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Determining the frequency of Candida and its strains in diabetic and non-diabetic patients

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ABSTRACT

Introduction: Diabetes is the most common endocrine disease, which affects about 150 million people worldwide. Disruption of the immune system and other factors reduces the resistance to microorganisms in diabetic patients. Therefore, the aim of this study was to determine the prevalence of Candida and its strains in diabetic and non-diabetic patients. *Materials and methods:* This cross-sectional and analytical study was conducted on 60 hospitalized patients, among whom 30 were diabetic and 30 were non-diabetic during June 2021 to December 2021. According to the location of the infection, sampling was done using a swab or a slow scalpel blade. Demographic information of patients such as: Age, gender, level of education, occupation, site of infection, underlying disease and drug use were collected. *Results:* The status of the frequency of isolated oral Candida showed no significant relationship between gender and the frequency of oral Candida (P=0.593). In our study there is no association between insulin intake, artificial teeth, smoking, antibiotic use, place of residence, level of education, age, duration of diabetes with Candidiasis (P>0.05). The results showed a significant relationship between the frequency of oral Candida isolated from diabetic and non-diabetic patients and the type of diabetes observed (P=0.008). *Conclusion:* In our research, there was a significant relationship between oral Candida infection and the type of diabetes and no significant relationship between diabetic and non-diabetic patients with the frequency of Candida and its strains.

Keywords: *Candida albicans*, Strain, Diabetic patients, Non-diabetic patients.

1. INTRODUCTION

Diabetes Mellitus is a chronic metabolic disease that affects many organs of the body. Due to the global changes in people's lives, it seems that diseases such as diabetes are of special importance in health systems nowadays (Meira et al., 2017; Patil et al., 2015). Due to the changes in the structure and function of different organs and tissues of the body during this disease, the arena is

prepared for the colonization of various objects. Patients with diabetes mellitus are prone to increase the growth of Candida in the oral cavity due to a defect in the function of oral saliva, a decrease in saliva pH and a high saliva glucose concentration, which provides the basis for the growth of fungi and Candida infections (Premkumar et al., 2014).

Candida is small ovoid yeast with a thin wall and a diameter of 4-6 microns and reproduces by budding. The Candida genus has more than 150 species, only a few of which cause disease in humans (Patel et al., 2017). Candida species, as one of the important members of the normal flora in the skin, digestive tract and vagina of most people, can be the cause of serious infections in these patients due to immunodeficiency. Fungal infections bother diabetic patients in a variety of ways. Oral mucosal tissue infection caused by different species of Candida, especially *Candida albicans*, is one of the most common infections in people with diabetes (Kumar et al., 2015; Rodrigues et al., 2019).

Diabetics are more susceptible to some infections. Oral candidiasis is one of the most common opportunistic infections in diabetic patients and those suffering from cellular immunodeficiency (Maboudi et al., 2019). Clinical forms of oral candidiasis include erythromatous candidiasis, pseudomembranous candidiasis, Angular cheilitis, Candida leukoplakia and median rhomboid glossitis. Oral infection in these people can be seen in the form of white lesions on the cheeks, gums and tongue, which are painless and in some cases, this infection can also involve the throat. Candida infection can be diagnosed by observing the clinical appearance of the lesion and observing pseudohyphae or hyphae in wet samples (saline and potassium hydroxide 10%) and gram staining for tissue (Singh et al., 2014; Chouhan et al., 2019; Zomorodian et al., 2016). Local and systemic treatments can be used to treat oral candidiasis depending on the patient's condition and type of disease (Mohammadi et al., 2016; Martinez et al., 2013; Sharma et al., 2017; Zakavi et al., 2015).

The increase in the prevalence of fungal infections caused by Candida species and strains resistant to antifungal drugs is one of the challenges facing the disease. Also, special attention should be paid to the toxicity of the drugs used, problems caused by drug interactions and the need to use drugs with greater effect and less toxicity in relation to the risks of fungal infections, including Candida, in diabetic patients. In this regard, the purpose of this was to determine the prevalence of oral candidiasis in the population of diabetic and non-diabetic patients, to identify different species of Candida and to compare their population structure in diabetic and non-diabetic patients.

2. MATERIALS AND METHODS

This cross-sectional and analytical study was conducted on the patients of Valiasr Hospital, Zanjan-Iran June 2021 to December 2021, who were collected as available samples in a one-week period. Inclusion criteria included type 1 and 2 diabetic patients and hospitalization. Exclusion criteria included lack of informed consent.

Sample size

According to the following formula, there were 30 diabetics and 30 non-diabetic individuals in our research, consisting of 60 patients.

Procedure

According to the site of infection, sampling was done using a swab or a blunt scalpel blade and the demographic information of the patients such as: Age, sex, level of education, occupation, site of infection, underlying disease and drug use were collected. The samples were immediately cultured on subrodextrose agar containing gentamicin and chloramphenicol. After culture, slide samples were prepared for direct observation and gram staining. The plates were incubated for 48 hours at 30 degrees and then the results were analyzed. In this study, several different methods were used, including: 1-Carbohydrate fermentation tests by different Candida species, 2-Use of CHROMagar Candida medium, 3-Germ tube test, 4- Rapid nitrogen regeneration test was used to isolate Candida and its types.

Data analysis

Quantitative variables were described as mean (standard deviation) and qualitative variables as number (percentage). The data was analyzed using SPSS version 21 software. A significance level of 0.05 was considered.

Ethical considerations

The information of all patients was kept confidential with the project manager. This study was performed in accordance with relevant guidelines and regulations in the ethics research committees of the University of Medical Sciences and Declaration of

Helsinki. The project was carried out after being approved by the Research Council of the Faculty of Medicine (IR.ZUMS.REC.1397.211).

3. RESULTS

In our research 60 patients, were included total. The frequency distribution of the basic characteristics of the studied population is in Table 1. Table 2 shows the frequency distribution of the basic characteristics of the study population in 2 groups.

Table 1 Frequency distribution of basic characteristics of the studied population

Variable	Condition	Percent (Frequency)
Gender	Male	41.7% (25)
	Female	58.3% (35)
Education	Under diploma	86.7% (52)
	Diploma	6.7% (4)
	University	6.7% (4)
Address	City	46.7% (28)
	Village	53.3% (32)
Insulin use	Has	33.3% (20)
	Has no	66.7% (40)
Taking oral sugar control medication	Has	40% (24)
	Has no	60% (36)
Dentures	Has	38.3% (23)
	Has no	61.7% (37)
Taking antibiotics in the last month	Had	13.3% (8)
	Had no	86.7% (52)
Smoking	Has	21.7% (13)
	Has no	78.3% (47)
Diabetic type	Diabetic type 1	23.3% (7)
	Diabetic type 2	76.7% (23)
Receiving immunosuppressive drugs	Has	15% (9)
	Has no	85% (51)
Non-diabetic underlying disease	Has	68.3% (41)
	Has no	31.7% (19)
Age	Under 40 years	18.3% (11)
	Between 40 and 60 years	30% (18)
	Over 60 years old	51.7% (31)
Duration of diabetes	Under 5 years	23.3% (7)
	Between 5 and 10 years	26.7% (8)
	Above 10 years	50% (15)

The prevalence of oral candidiasis isolated from patients was investigated. According to the study, candidiasis was found in 56.6% (17 people) of diabetic patients and 63.3% (19 people) of non-diabetic patients and no significant relationship was found between them (P=0.598). The spread of candidiasis (oral), isolated from patients according to gender showed that Candida was found in 40% (4 cases) of diabetic male patients and 66.7% (10 people) of non-diabetic male patients. Furthermore, candidiasis was found in 65% (13 cases) of diabetic female patients and 60% (9 people) of non-diabetic female patients and no significant relationship was found between gender and frequency of oral candidiasis (P=0.593).

Table 2 Frequency distribution of basic characteristics of the study population in 2 groups

Variable	Condition	Percent (Frequency)		P-value
		Diabetic	Non-diabetic	
Gender	Male	33.3% (10)	50% (15)	0.295
	Female	66.7% (20)	50% (15)	
Education	Under diploma	90% (27)	83.3% (25)	0.584
	Diploma	3.3% (1)	10% (3)	
	University	6.7% (2)	6.7% (2)	
Address	City	63.3% (19)	30% (9)	0.01
	Village	36.7% (11)	70% (21)	
Dentures	Has	43.3% (13)	33.3% (10)	0.426
	Has no	56.7% (17)	66.7% (20)	
Taking antibiotics in the last month	Had	10% (3)	16.7% (5)	0.448
	Had no	90% (27)	3/83% (25)	
Smoking	Has	20% (6)	23.3% (7)	0.754
	Has no	80% (24)	76.7% (23)	
Receiving immunosuppressive drugs	Has	3.3% (1)	26.7% (8)	0.011
	Has no	96.7% (29)	73.3% (22)	
Non-diabetic underlying disease	Has	73.3% (22)	63.3% (19)	0.405
	Has no	26.7% (8)	36.7% (11)	
Age	Under 40 years	10% (3)	26.7% (8)	0.214
	Between 40 and 60 years	30% (9)	30% (9)	
	Over 60 years old	60% (18)	43.3% (13)	

The spread of candidiasis (oral) isolated from patients according to insulin intake showed that 65% (13 cases) of diabetic patients receiving insulin were infected with oral Candida and 40% (6 people) of diabetic patients not receiving insulin were infected with oral candidiasis. No significant relationship was found between the prevalence of oral candidiasis isolated from diabetic and non-diabetic patients and insulin consumption (P=0.196).

The spread of candidiasis (oral) isolated from diabetic and non-diabetic patients with artificial teeth showed that 61.1% (11 people) of diabetic patients and 70% (7 people) of non-diabetic patients were infected with oral candidiasis. Among patients who do not use artificial teeth, 50% (6 people) of diabetic patients and 60% (12 people) of non-diabetic patients were infected with oral candidiasis. No significant relationship was found between the prevalence of oral candidiasis isolated from diabetic and non-diabetic patients using dentures (P=0.665). The spread of candidiasis (oral) isolated from diabetic and non-diabetic patients admitted to the hospital was investigated according to smoking. According to the results, among patients who use cigarettes, 33.3% (2 people) of non-diabetic patients and 71.4% (5 people) of diabetic patients were infected with oral candidiasis. Also, among patients who do not use cigarettes, 62.5% (15 people) of diabetic patients and 60.9% (14 people) of non-diabetic patients were infected with oral candidiasis. No significant relationship was found between the spread of candidiasis (oral) isolated from diabetic and non-diabetic patients and smoking (P=0.609).

The spread of candidiasis (oral) isolated from patients according to antibiotic use in one month showed that among the patients who used antibiotics in the last month, 66.7% (2 people) of diabetic patients and 100% (5 people) of Non-diabetic patients were infected with oral candidiasis. Furthermore, among patients who did not take antibiotics in the last month, 55.6% (15 people) of diabetic patients and 56% (14 people) of non-diabetic patients were infected with oral candidiasis. No significant relationship was observed between the frequency of isolated oral candidiasis and antibiotic consumption in the last month (P=0.088).

The results of the frequency of oral candidiasis isolated from diabetic and non-diabetic patients according to the type of diabetes showed that among people with diabetes, 100% (7 people) of people with type 1 diabetes were infected with oral candidiasis and 43.5% (10 people) of type 2 diabetes patients were infected with oral candidiasis. There was a significant relationship between the spread of candidiasis (oral) isolated from diabetic and non-diabetic patients and the type of diabetes (P=0.008). The frequency of oral Candida according to the place of residence demonstrated that 54.5% (6 cases) of diabetic patients living in the village and 61.9% (13 people) of non-diabetic patients living in the village were infected with oral candidiasis.

Furthermore, among patients living in the city, 57.9% (11 cases) of diabetic patients and 66.7% (6 people) of non-diabetic patients were infected with oral candidiasis and no statistically significant relation between the prevalence of candidiasis (oral) and the place of residence (P=0.916).

The prevalence of candidiasis (oral) similar to the level of education showed that among patients who have education below diploma, 55.6% (15 people) of diabetic patients and 72% (18 people) of non-diabetic patients were infected with oral candidiasis. Among the patients with diploma education, no oral candidiasis was found in any of the diabetic patients, but 33.3% (1 person) of the non-diabetic patients were infected with oral candidiasis. Among the patients with university education, 100% (2 cases) were infected with oral candidiasis. No significant relationship was found between the frequency of oral candidiasis and the level of education of the patients (P=0.291).

In patients under 40 years old, 100% (3 people) of diabetic patients and 62.5% (5 people) of non-diabetic patients were infected with candidiasis. In 40 to 60 years old of patients, 55.6% (5 people) of diabetic patients and 44.4% (4 people) of non-diabetic patients were infected with oral candidiasis. In patients over 60 years old, 50% (9 people) of diabetic patients and 76.9% (10 people) of non-diabetic patients were infected with oral Candida. No significant relationship was found between the prevalence of oral candidiasis and the age of the patients (P=0.469).

In terms of the duration of diabetes, 42.9% (3 people) of diabetic patients with a history of less than 5 years of diabetes were infected with oral candidiasis and in diabetic patients with a history of 5 to 10 years of diabetes, 62.5% (5 people) of them showed the oral candidiasis. Also, 60% (9 people) of diabetic patients with a history of more than 10 years of diabetes A were infected with oral candidiasis. There was no significant relationship between the spread of candidiasis (oral) isolated from diabetic and non-diabetic patients and the duration of diabetes (P=0.698). In addition, 37.5% (3 people) of diabetic patients who had fasting blood sugar less than or equal to 130 (controlled sugar) were infected with oral candidiasis. Furthermore, 66.7% (14 people) of diabetic patients with measured fasting blood sugar more than 130 were infected with oral candidiasis. No significant relationship between the frequency of oral candidiasis and fasting blood sugar measured in patients was found (P=0.218).

The frequency of different oral candida strains isolated according to gender and age (Table 3). The results showed no significant relationship between the prevalence of different strains of oral candidiasis isolated from diabetic and non-diabetic patients and sex and age (P>0.05).

Table 3 Frequency of different oral candida strains isolated according to gender and age

Gender	Diabetic	Oral Candida strains			P-value
		C. albicans	*C. krusei*	*C. tropicalis*	
Male	Positive	30% (3)	0	10% (1)	
	Negative	53.3% (8)	13.3% (2)	0	
Female	Positive	45% (9)	10% (2)	5% (1)	0.758
	Negative	26.7% (4)	20% (3)	13.3% (2)	
Age	Diabetic	Oral Candida strains			
		C. albicans	*C. krusei*	*C. tropicalis*	
Under 40 years	Positive	66.7% (2)	0	0	
	Negative	25% (2)	25% (2)	12.5% (1)	
Between 40 and 60 years	Positive	33.3% (3)	22.2% (2)	0	
	Negative	33.3% (3)	11.1% (1)	0	
Over 60 years old	Positive	38.9% (7)	0	11.1% (2)	0.662
	Negative	53.8% (7)	15.4% (2)	7.7% (1)	

Table 4 shows the frequency of different strains of oral candidiasis according to place of residence, level of education and insulin. The results showed that there was no significant relationship between the frequency of different strains of oral candidiasis and the place of residence, the level of education and insulin of the patients (P>0.05).

Table 4 Frequency of different strains of oral Candida according to place of residence, level of education and insulin

Address	Diabetic	No Candida	Oral Candida strains			P-value
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
City	Positive	47.4% (9)	47.4% (9)	0	5.3% (1)	
	Negative	33.3% (3)	44.4% (4)	11.1% (1)	11.1% (1)	
Village	Positive	45.5% (5)	27.3% (3)	18.2% (2)	9.1% (1)	0.317
	Negative	38.1% (8)	38.1% (8)	19% (4)	4.8% (1)	
Education	Diabetic	No Candida	Oral Candida strains			
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
Under diploma	Positive	48.1% (13)	37% (10)	7.4% (2)	7.4% (2)	
	Negative	28% (7)	44% (11)	20% (5)	8% (2)	
Diploma	Positive	100% (1)	0	0	0	
	Negative	66.7% (2)	33.3% (1)	0	0	0.773
University	Positive	0	100% (2)	0	0	
	Negative	100% (2)	0	0	0	
Insulin	Diabetic	No Candida	Oral Candida strains			
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
Takes	Positive	40% (8)	45% (9)	5% (1)	10% (2)	
No Takes	Positive	60% (6)	30% (3)	10% (1)	0	0.604
	Negative	36.7% (11)	40% (12)	16.7% (5)	6.7% (2)	

The frequency of different oral candidiasis strains isolated from patients according to smoking and non-diabetic underlying disease (Table 5). The results showed that between the prevalence of different isolated oral Candida strains and smoking and non-diabetic underlying disease there were no significant relationship (P>0.05).

Table 5 Frequency of different oral Candida strains isolated from patients according to smoking and non-diabetic underlying disease

Smoking	Diabetic	No Candida	Oral Candida strains			P-value
			C. albicans	*C. krusei*	*C. tropicalis*	
Has	Positive	66.7% (4)	16.7% (1)	0	16.7% (1)	
	Negative	28.6% (2)	71.4% (5)	0	0	
Has no	Positive	41.7% (10)	45.8% (11)	8.3% (2)	4.2% (1)	0.532
	Negative	39.1% (9)	30.4% (7)	21.7% (5)	8.7% (2)	
Non-diabetic underlying disease	Diabetic	No Candida	Oral Candida strains			
			C. albicans	*C. krusei*	*C. tropicalis*	
Has	Positive	40.9% (9)	45.5% (10)	4.5% (1)	9.1% (2)	
	Negative	31.6% (6)	42.1% (8)	21.1% (4)	5.3% (1)	0.704
Has no	Positive	62.5% (5)	25% (2)	12.5% (1)	0	
	Negative	45.5% (5)	36.4% (4)	9.1% (1)	9.1% (1)	

The prevalence of different Candida species isolated from patients according to the duration of diabetes showed that among patients with less than 5 years of diabetes, 28.6% (2 people) showed *Candida albicans*, followed by *Candida tropicalis* (14.3%, 1 cases). Among patients with a history of 5-10 years of diabetes, 12.5% (1 person) showed *Candida albicans*, followed by *Candida krusei* (25%, 2 people) and *Candida tropicalis* (12.5%, 1 person). Among patients with diabetes mellitus for more than 10 years, 60% (9 people) of patients exhibited *Candida albicans*. No significant relationship was observed between the prevalence of different oral candida strains isolated from diabetic and non-diabetic patients and the duration of diabetes (P=0.086). According to the prevalence of

different strains, 66.7% (2 people) of the patients were found to have *Candida albicans*. Among non-diabetic patients who have taken antibiotics in the last month, all of them were infected with oral candidiasis, including *Candida albicans* (60%, 3 persons), *Candida krusei* (20%, 1 person) and *Candida Tropicalis* (20%, 1 person). Among diabetic patients without taking antibiotics in the last month, 37% (10 people) had *Candida albicans*, followed by *Candida krusei* (7.4%, 2 people) and *Candida tropicalis* (7.4%, 2 people). Among non-diabetic patients without taking antibiotics in the last month, 36% (n = 9) had *Candida albicans*, followed by *Candida krusei* (16%, 4 cases) of and (4%, 1 cases) of *Candida tropicalis*. No significant relationship was found between the prevalence of different strains of oral candidiasis and the use of antibiotics in the last month (P=0.317).

The frequency of different strains of oral candidiasis isolated from patients according to the type of diabetes showed that 85.7% (6 people) of patients with type 1 diabetes had *Candida albicans*, while the other two species were not observed. Furthermore, 26.1% (6 people) of type 2 diabetes patients showed *Candida albicans*, followed by *Candida krusei* (8.7%, 2 people) and *Candida tropicalis* (8.7%, 2 people). A significant relationship was observed between the prevalence of different strains of oral candidiasis and the type of diabetes (P=0.045).

Table 6 shows the frequency of different oral Candida strains isolated from patients according to fasting blood sugar, immunosuppressive drug and diabetes status. The results showed no significant relationship between the prevalence of different oral candida strains and fasting blood sugar, immunosuppressive drugs and diabetes status (P>0.05).

Table 6 Frequency of different oral Candida strains isolated from patients according to fasting blood sugar, immunosuppressive drug and diabetes status

Fasting blood sugar	Diabetic	No Candida	Oral Candida strains			P-value
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
Less than or equal to 130	Positive	62.5% (5)	25% (2)	12.5% (1)	0	0.432
More than 130	Positive	38.1% (8)	47.6% (10)	4.8% (1)	9.5% (2)	
Receiving of immunosuppressive drug	Diabetic	No Candida	Oral Candida strains			0.072
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
Has	Positive	48.3% (14)	41.4% (12)	3.4% (1)	6.9% (2)	
	Negative	45.5% (10)	27.3% (6)	18.2% (4)	9.1% (2)	
Has no	Positive	0	0	100% (1)	0	
	Negative	12.5% (1)	75% (6)	12.5% (1)	0	
Diabetes status	Number	No Candida	Oral Candida strains			0.649
			C. Albicans	*C. Krusei*	*C. Tropicalis*	
Has	30	46.7% (14)	40% (12)	6.7% (2)	6.7% (2)	
Has no	30	36.7% (11)	40% (12)	16.7% (5)	6.7% (2)	

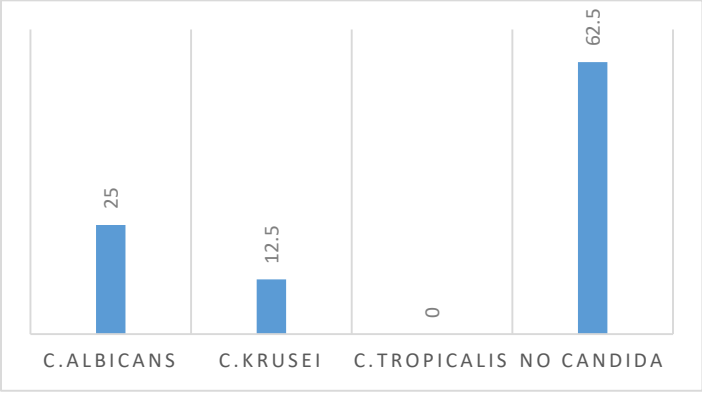

Figure 1 Frequency of different oral Candida strains isolated from positive diabetic patients according to fasting blood sugar, Less than or equal to 130

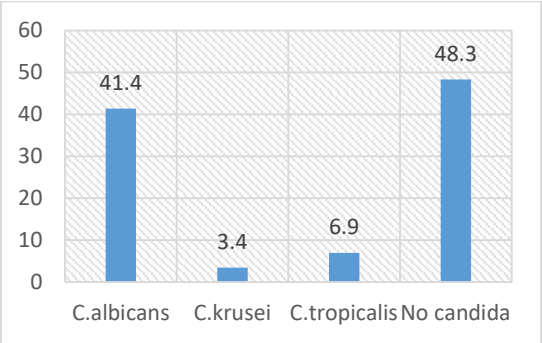

Figure 2 Frequency of different oral Candida strains isolated from positive diabetic patients according to receiving of immunosuppressive drug

4. DISCUSSION

Diabetes is the most common endocrine disease, which affects about 150 million people worldwide (Kawashita et al., 2020). Disruption of the immune system and other factors reduces the resistance to microorganisms in diabetic patients and these patients suffer from various infections, which are related to poor blood sugar control in these patients (Nazir et al., 2018; Deshpande et al., 2018). Therefore, the purpose of our research was to determine the prevalence of Candida and its strains in non-diabetic and diabetic patients.

The results of the present study did not show a significant relationship between the presence of diabetes and the positivity of oral samples in terms of Candida, although diabetes can cause the growth of some organisms including fungal infections (e.g., *Candida albicans*) due to immune deficiency. However, it should be noted that the present study only evaluated the positivity of the organism and not the clinical manifestations of the disease. Usually, pathogens can exist in different tissues saprophytically or sometimes due to local contamination and immune deficiency in these cases will cause the organisms to show their clinical forms.

The lack of relationship between diabetes and *Candida albicans* in the present study could be due to this (Rajakumari and Kumari, 2016). On the other hand, factors such as the duration of hospitalization of patients, other underlying diseases, as well as other known immune deficiencies in hospitalized patients can also be effective in this field. On the other hand, more medical and health care is provided for patients, which can contribute to the possible reduction of organisms in this category of patients. In addition, if diabetes plays an effective role in immunodeficiency, it is necessary that patients are involved for a long time and the disease is not under control (Soni et al., 2019). Although there was no significant relation between diabetes and Candida by gender, the frequency of Candida in diabetic women was higher than in non-diabetic women, while the situation was different in men, this could be influenced by other variables in this study. More drug addiction and smoking in men and less opium and smoking in diabetics can cause this difference.

In the present study, the effect of type of diabetes on Candida infection was evaluated. The results showed that there is a significant relationship between the type of diabetes and the frequency of oral Candida infection, so that this frequency was significantly higher in type 1 diabetes than in type 2 diabetes, while 100% of type 1 diabetics were infected with oral Candida. In type 2 diabetes, this rate was only 43.5%. Although there was no significant relationship between diabetes and Candida according to smoking, the frequency of Candida among diabetic patients who smoke is higher than among diabetic patients who do not smoke. Furthermore, despite the absence of a significant relationship between diabetes and Candida according to the use of antibiotics in the last month, in the present study, the frequency of Candida among diabetic patients who have used antibiotics in the last month is more than that of diabetic patients who have used antibiotics in the last month. This was also observed among non-diabetic patients who had taken antibiotics in the last month.

In all separated groups, *Candida albicans* were the utmost abundant species, which is in line with previous studies. In the study conducted by Mohammadi et al., (2016) the frequency of Candida isolated from the mouth of diabetic patients was higher compared to non-diabetic patients. The most common Candida species among them was *Candida albicans* (36.2%), followed by *Candida krusei* (10.4%) and *Candida tropicalis* (2.4%) that the predominance of *Candida albicans* in mentioned study is consistent with the present study.

A study conducted by Zommorodian et al., (2016) showed that the frequency of Candida isolated from the mouths of diabetic patients was higher compared to healthy people, which is not consistent with the present study. Although no significant correlation was found between the high prevalence of Candida and glycosylated hemoglobin, the most common isolated Candida species among all ten healthy and diabetic groups was *Candida albicans*. In the study conducted by Premkumar et al., (2014) diabetic

patients showed significantly higher frequency and prevalence of Candida colonization. *Candida albicans* species was the most prevalent among Candida colonies isolated from patients, which is consistent with the present study.

In the study conducted by Kumar et al., (2015) 83% of patients with type 1 diabetes and 68.5% of patients with type 2 diabetes were infected with oral Candida, which is consistent with the present study. A study conducted by Martinez et al., (2013) evaluated 141 patients where Candida isolates were found in 58 patients. The most common species obtained was *Candida albicans* (82.7%), which is consistent with the present study. Twenty-one people (45.6%) also had blood sugar above 126. Also, Candida isolated from patients was 31.6% among patients with dental prosthesis and 9 out of 15 smoking patients (60%) were infected with oral Candida (Martinez et al., 2013).

Finally, this study did not show a significant relationship between the frequency of positive samples collected from patients in terms of Candida organism and diabetes. However, the type of diabetes in this context showed a significant relationship with the frequency of this organism in the samples, where 100% of the samples collected from patients with type 1 diabetes were reported to be Candida positive.

5. CONCLUSION

In our study there were no significant relation between the frequency of Candida and its strains in 2 groups. However, the type of diabetes showed a significant relationship with oral Candida infection.

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Author Contributions

All authors contributed to the design of the study, as well as data collection and analysis and the writing of the manuscript. All authors read and approved the final manuscript.

Ethical approval

The study was approved by the Medical Ethics Committee of (Ethical approval code: IR.ZUMS.REC.1397.211).

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES AND NOTES

1. Chouhan S, Kallianpur S, Prabhu KT, Tijare M, Kasetty S. Candidal prevalence in diabetics and its species identification. Int J Appl Basic Med Res 2019; 9:49.
2. Deshpande NP, Riordan SM, Castaño-Rodríguez N, Wilkins MR. Signatures within the esophageal micro biome is associated with host genetics, age and disease. Microbiome 2018; 6:1-14.
3. Kawashita Y, Soutome S, Umeda M, Saito T. Oral management strategies for radiotherapy of head and neck cancer. Jpn Dent Sci Rev 2020; 56:62-67.
4. Kumar DA, Muralidhar S, Banerjee U, Basir SF, Mathur P, Khan LA. Diversity and antifungal resistance patterns of prevalent opportunistic pathogenic yeasts colonizing the oral cavities of asymptomatic human immune deficiency virus-infected individuals and their relation to CD4+ counts. Indian J Sex Transm Dis AIDS 2015; 36:53.

5. Maboudi A, Akha O, Heidari M, Mohammadpour RA, Gheblenama P, Shiva A. Relation between periodontitis and pre diabetic condition. J Dent 2019; 20:83.
6. Martinez RF, Jaimes-Aveldañez A, Hernández-Pérez F, Arenas R, Miguel GF. Oral Candida spp carriers: Its prevalence in patients with type 2 diabetes mellitus. Anais Brasileiros de Dermatol 2013; 88:222-225.
7. Meira HC, De-Oliveira BM, Pereira IF, Naves MD, Mesquita RA, Santos VR. Oral candidiasis: A retrospective study of 276 Brazilian patients. J Oral Maxillofac Pathol 2017; 21:351.
8. Mohammadi F, Javaheri MR, Nekoeian S, Dehghan P. Identification of Candida species in the oral cavity of diabetic patients. Curr Med Mycol 2016; 2:1.
9. Nazir MA, Alghamdi L, Alkadi M, Albeajan N, Alrashoudi L, Alhussan M. The burden of diabetes, its oral complications and their prevention and management. Open Access Maced J Med Sci 2018; 6:1545-1553.
10. Patel PN, Sah P, Chandrashekar C, Vidyasagar S, Rao JV, Tiwari M. Oral Candidal speciation, virulence and antifungal susceptibility in type 2 diabetes mellitus. Diabetes Res Clin Pract 2017; 125:10-19.
11. Patil S, Rao RS, Majumdar B, Anil S. Clinical appearance of oral Candida infection and therapeutic strategies. Front Microbiol 2015; 6:1391.
12. Premkumar J, Ramani P, Chandrasekar T, Natesan A, Premkumar P. Detection of species diversity in oral Candida colonization and anti-fungal susceptibility among non-oral habit adult diabetic patients. J Nat Sci Biol Med 2014; 5:148.
13. Rajakumari ML, Kumari PS. Prevalence of Candida species in the buccal cavity of diabetic and non-diabetic individuals in and around Pondicherry. J Mycol Med 2016; 26:359-367.
14. Rodrigues CF, Rodrigues ME, Henriques M. Candida sp. Infections in patients with diabetes mellitus. J Clin Med 2019; 8:76.
15. Sharma U, Patel K, Shah V, Sinha S, Rathore VPS. Isolation and speciation of Candida in type II diabetic patients using CHROM agar: A microbial study. J Clin Diagn Res 2017; 11: DC09.
16. Singh A, Verma R, Murari A, Agrawal A. Oral candidiasis: An overview. J Oral Maxillofac Pathol 2014; 18:S81.
17. Soni AP, Astekar M, Metgud R, Vyas A, Ramesh G, Sharma A. Candida carriage in diabetic patients: A microbiological study. J Exp Ther Oncol 2019; 13.
18. Zakavi F, Shokohi T, Mofarrah R, Taghizadeh M, Hedayati MT. Identification of different species of Candida in diabetic patients using PCR-RFLP. J Maz Univ Med Sci 2015; 25:1-9.
19. Zomorodian K, Kavoosi F, Pishdad G, Mehriar P, Ebrahimi H, Bandegani A. Prevalence of oral Candida colonization in patients with diabetes mellitus. J Mycol Med 2016; 26:103-110.