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## Oral and systemic complications associated with type 2 diabetes mellitus in a sample of the Libyan population: A single-center study

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### Abstract

**Background:** Diabetes mellitus (DM) is the most common serious chronic endocrine and metabolic disorders. Diabetics with poor control blood glucose levels are at risk of oral and systemic complications. Oral conditions such as xerostomia, gingivitis, periodontitis, tooth loss. Systemic consequences including coronary, peripheral, and vascular diseases.

**Aim of the work:** This study was designed to identify the most common oral and systemic complications associated with controlled and uncontrolled type 2 DM (T2DM) among a sample of Libyan population.

**Materials and Methods:** This study was conducted in 426 adults of both genders who diagnosed with T2DM. This study sample included controlled (HbA1c 7%) and uncontrolled (HbA1c > 7%).

**Statistical analysis:** The acquired data was tabulated and forwarded for statistical analysis. The data was described using cross tabulation tables, bar and pie charts. To determine the P value, the Chi-square test was used to investigate the significant presence of oral and systemic complications associated with T2DM.

**Result:** A total of 426 patients diagnosed with T2DM were considered for this study showed (52.1%) were males and (47.9%) were females. The ages varied between 23 and 95 years old. According to the HbA1c values, 331 (77.7%) were non-controlled diabetic patients (NCDPs) and 95 (22.3%) were controlled diabetic patients (CDPs). Amongst 426 (DPs) 422 patients were diagnosed with oral complications. A total of 187 patients were diagnosed with systemic complications.

**Conclusion:** There was a significant correlation between T2DM with oral and systemic complications. The oral complications in DPs indicated uncontrolled glycemic status.

**Keywords:** Oral complications, systemic complications, T2DM, CDPs, NCDPs

### Introduction

Diabetes mellitus (DM) is the most prevalent serious chronic endocrine disorder and is considered the seventh most common cause of death [1]. DM is defined by the World Health Organization (WHO) as a metabolic disease characterized by numerous etiologies by persistent hyperglycemia and a change in carbohydrate, lipid, and protein metabolism caused by a deficiency in insulin secretion, action, or both [2].

There are various forms of DM, each caused by a complex interaction of genetic predisposition and environmental variables [3]. It is categorized into four main classifications based on the pathophysiology of the disease: type 1 diabetes (T1DM), T2DM, gestational diabetes (GDM), and particular forms of diabetes due to other causes [4].

T2DM is becoming a significant chronic disease burden in Africa. DM was predicted to affect fourteen million people in Africa in 2011, with the figure projected to increase to twenty eight million by 2030 [5]. However, the rise in DM incidence in developing nations correlates to the trend of urbanization and lifestyle changes [6].

DPs who do not control blood glucose levels carefully are at risk of oral and systemic complications [7]. When the disease and its devastating consequences are widespread, these complications cause significant levels of morbidity and mortality [8].

DM, if not controlled, causes systemic consequences due to prolonged hyperglycemia, including coronary, peripheral, and vascular diseases, including cerebrovascular disease. Microvascular problems include retinopathy, neuropathy, and nephropathy [9].

HbA1c is often evaluated for long-term blood sugar control [10]. According to American Diabetes Association (ADA) standards, a person with an HbA1c level in the range of 4.0-5.6% is non-diabetic (normal patient) and a person with an HbA1c level in the range of 5.7- 6.4% is pre-diabetic. While, people who had an HbA1c level above 6.5% were diagnosed with DM [11].

DM can be associated with oral conditions such as xerostomia, gingivitis, periodontitis, tooth loss, caries, periapical lesions, taste disturbances and salivary gland dysfunction [12]. Periodontal disease is a chronic inflammatory disease and the sixth most common cause of diabetes-related complications [13]. Various oral mucosal lesions such as recurrent aphthous stomatitis, lichen planus, and angular stomatitis have been identified in DPs [14]. Complications with T2DM in the oral cavity are caused by neutrophil dysfunction, microangiopathy, neuropathy, decreased collagen synthesis, and decreased collagenase activity [15].

Multidisciplinary strategies are needed for prevention, early detection and adequate management of oral complications [16]. Therefore, primary care physicians should be more aware of these complications [17]. Dental practitioners can play an active role in detecting and minimizing complications, morbidity and mortality associated with undiagnosed DM by screening patients for oral health and referring such patients to physicians for definitive diagnosis [18].

## Materials and Methods

This study was conducted in 426 adults of both genders who were diagnosed with T2DM and attended the Diabetes and Endocrinology Center, Libyan Ministry of Health, Tripoli for one year from January 2023 to September 2023.

A complete medical history was collected and a general examination related to diabetes was performed. According to medical records, they had high blood sugar level and had been diabetic for some time. This study sample included controlled (HbA1c 7%) and non-controlled (HbA1c > 7%) type 2 DPs.

Additional details, such as demographics, previous dental history, and oral hygiene routines, were recorded. Oral medicine specialist performed clinical intra-oral examinations of soft and hard tissues in the same center's dental clinic. According to WHO guidelines, the state of the lips, tongue, floor of the mouth, alveolar mucosa, hard and soft palates, and use of dentures were all evaluated. Furthermore, each patient with angular cheilitis, dental caries, missing teeth, gingivitis, periodontitis, and other mucosal lesions (burning sensation or xerostomia) were observed. All patients provided written informed consent when the study was described to them.

The acquired data was then tabulated and forwarded for statistical analysis using Microsoft Excel (Microsoft Office 2013) and SPSS® 21 (IBM, USA). Mean and standard deviation were used to summarize the quantitative data. The qualitative data was described using cross tabulation tables, bar and pie charts. To determine the P value, the Chi-square test was used to investigate the significant presence of oral and systemic problems associated with T2DM. A P value of 0.05 was deemed statistically significant.

## Result

This study included 426 T2DM patients, with 222 (52.1%) were males and 204 (47.9%) were females, yielding a male-to-female ratio of approximately 1.1:1. There was no significant gender difference ( $p = 0.383$ ) (Fig. 1).

Diabetic participants ranged in age from 23 to 95 years old, with a mean age of 58.62 years, a standard deviation (SD) of 10.4 years, and a median age of 59 years.

Subjects were stratified into three age groups (<50, 50-69, ≥70). The number of NCDPs exceeded that of CDPs across all age groups, with a noteworthy increase noted in the 50-69 age group (Fig. 2). Additionally, the prevalence of oral complications was markedly higher in the 50-69 age group, demonstrating statistical significance ( $p < 0.001$ ) (Table 1).

HbA1c readings revealed 331 (77.7%) NCDPs and 95 (22.3%) CDPs (Fig. 3), showing that the percentage of NCDPs was significantly greater than that of CDPs ( $p < 0.001$ ).

With 422 DPs diagnosed with oral complications, the prevalence of oral complications in all diabetes cases was 99.1%. Tongue lesions was the most common oral complication observed in the sample 327 (77.5%), followed by tooth loss 312 (73.9%), periodontitis 305 (27.3%), carious lesions in 240 (56.9%), xerostomia in 226 (53.6%), angular cheilitis in 85 (20.1%), burning sensation in 74 (17.5%), gingivitis in 49 (11.6%), and oral ulceration in 9 (2.1%) (Table 2).

A fissured tongue was the most common tongue lesion in the entire study category, accounting for 327 (76.8%) of the cases (Fig. 4). Other tongue lesions seen included median rhomboid glossitis (MRG) in seven (1.6%) cases, benign migratory glossitis (BMG) in three (0.7%) cases, hairy tongue (HT) in two (0.5%) cases, and lichen planus (LP) in one (0.2%) case (Fig. 5).

Table 3 displays the distribution and percentage of oral complications according to gender, presenting male-to-female ratios for each oral lesion.

Among 187 DPs with systemic complications (hypertension, cardiac diseases, and retinopathy), 79 were males and 108 were females. The prevalence of these systemic complications, according to age distribution, was significantly higher in the 50-69 age group, while being least prevalent in those <50 years old. The difference was statistically not significant ( $P = 0.391$ ) (Table 4).

Examining the association between systemic diseases and oral complications revealed that hypertension (104 cases) was highly frequent with fissured tongue (89 cases), cardiac diseases (49 cases) were more frequently associated with periodontitis (43 cases), and retinopathy (34 cases) was more frequent with teeth loss (28 cases) (Table 5).

## Discussion

The goal of this study was to detect oral and systemic problems correlated with CDPs and NCDPs T2DM in a sample of Libyans.

NCDPs are more susceptible to systemic and oral problems [9]. In our study, HbA1c analysis revealed 331 (77.7%) NCDPs and 95 (22.3%) CDPs. Variable results found in various parts of the world can be attributable to differences in sample sizes and patient education.

In young and middle-aged populations, men show a higher prevalence of T2DM than women [19]. In presented study, 52.1% of the patients were males while 47.9% of the patients were females with no significant differences between males

and females ( $p = 0.383$ ). This finding was in agreement with the study conducted by Vidyashri, *et al* (2021) [20] and also concordance with Tracey, *et al* (2016) [21] who stated that the prevalence of T2DM was consistently higher in males compared to females.

DM affects people of all ages, but it is more frequent in adults. [18]. In this study, the age group most frequently involved and significantly higher was 50-69 age group. This result was similar to study conducted by Alqurashi, *et al* (2011) [22] who found that the age most frequently affected was over 50 years and inconsistent with Kathiresan, *et al* (2017) [1] and MIMOZA, *et al* (2022) [2] who reported that majority of diabetic patients belonged to the age group of 41 to 50 year olds.

Although there are no specific oral diseases correlated with DM, persistent hyperglycemia may result in oral manifestations such as burning sensations of the oral mucosa, xerostomia, caries, and periodontal disease, which can lead to premature tooth loss [4]. Tooth loss (73.9%) was the most prevalent oral complication in our study, followed by periodontitis (72.3%), carious lesions (56.9%), xerostomia (53.6%), angular cheilitis (20.1%), burning sensation (17.5%), gingivitis (11.6%), and oral ulceration (2.1%). This findings were in agreement with Aiuto, *et al* (2017) [23] who stated that the two most common diseases affecting oral health are dental caries and periodontitis in DM type 2 and also in agreement with Wang *et al* (2020) [24] who reported that NCDPs are at a higher risk of tooth loss. While in disagreement with MIMOZA, *et al* (2022) [12] who reported that the gingivitis was the most common oral complication and also inconsistent with Rohani (2019) [25] who stated that periodontal disease has been reported with increased incidence and prevalence in patients with type1 and 2 DM. Furthermore, many previous studies revealed that the main oral complication attributed to diabetes is periodontal disease, considered the 6<sup>th</sup> complication of DM [6].

Diabetes causes xerostomia, which increases the occurrence of dental caries due to decreased clearance of dental plaque microbes, as well as taste impairment [26]. In the presented study the most commonly manifested oral lesions (99.1%) related to T2DM were markedly higher in the 50-69 age group, demonstrating statistical significance ( $p < 0.001$ ) and included teeth loss, periodontitis, carious teeth, xerostomia, gingivitis, angular cheilitis, burning sensation, geographic tongue, fissured tongue, MRG, oral lichen planus and mouth ulcerations. Many previous studies confirmed the presence of these oral lesions. Furthermore, it is clear that the

majority of these complications developed in the middle and elderly age groups.

Poor prolonged glycemic control of DM causes serious systemic complications such as diabetic retinopathy, diabetic nephropathy, coronary heart disease and stroke [27]. In our study, the most prevalent types of systemic complications were hypertension (67.5%), cardiac diseases (31.8%), and retinopathy (22.1%). This findings were consistent with Vidyashri, *et al* (2021) [20] who conducted study on 800 DPs and found that the most common associated systemic complication observed was hypertension (32.57%) and also consistent with Dregan, *et al* (2014) [28] who found that hypertension was more prevalent. Whilst inconsistent with Priya, *et al* (2020) [29] who carried study on 310 DPs and revealed that the most common systemic complication was diabetic retinopathy (34.8%) and also inconsistent with Bajaj, *et al* (2012) [30] who reported that retinopathy was significantly more prevalent in DPs.

Teeth loss as an indicator for oral health reputation has a more potent association with risk of diabetes complications. [31] The current study found a correlation between oral and systemic complications, with hypertension was highly prevalent with fissured tongue, cardiac diseases were more commonly associated with periodontitis and retinopathy was more frequent with teeth loss. However, the presence of oral complications could be used as a predictor of DM and some systemic diseases or vice versa.

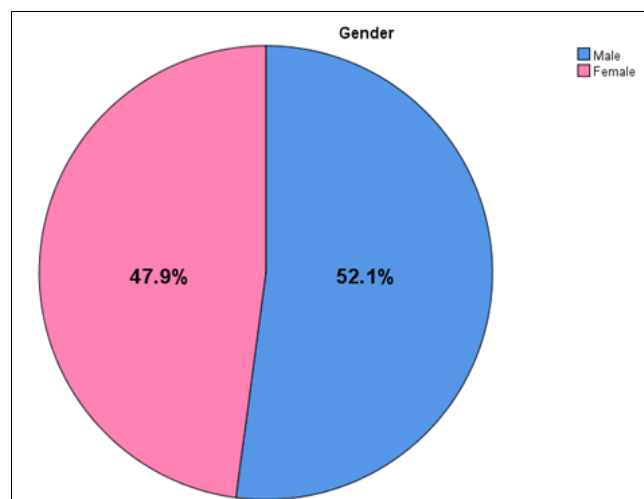


Fig 1: Pie chart representing the percentage distribution of DPs in the entire study sample according to the gender

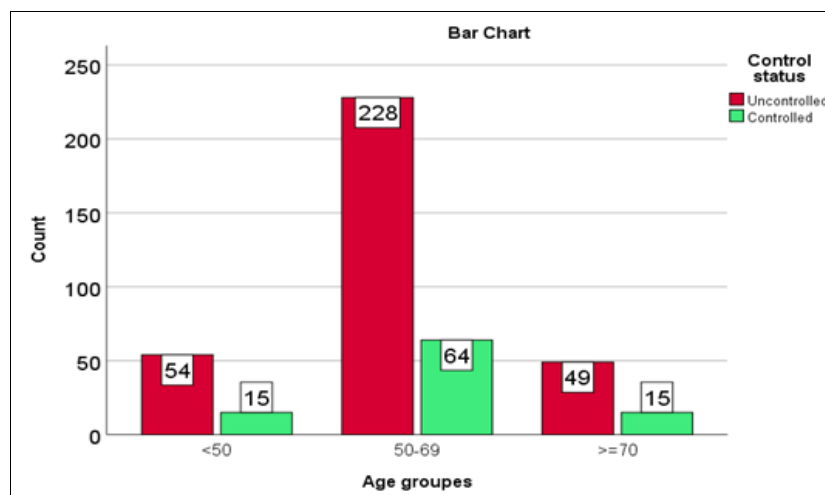
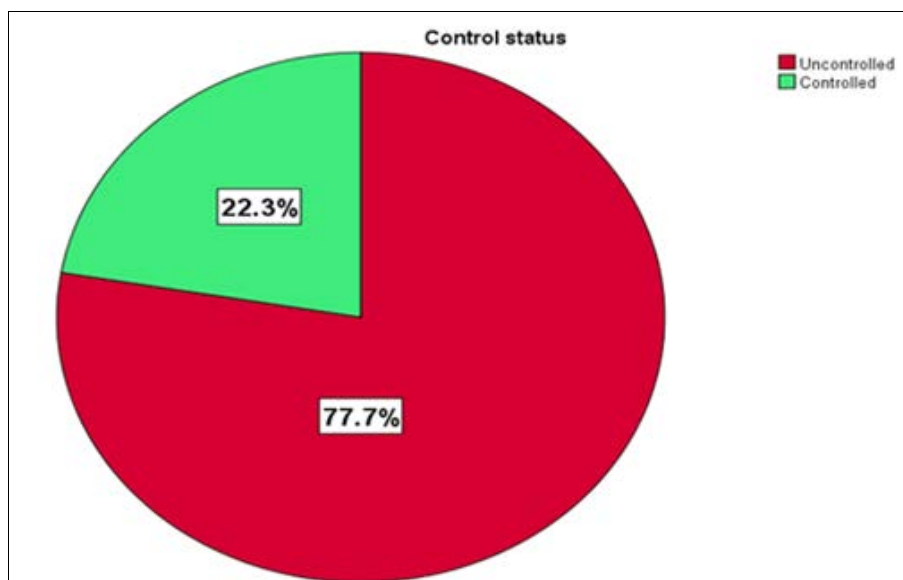


Fig 2: Bar graphs shows association of control status with different age groups

**Table 1:** Association of oral complications with the different age groups, it was markedly higher in the 50-69 age group

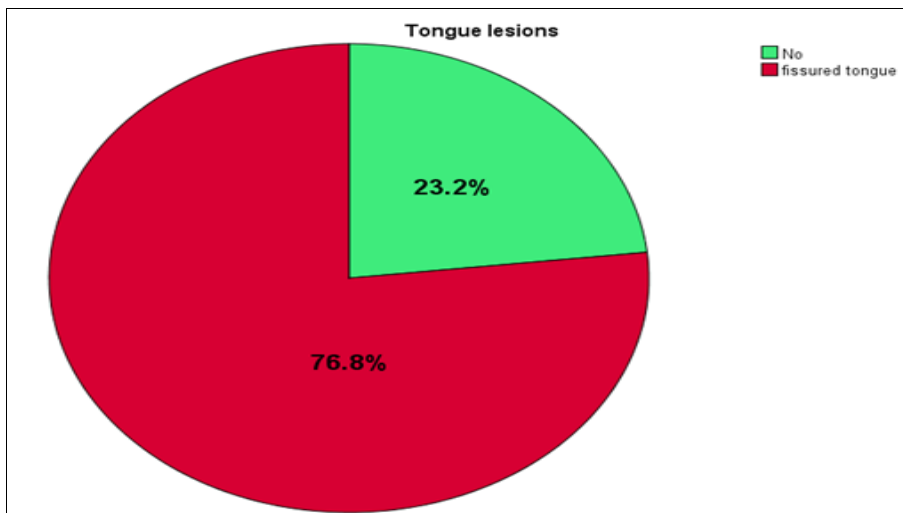
Oral complications	number & percentage	Age groups			Total
		<50	50-69	>=70	
Xerostomia	Count	37	153	36	226
	% within Oral complications	16.4%	67.7%	15.9%	100.0%
Burning sensation	Count	11	58	5	74
	% within Oral complications	14.9%	78.4%	6.8%	100.0%
Angular Cheilitis	Count	5	63	17	85
	% within Oral complications	5.9%	74.1%	20.0%	100.0%
Gingivitis	Count	21	25	3	49
	% within Oral complications	42.9%	51.0%	6.1%	100.0%
Periodontitis	Count	36	223	45	304
	% within Oral complications	11.8%	73.4%	14.8%	100.0%
Teeth loss	Count	40	221	50	311
	% within Oral complications	12.9%	71.1%	16.1%	100.0%
Cariou lesion	Count	44	167	28	239
	% within Oral complications	18.4%	69.9%	11.7%	100.0%
Fissured tongue	Count	53	219	55	327
	% within Oral complications	16.2%	67.0%	16.8%	100.0%
Ulcerations	Count	0	8	1	9
	% within Oral complications	0.0%	88.9%	11.1%	100.0%
Total	Count	247	1137	240	1624
	% within Oral complications	15.2%	70.0%	14.8%	100.0%



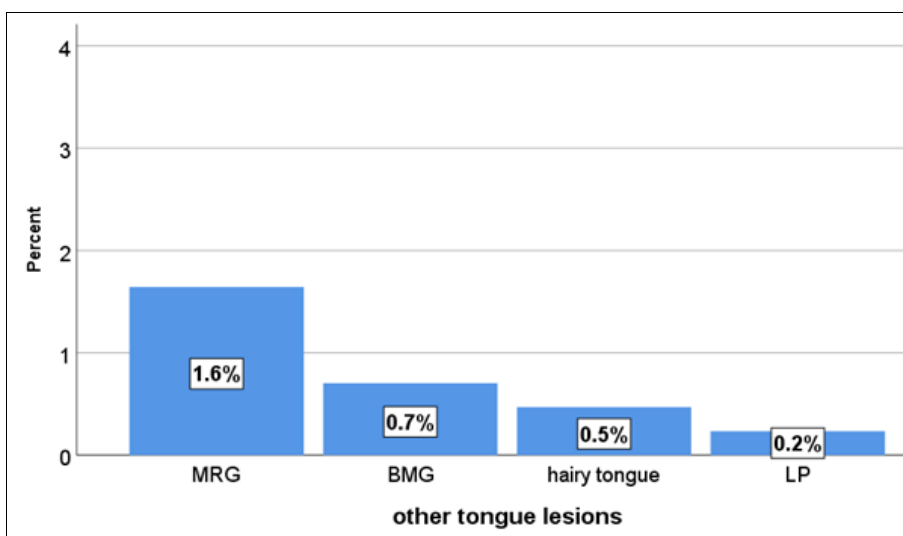
**Fig 3:** Pie chart shows the percentage distribution of uncontrolled and controlled DPs in the entire study sample

**Table 2:** Frequency and percentage distribution of the most common oral complications

Oral complications	Number of cases	Percent of Cases
Xerostomia	226	53.6%
Burning sensation	74	17.5%
Angular Cheilitis	85	20.1%
Gingivitis	49	11.6%
Periodontitis	305	72.3%
Teeth loss	312	73.9%
Cariou lesion	240	56.9%
Tongue lesions	327	77.5%
Ulcerations	9	2.1%
Total	1627	385.5%



**Fig 4:** Pie chart shows the percentage distribution of fissured tongue in the entire study sample



**Fig 5:** Bar graphS demonstrates the percentage distribution of other tongue lesions

**Table 3:** The distribution of oral complication according to the gender with male-to-female ratios for each oral lesion

Oral manifestation	Males	Females	Ratios approximation
Xerostomia	101	125	1: 1.2
Burning sensation	30	44	1: 1.5
Angular Cheilitis	39	46	1: 1.2
Gingivitis	21	28	1: 1.3
Periodontitis	158	147	1: 0.9
Teeth loss	162	150	1: 0.9
Cariou lesion	114	126	1: 1.1
Fissured tongue	170	157	1: 0.9
Ulcerations	2	7	1: 3.5

**Table 4:** The frequency of associated systemic diseases according to the different age groups was significantly higher in the 50-69 age group

Associated systemic diseases	Age groups		
	<50	50-69	>=70
	Count	Count	Count
Hypertensive	9	70	25
Cardiac diseases	2	33	14
Retinopathy	3	25	6

**Table 5:** Association between associated systemic diseases and oral complications

Associated systemic diseases	Oral Complications								
	Xerostomia	Burning sensation	Angular Cheilitis	Gingivitis	Periodontitis	Teeth loss	Cariou lesion	Fissured tongue	Ulcerations
	Count	Count	Count	Count	Count	Count	Count	Count	Count
Hypertensive	64	20	25	3	83	81	60	89	2



Cardiac diseases	23	8	17	3	43	38	28	38	1
Retinopathy	15	6	10	2	27	28	19	27	2

## Conclusion

According to the study, diabetes is a prevalent chronic metabolic illness with multiple oral and systemic symptoms. Periodontitis, carious lesions, xerostomia, angular cheilitis, burning sensation, gingivitis, and oral ulceration were the most prevalent oral complications seen. While hypertension, heart disorders, and retinopathy were the most prevalent systemic complications. Both complications are more commonly seen in middle-aged and elderly persons aged 50 to 69 years old. In the Libyan population, there was a substantial association between T2DM and oral and systemic complications with hypertension was significantly connected with fissured tongue, cardiac disorders were more commonly associated with periodontitis, and retinopathy was more frequently associated with tooth loss. Oral complications in DPs were indicative of an uncontrolled glycemic state.

Dentists and physicians must educate and motivate DPs about the oral and systemic complications correlated with DM and inform them about the impact of these issues on oral and general health in order to promote good oral health and lower the risk of systemic consequences. However, diabetes management is required to avoid periodontal disorders, tooth loss, carious lesions, xerostomia, gingivitis, and angular cheilitis.

**Conflict of Interest:** Not available

**Financial Support:** Not available

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