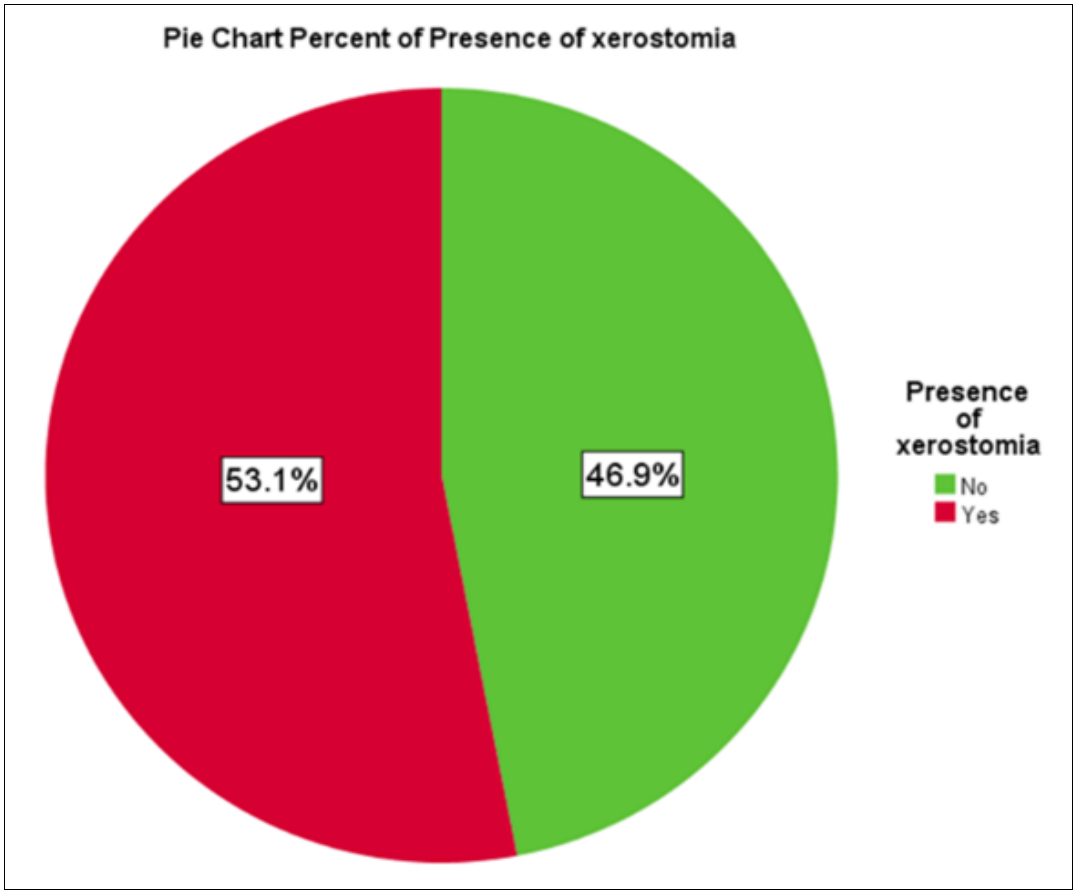

Fig 3: The Pie chart shows the presence and absence of xerostomia cases

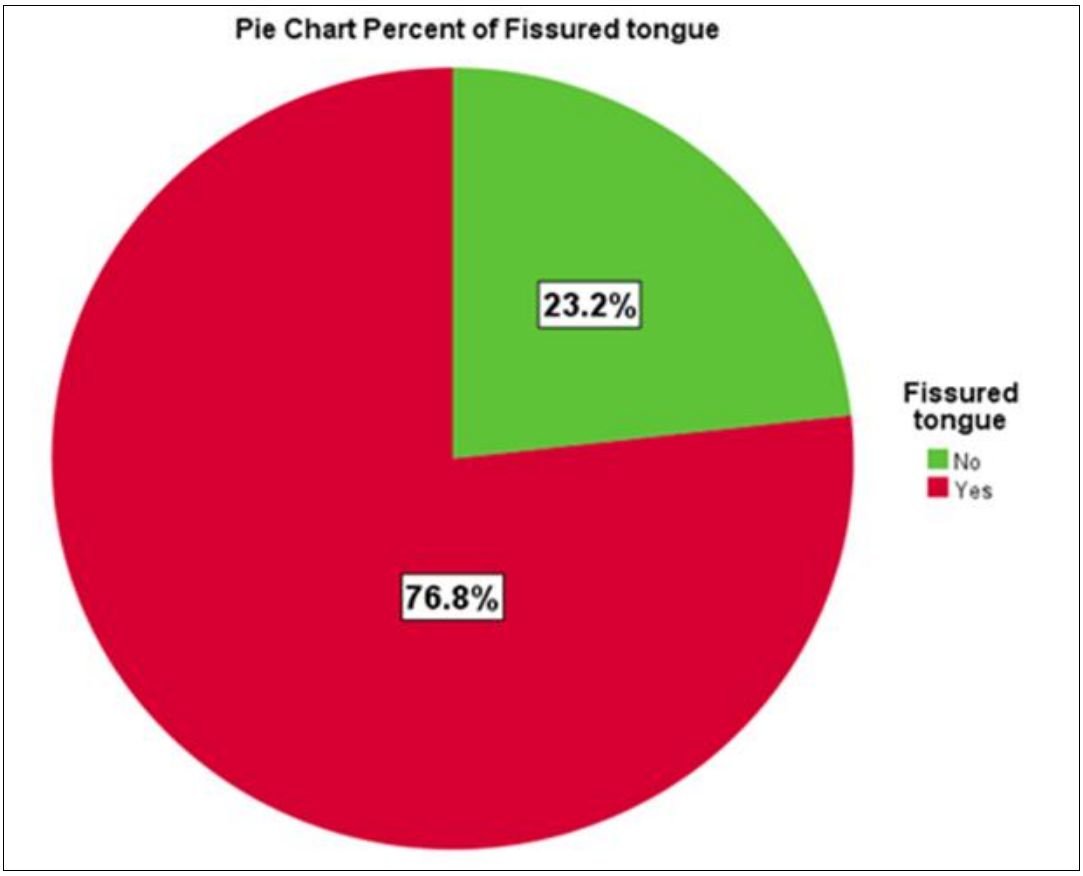

Fig 4: The Pie chart illustrates the presence and absence of FT conditions

Table 2: Shows an association between the presence of xerostomia and gender

Presence of xerostomia by gender (No. & %)			Gender		Total
			Female	Male	
xerostomia	No	Count	79	121	200
		% within Presence of xerostomia	39.5%	60.5%	100.0%
	Yes	Count	125	101	226
		% within Presence of xerostomia	55.3%	44.7%	100.0%
Total		Count	204	222	426
		% within Presence of xerostomia	47.9%	52.1%	100.0%

Table 3: Displays the relationship between the presence of FT and gender.

Presence of FT by gender (No. & %)			Gender		Total
			Female	Male	
FT	No	Count	47	52	99
		% within Fissured tongue	47.5%	52.5%	100.0%
	Yes	Count	157	170	327
		% within Fissured tongue	48.0%	52.0%	100.0%
Total		Count	204	222	426
		% within Fissured tongue	47.9%	52.1%	100.0%

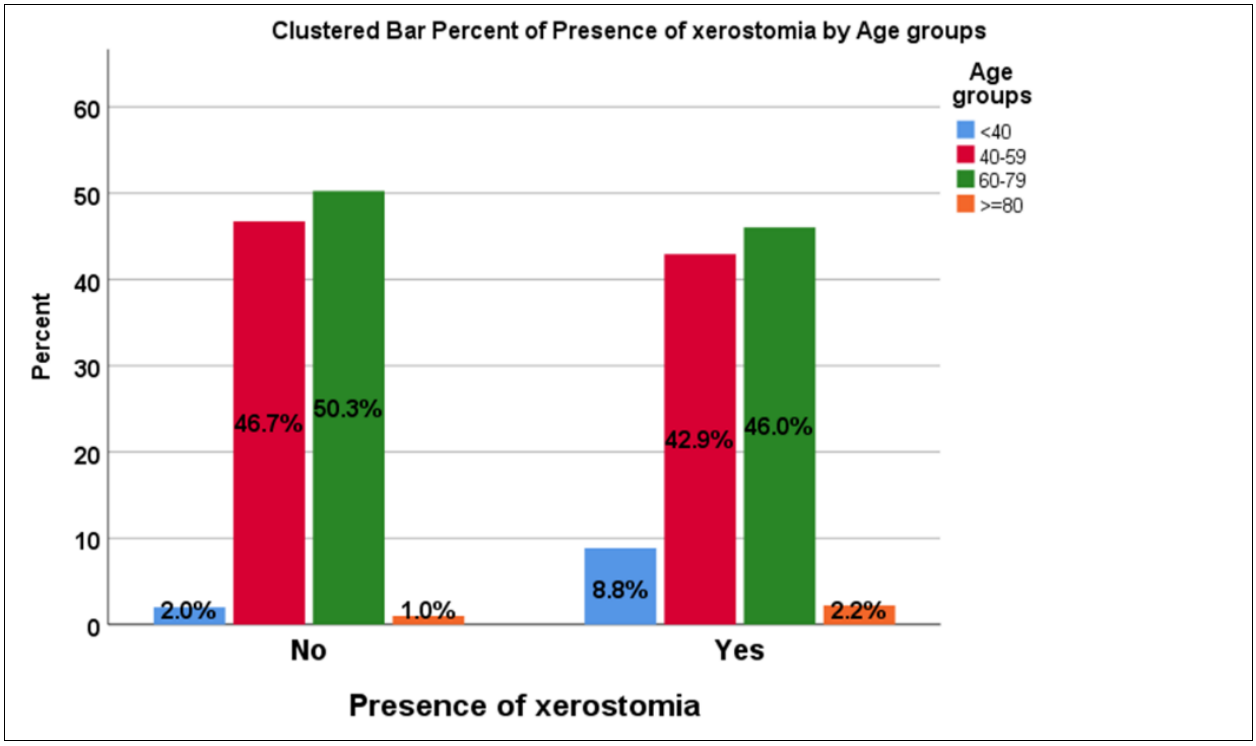

Fig 5: Bar graph demonstrates the percentages of xerostomia according to the different age groups

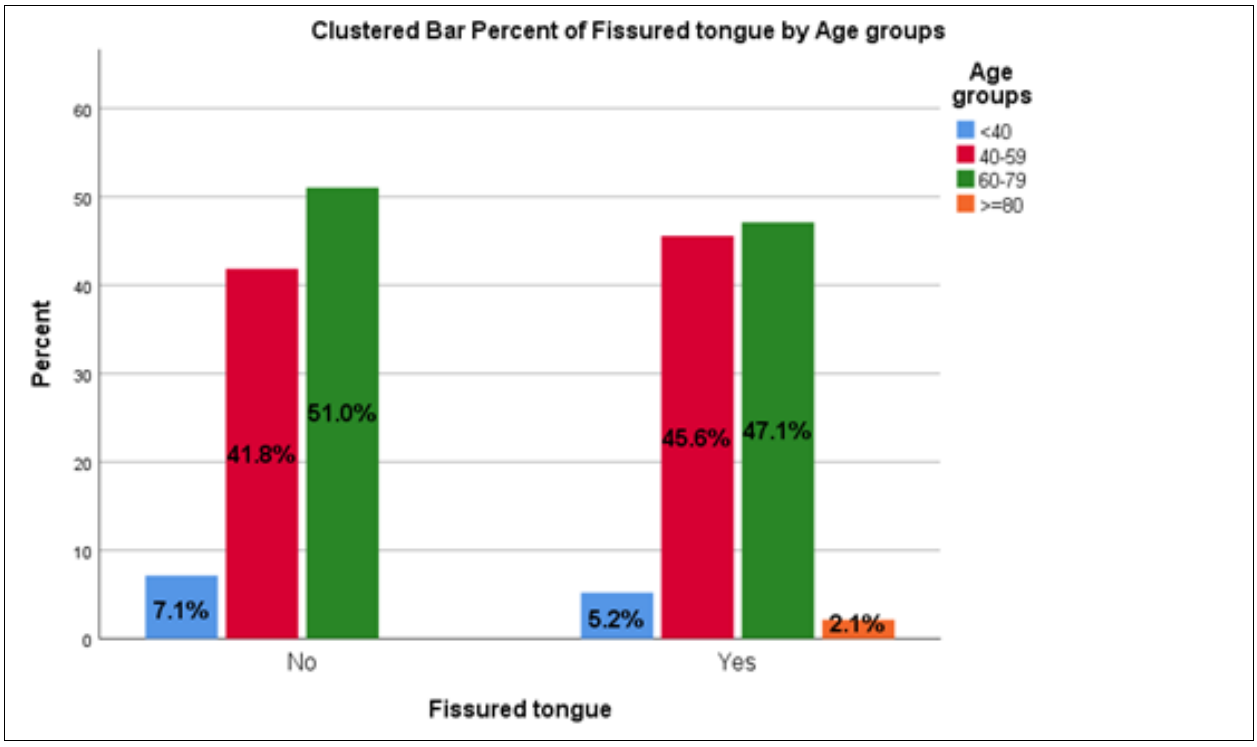

Fig 6: Bar graph shows an association between the presence of FT in different age groups

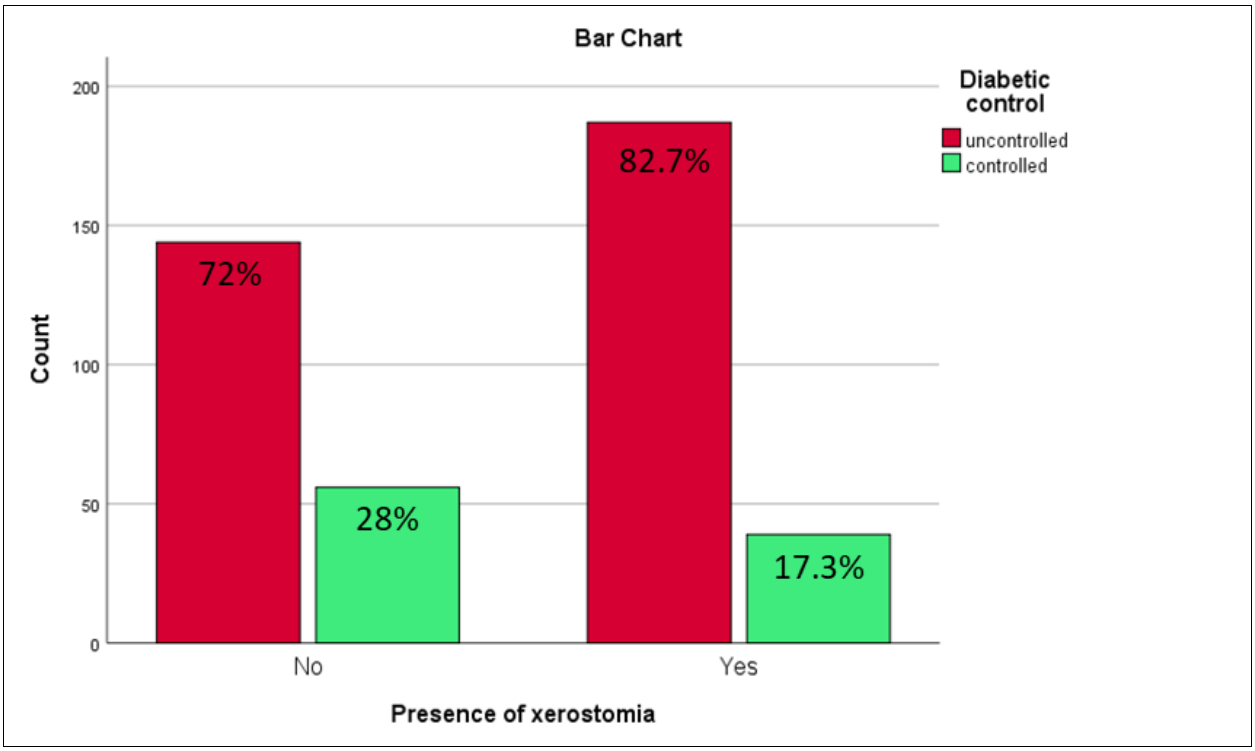

Fig 7: Bar graph demonstrates the presence of xerostomia with the state of glycemia (controlled and uncontrolled diabetic patients)

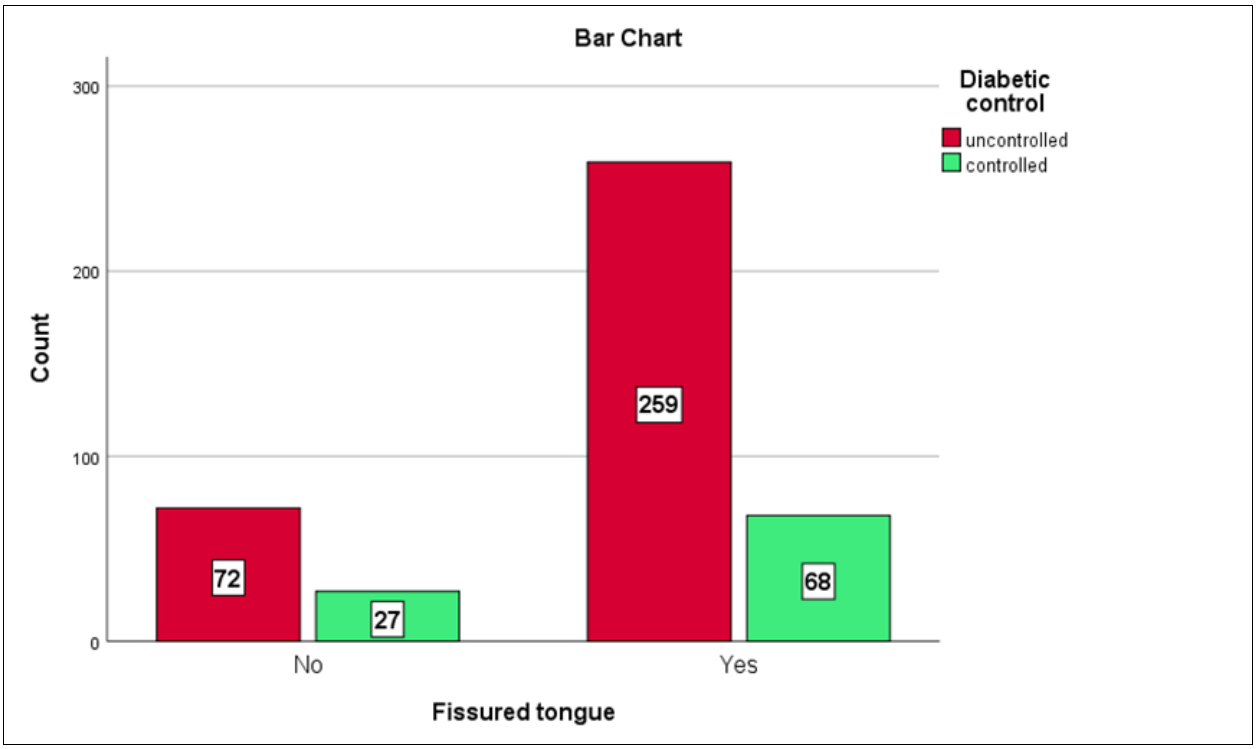

Fig 8: A bar graph illustrates the number of FT conditions with the state of glycemia in diabetic patients

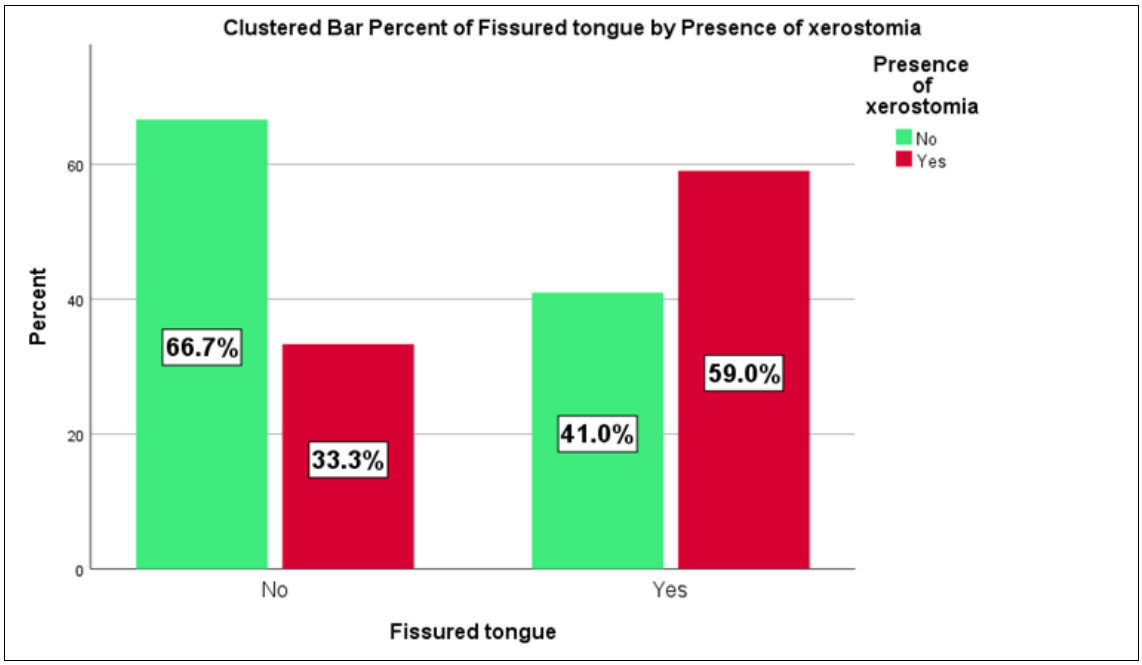

Fig 9: Bar graph shows a significant relationship between xerostomia and FT in T2DM

Table 4: Demonstrates the presence of FT conditions within the cases of xerostomia,indicating a significant correlation between xerostomia and FT in T2DM

FT		Presence of xerostomia		Total
		No	Yes	
No	Count	66	33	99
	% within Fissured tongue	66.7%	33.3%	100.0%
Yes	Count	134	193	327
	% within Fissured tongue	41.0%	59.0%	100.0%
Total	% within Fissured tongue	46.9%	53.1%	100.0%

Discussion

The objective of the present study is to evaluate the correlation between xerostomia and FT in T2DM.

Xerostomia is the most common oral manifestation in diabetic patients, with prevalence rates ranging from 13% to 63% [21]. Our study found that the prevalence rate of xerostomia was 53.1%. This result was similar to Yeğinoğlu and Ereş (2024) [30], who conducted a study on 300 patients and found that 54.6% with xerostomia and our finding was inconsistent with Fornari *et al.* (2021) [31], who conducted a study on 300 patients with T2DM, and reported a high prevalence rate of 19.1%.

The occurrence of xerostomia increases with advancing age, affecting approximately 30% of people aged 65 and above **(14)**. In the current study, the age group most commonly affected by xerostomia was between 60 and 79 years old. Similar findings were reported by Ivanovski *et al.* (2012) [32], who noted that symptoms of xerostomia are more prevalent among the elderly population. Additionally, DJ O, *et al.* (2008) [33] stated that the sensation of xerostomia occurs up to three times more frequently in individuals over 60 compared to younger adults.

Xerostomia is more prevalent in females than in males **(15)**. Our findings indicated a significant predominance of females over males, which is consistent with the research of Guggenheimer and Moore (2003) [11], who noted that complaints of xerostomia are generally more common in women. Additionally, Sreebny *et al.* (1992) [34], found that 43% of DPs reported experiencing xerostomia, with 82% of those affected being women.

Some research indicates that complaints of xerostomia are associated with higher HbA1c levels [13]. Our study found a significant association between xerostomia and patients with uncontrolled diabetes (82.7%), with a p-value of less than 0.001 when HbA1c levels were greater than 7. This finding is in line with AL-Maweri *et al.* (2013) [35], who reported that diabetic patients with uncontrolled glycaemia had a significantly higher prevalence of xerostomia compared to those with moderately or well-controlled disease (P<0.05). It was also consistent with Ivanovski *et al.* (2012) [32], who identified a significant correlation between the degree of xerostomia and HbA1c levels.

The estimated prevalence of (FT) in the general population is between 10% and 20% [27]. In the current study, we found that the prevalence rate was 76.8% this marked variation may be due to a high incidence of FT in the general Libyan population. However, our findings were consistent with those of Keshlaf *et al.* (2025) [36], who reported a high prevalence of 96% in Libyan T2DM. This finding was inconsistent with Abdurahman (2021) [37], who reported a prevalence of 6.1% in 28 cases of T2DM. This low incidence may be attributed to the small size of the studied sample.

The incidence of the FT condition is higher in males than in females and increases with age [26]. Our study revealed FT predominance in males, 52% compared to females, 48.0%. These findings were similar to Hamrah *et al.* (2021) [38], who found that the FT was more common in males 51.5% than in females 48.5% and disagreed with Byahatti (2010) [22], who reported that the FT is more common in females than in males.

In our study, we found that the age group most affected by FT conditions was between 60 and 79 years old. This finding

aligns with Erriu *et al.* (2016) [24], who stated that FT is typically associated with aging and is considered the most common lingual defect. However, it contrasts with the findings of Saxena *et al.* (2019) [29], who reported that FT was most prevalent in the 51-60 age group.

A fissured tongue is often associated with DM, especially in patients with uncontrolled blood sugar levels [22]. Our findings showed that the prevalence of fissured tongue in patients with poorly controlled diabetes was significantly higher, 79.2% than in those with well-controlled diabetes, 20.8% with a p-value of less than 0.001. This finding is consistent with Mohsin *et al.* (2014) [39], who found that the relationship between diabetes and a fissured tongue may result from poor blood glucose control.

Multiple factors lead to the development of FT, including xerostomia and diabetes mellitus [40]. With a p-value of less than 0.001, our findings demonstrated a significant and accurate correlation between xerostomia and FT in Libyan patients with T2DM. This implies that xerostomia might be a contributing cause to the development of FT.

Conclusion

Our results indicated a significant proportion of uncontrolled DPs who require enhanced education and motivation regarding the oral and systemic complications of DM from both general dental practitioners and physicians. The prevalence of fissured tongue conditions was notably higher than that of xerostomia cases. A high percentage of uncontrolled DPs exhibited a high prevalence rate of both xerostomia and FT conditions. Our research reveals a significant relationship between xerostomia and FT in Libyan patients with type T2DM. Understanding these relationships is crucial for improving the health outcomes related to oral complications of DM.

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