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Prevalence and Risk Factors of Oral Candidiasis in Gharyan, Libya: A Cross-Sectional Study

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Abstract:

Background: Oral candidiasis is a common opportunistic infection, but its epidemiology varies significantly by region. Recent data on the prevalence, causative species, and risk factors for oral fungal infections in Libya, particularly in the Gharyan area, is scarce. Objective: This study aimed to determine the incidence, distribution of *Candida* species, and associated demographic and health-related risk factors for oral candidiasis in Gharyan, Libya. Methods: A cross-sectional study was conducted from February to April 2025 with 140 participants. Oral swabs were collected following a clinical examination and structured interview. Samples were cultured on Sabouraud Dextrose Agar, and *Candida* species were identified using chromogenic agar. Statistical analysis was performed using SPSS version 27, employing Chi-square tests and ANOVA. Results: The incidence of oral candidiasis was 47.9% (67/140). *Candida albicans* was the predominant species (85.1%), followed by *C. glabrata* (6.0%), *C. krusei* (3.0%), *C. parapsilosis* (3.0%), and *C. tropicalis* (3.0%). Among the analyzed risk factors (age, gender, diabetes, hypertension, smoking, dental prostheses, oral hygiene, and pregnancy), only pregnancy showed a statistically significant association with infection ($\chi^2 = 4.486$, *p* = 0.034). All pregnant women in the sample were in the infected group. Conclusion: The study reveals a high incidence of oral candidiasis in Gharyan, predominantly caused by *C. albicans*. Pregnancy was identified as a significant risk factor, underscoring the need for targeted oral healthcare and screening for pregnant women. The lack of association with other classic risk factors warrants further investigation with larger samples.

Keywords: Oral Candidiasis, *Candida albicans*, Epidemiology, Risk Factors, Libya, Gharyan, Pregnancy.

الملخص

الخلفية :يعد داء المبيضات الفموي عدوى انتهازية شائعة، لكن وبائيتها تختلف باختلاف المنطقة. البيانات الحديثة عن معدل الانتشار والأنواع المسببة وعوامل الخطر للعدوى الفطرية الفموية في ليبيا، خاصة بمنطقة غريان نادرة جدا. **الهدف :**هدف هذه الدراسة إلى تحديد معدل الإصابة وتوزيع أنواع فطريات المبيضات وعوامل الخطر الديموغرافية والصحية المرتبطة بها في غريان بليبيا. **الطرق :**أُجريت دراسة مقطعية من فبراير إلى أبريل 2025 على 140 مشاركًا. جُمعت مسحات فموية بعد فحص سريري ومقابلة منظمة. وُزرعت العينات على آجار سابورو دكستروز، وتُعرّفت أنواع المبيضات باستخدام آجار كروموجيني. حُللت البيانات إحصائياً باستخدام برنامج SPSS الإصدار 27) اختبار كاي مربع وتحليل التباين.(ANOVA

النتائج :بلغ معدل الإصابة 47.9% (140/67). كان النوع السائد هو المبيضات البيضاء (85.1%)، ثم المبيضات الملساء (6.0%)، فالكروزية والنظيرة الغمد والاستوائية (3.0% لكل منها). من بين عوامل الخطر المُحللة (العمر، الجنس، السكري، ارتفاع الضغط، التدخين، أطقم الأسنان، النظافة الفموية، والحمل)، أظهر الحمل فقط ارتباطاً ذا دلالة إحصائية بالعدوى($\chi^2 = 4.486$ ، *p* = 0.034). كانت جميع الحوامل في العينة ضمن المجموعة المصابة. **الاستنتاج :**تكشف الدراسة عن معدل إصابة مرتفع بداء المبيضات الفموي في غريان، يهيمن عليه المبيضات البيضاء.

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ويُعد الحمل عاملاً خطراً مهماً، مما يبرر الحاجة لرعاية فموية مستهدفة وفحص للحوامل في المنطقة. يستدعي غياب ارتباط العوامل الأخرى بإجراء مزيد من البحث بعينات أكبر.

الكلمات المفتاحية :داء المبيضات الفموي، المبيضات البيضاء، الوبائيات، عوامل الخطر، ليبيا، غريان، الحمل.

Introduction

The human oral cavity hosts a complex microbial ecosystem, the microbiome, which includes bacteria, viruses, protozoa, and fungi. This community exists in a symbiotic relationship with the host, playing a crucial role in maintaining health [1]. The fungal component, known as the mycobiome, is an integral part of this system, with *Candida* species, particularly *Candida albicans*, being the most prevalent commensal fungi [2]. Under normal conditions, these organisms coexist harmlessly. However, alterations in the host's immune status or the oral environment can lead to an overgrowth of these fungi, resulting in opportunistic infections known collectively as oral candidiasis [3].

Oral candidiasis is one of the most common fungal infections in humans [4]. Its manifestation depends on a delicate balance between the host's defenses and the virulence of the fungus. Numerous predisposing factors have been well-documented, including immunosuppression (e.g., HIV/AIDS, chemotherapy), endocrine disorders (e.g., diabetes mellitus), xerostomia, use of broad-spectrum antibiotics or corticosteroids, poor oral hygiene, and the use of dental prostheses [5, 6]. Demographic factors such as extreme age and smoking have also been implicated [7].

Despite its global prevalence, the epidemiological profile of oral candidiasis—including the incidence, distribution of causative species, and relevant local risk factors—can vary considerably between different geographical locations and populations [8]. This variation is influenced by local healthcare practices, socioeconomic conditions, dietary habits, and genetic factors. In Libya, and specifically in the Gharyan area, there is a notable lack of recent and comprehensive studies documenting the burden and characteristics of this condition. Understanding the local epidemiology is essential for developing effective, targeted prevention and treatment strategies.

Therefore, this study was conducted to address this knowledge gap by determining the prevalence of oral fungal infections in the Gharyan region, isolating and identifying the pathogenic and opportunistic fungal species involved, and analyzing the major demographic and systemic risk factors associated with increased susceptibility, including diabetes mellitus, hypertension, pregnancy, and other relevant conditions. By elucidating the local epidemiological profile of oral candidiasis, this research aims to provide evidence-based data that may support improved diagnostic, preventive, and therapeutic strategies within the region.

Material and methods:

Study Design and Population

A cross-sectional study was conducted between February 2nd and April 20th, 2025. A total of 140 participants were recruited using a non-probability (convenience) sampling method from patients attending the Poly Clinics Center in Gharyan city. The sample size was determined based on preliminary estimates of the prevalence of oral fungal infections in similar regions, ensuring adequate representation relative to the population density of Gharyan city. Ethical approval was obtained from the Libyan Academy for Postgraduate Studies, Gharyan branch, and written informed consent was obtained from all participants prior to their inclusion in the study.

Clinical Examination and Data Collection

A thorough oral examination was performed for each participant using disposable dental instruments, including direct visual inspection of the oral soft tissues, to identify clinical signs of fungal infection such as pseudomembranous plaques, erythema, or ulcers. Oral hygiene status was clinically assessed using a validated dental index, the Oral Hygiene Index (OHI). A structured data sheet was used to collect information on demographic characteristics and potential risk factors, including age, gender, medical history (diabetes mellitus, hypertension, cancer), smoking status, pregnancy, use of dental prostheses, and oral hygiene status (categorized as good, fair, or poor) (Figure 1).

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Figure 1. Clinical photograph of a 46-year-old female from Gharyan diagnosed with oral candidiasis caused by *Candida albicans*.

Sample Collection and Processing

Oral samples were collected using three sterile swabs per participant from various sites, including teeth, soft tissues, dental pockets, and prostheses (if present). The swabs were immediately placed in a sterile container and transported under chilled conditions to the mycology laboratory at the Faculty of Medical Technology, University of Zintan.

One swab was used for direct microscopic examination with Gram stain and cotton blue stain. The other two swabs were used for culturing on Sabouraud Dextrose Agar (SDA) (Liofilchem, Italy) supplemented with chloramphenicol (0.05 g/L) to inhibit bacterial growth and cycloheximide (0.5 g/L) to select for pathogenic fungi. The inoculated plates were incubated at 37°C and examined daily for fungal growth for up to 14 days.

Identification of Fungal Isolates

Fungal isolates were primarily identified based on macroscopic colony morphology (color, texture) and microscopic characteristics (cell shape, hyphae, pseudohyphae) using lactophenol cotton blue staining [9]. For yeast isolates, species-level identification was performed using CHROMagar™ Candida (Liofilchem, Italy), a chromogenic medium that allows for the preliminary differentiation of major *Candida* species based on colony color after 24-48 hours of incubation at 37°C [10].

Statistical Analysis

All statistical analyses were conducted using SPSS Statistics version 27 (IBM Corp., USA). Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize the data. The Chi-square test of independence was used to assess the associations between categorical variables (demographic and health factors) and oral fungal infection status. A p-value of less than 0.05 was considered statistically significant. The distribution of *Candida* species was also analyzed using frequencies and percentages.

Results:

3.1. Prevalence of Oral Candidiasis

Out of the 140 participants included in the study, 67 (47.9%) were positive for oral candidiasis based on culture and identification, while 73 (52.1%) were negative (Figure 2).

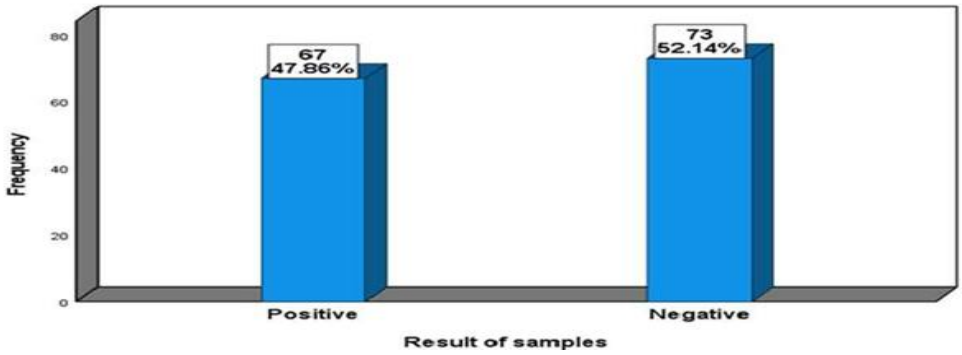

Figure 2. Prevalence of oral candidiasis among the study participants (n=140).

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Demographic and Health Characteristics

The demographic and health characteristics of the participants, stratified by infection status, are presented in Table 1. The age of participants ranged from 2 to 78 years, with a comparable distribution across age groups between the positive and negative cases. The sample consisted of 62 males (44.3%) and 78 females (55.7%), with a nearly equal gender distribution among infected and non-infected individuals.

Table 1. Demographic and Health Variables in Relation to Oral Fungal Infection Status.

Variable	Result				Chi square	P value
	Positive		Negative			
	Count	%	Count	%		
Age						
< 20	22	32.8	31	42.4	1.474	0.688
20-39	16	23.9	16	21.9		
40-59	24	35.8	21	28.8		
>=60	5	7.5	5	6.8		
Gender						
Male	28	41.8	32	43.8	0.005	0.942
Female	39	58.2	41	56.2		
Diabetes mellitus						
Yes	3	4.5	3	4.1	0.012	0.914
No	64	95.5	70	95.9		
Blood pressure						
Yes	7	10.4	3	4.1	2.116	0.146
No	60	89.6	70	95.9		
Pregnant						
Yes	4	6.0	0	0.0	4.486	0.034
No	63	94.0	73	100.0		
Smoke						
Yes	4	6.0	7	9.6	0.632	0.427
No	63	94.0	66	90.4		
Dental procedure						
Yes	18	26.9	14	19.2	1.171	0.279
No	49	73.1	59	80.8		
Oral hygiene						

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Bad	32	44.8	34	46.6	1.951	0.377
Fair	26	38.8	23	31.5		
Good	9	13.4	16	21.9		
Cancer						
Yes	4	6.0	2	2.7	0.889	0.346
No	63	94.0	71	97.3		

*Statistically significant ($p < 0.05$)

Statistical analysis using the Chi-square test revealed that the majority of variables, including age, gender, diabetes mellitus, hypertension, smoking, use of dental prostheses, oral hygiene status, and cancer history, showed no statistically significant association with oral fungal infection status ($p > 0.05$). The only exception was pregnancy ($\chi^2 = 4.486$, $p = 0.034$). All four pregnant women in the study were in the infected group, constituting 6.0% of the positive cases.

Distribution of Candida Species

The distribution of the different *Candida* species isolated from the 67 positive cases is detailed in Table 2. *Candida albicans* was the most frequently isolated species, accounting for 85.1% (n=57) of all infections. Non-*albicans Candida* (NAC) species were less common, comprising 14.9% of isolates. These included *Candida glabrata* (6.0%, n=4), *Candida krusei* (3.0%, n=2), *Candida parapsilosis* (3.0%, n=2), and *Candida tropicalis* (3.0%, n=2). A chi-square test confirmed a statistically significant difference in the frequency distribution of these species ($\chi^2 = 177.55$, $p < 0.001$). (Figure 3).

Table 2. Incidence and Distribution of *Candida* Species Isolated from Oral Infections.

***Candida* spp.**	**Count**	**%**	**Chi square**	**P value**
C. albicans	57	85.0	177.552	< 0.001
C. glabrata	4	6.0		
C. krusei	2	3.0		
C. parapsilosis	2	3.0		
C. tropicalis	2	3.0		
Total	67	100.0		

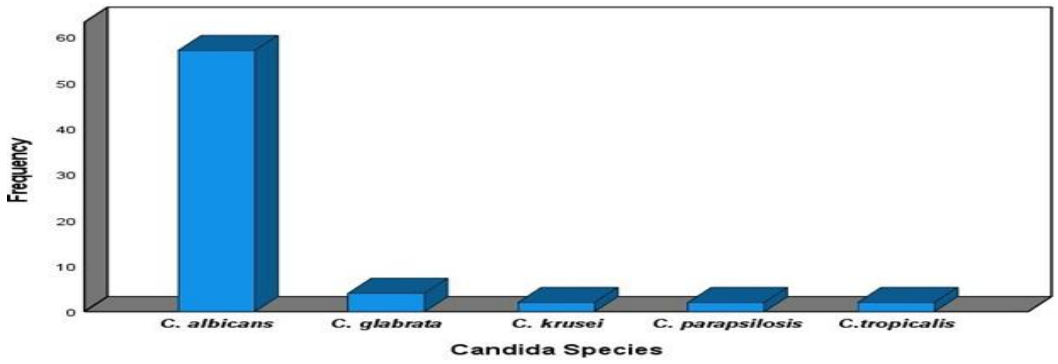

Figure 3. Distribution of *Candida* species isolated from oral infections in the Gharyan area (n=67).

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Discussion:

This cross-sectional study provides valuable insights into the epidemiology of oral candidiasis in Gharyan, Libya. Nearly half of the participants (47.9%) tested positive, highlighting oral candidiasis as a significant oral health concern, consistent with findings from similar populations [11, 12].

Mycological analysis revealed a predominance of *Candida albicans*, accounting for 85.1% of infections, which aligns with global reports attributing its virulence and adaptability to its primary etiological role [2, 13]. Our findings are consistent with a local study in Benghazi [14] regarding the predominance of *C. albicans*, but differ in the proportion of non-albicans species, potentially reflecting variations in environmental or immune-related factors between the two regions. Non-albicans Candida (NAC) species, including *C. glabrata*, *C. krusei*, *C. parapsilosis*, and *C. tropicalis*, were identified in 14.9% of cases. The clinical significance of NAC species lies in their emerging role in infection and their reduced susceptibility to common antifungal agents [15, 16], emphasizing the importance of accurate species identification to guide effective therapy, particularly in cases of treatment failure.

Analysis of risk factors revealed that classic determinants such as diabetes mellitus, use of dental prostheses, smoking, and poor oral hygiene were not statistically associated with infection in this cohort. This may be attributed to the limited sample size, the convenience sampling method, and the small number of participants in certain subcategories (e.g., six diabetic patients and eleven smokers), which may have reduced the detectable impact of these factors. Furthermore, the lack of a significant association with diabetes and smoking may reflect the sampling approach, which did not specifically target high-risk groups, thereby potentially underestimating their effect on infection rates. The subjective nature of self-reported oral hygiene may also have contributed to the absence of a significant association.

Pregnancy emerged as the only factor significantly associated with oral candidiasis ($p=0.034$), with all pregnant participants testing positive. This finding is consistent with physiological changes during pregnancy, including hormonal fluctuations (elevated estrogen and progesterone) and immune modulation, which can enhance Candida adherence and proliferation [17, 18 and 19]. These results identify pregnant women in Gharyan as a vulnerable group who would benefit from targeted oral health education and preventive dental care during prenatal visits.

Overall, this study underscores the high prevalence of oral candidiasis in Gharyan, the predominance of *C. albicans*, and the clinical relevance of NAC species. It highlights the need for larger, targeted studies to better elucidate the role of traditional risk factors and to inform tailored preventive and therapeutic strategies for this population.

Limitations:

This study has several limitations. The sample size, particularly for specific risk groups (e.g., diabetics, cancer patients), was small, which may have limited the statistical power to detect significant associations for these variables. The use of self-reported data for oral hygiene and some medical histories is subject to recall and social desirability bias. Furthermore, the study was conducted in one geographic location, which may limit the generalizability of the findings to the entire Libyan population.

Recommendations for Future Research:

To build upon these findings and address the noted limitations, we recommend conducting a prospective longitudinal study to follow pregnant women and monitor the development of oral fungal infections throughout different stages of pregnancy. Such a design would provide stronger evidence for causality and a clearer understanding of the dynamics of infection relative to gestational hormonal and immunological changes.

Conclusion:

In conclusion, this study establishes a high incidence of oral candidiasis in the Gharyan area of Libya, predominantly caused by *C. albicans*, but with a notable presence of non-*albicans* species. While most classic risk factors were not significant in this particular cohort, pregnancy was identified as a key predisposing condition. These findings underscore the need for increased awareness among healthcare providers regarding the oral health of pregnant women in this region. We recommend integrating routine oral examinations and fungal screening into prenatal care programs in Gharyan. Furthermore, we recommend implementing educational programs at health

centers in Gharyan targeting pregnant women to raise awareness about oral care and the prevention of fungal infections. Further research with a larger and more targeted sample size is warranted to better elucidate the full spectrum of risk factors in the Libyan population.

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