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The Association Between Oral Candidiasis and ABO Blood Type in Infants in Kirkuk City, Iraq

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ABSTRACT

Background and Aim: Candidiasis is the most prevalent mouth fungal infection. It is unclear whether variations in human ABO blood types contribute to the onset of this illness. We aimed to identify the association between blood type antigens (ABO) and oral candidiasis in infants.

Materials and Methods: The specimens were taken from 110 infants with oral candidiasis symptoms, ages between 1 and 18 months, primarily from the Children's Hospital in Kirkuk City and a few outlying clinics. Direct hemagglutination technique was conducted using monoclonal antibodies against human A, B, and Rh D antigens of the blood types. Macroscopic and microscopic evaluations were also performed. Chromogenic Agar +(CAC) was used to selectively develop the isolates with characteristic of *Candida* spp.

Results: The results showed significant difference between 72 positive infants (65%) and 38 infants without oral candidiasis (35%) (P<0.05). Most infected infants were males (67%), age groups 7-12 months (60%) with O+ (46%), A+ (26%) and Rh+ (92%) blood groups with significant differences (P<0.05). The *Candida (C.) albicans* scored the highest infection (85%) followed by the *C. glabrata* (8%), *C. krusei* (6%), and *C. tropicalis* (1%) with significant differences (P<0.05).

Conclusion: The prevalence of oral candidiasis in infants was related to the impaired immune status. Most infections with these diseases were in males age ranged 7-12 months with A+, O+, and Rh+ blood groups. *C. albicans* recorded the highest prevalence for the oral infants' cases compared to the other studied Candida types because of the highest pathogenicity.

Keywords: Oral candidiasis, *C. albicans*, Oral infection, Blood group (ABO)

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1. Introduction

Candida albicans (*C. albicans*) infection of the mouth cavities, called oral candidiasis, was initially documented in 1838. According to the GonÇAlo, de Souto Medeiros **(1)**, immunocompromising disorders such as HIV/AIDS, chronic systemically steroid and antibiotic usage, and extremities in age (infants and elderlies) can all contribute to the immunological reduction, which is the broader cause of the syndrome **(1, 2)**.

Oral candidiasis is diagnosed clinically, gathering health information, and evaluating risk factors for the disease. For some forms, biopsy is advised in addition to the empirical therapy. When antifungal therapy is unsuccessful, cultures are often conducted **(3, 4)**.

Immunocompetent people's typical oral microbiota includes candida. According to the Hellstein and Marek **(5)**, 30–60% of the mature individuals and 45–65% of babies have *Candida* spp within their mouths. *C. albicans*, which has been isolated from over 80% of the lesions, is the most frequent species of *Candida* that causes oral candidiasis. According to the Macias-Paz, Pérez-Hernández **(6)**, *C. albicans* is a dysmorphic

yeast that can appear as either a yeast or a hypha depending upon the surroundings.

Candida glabrata (C. glabrata), *Candida tropicalis (C. tropicalis)*, *Candida kruesi (C. kruesi)*, *Candida guillermondii (C. guillermondii)*, *Candida lusitaniae (C. lusitaniae)*, *Candida parapsilosis (C. parapsilosis)*, *Candida pseudotropicalis (C. pseudotropicalis)*, and *Candida stellate (C. stellate)* are additional species that have been linked, however, they are far less prevalent **(5)**. It has been demonstrated that non-albicans *Candida* species invade individuals 80 years of age and older at higher rates than young people **(7)**.

Immunocompetent and immunocompromised persons can both get oral candidiasis, although immunocompromised hosts are more likely to contract it. Oral candidiasis affects almost 90% of people with HIV at some time throughout their illness **(8)**. Both men and women can get oral candidiasis. It usually affects newborns and neonates. Due presumably to the establishment of the host immunity, it is less prevalent in neonates who are older than six months but more widespread throughout the 4th week of life. Hepatosplenomegaly, rashes, diarrhea, and recurrent infections are indications and symptoms of the immunosuppression in these individuals **(9)**.

Since fungi are opportunistic microorganisms, maternity and puberty appear to be especially vulnerable times for mom as well as baby to contract fungal infections. Pregnant women (30-40%) experience vaginal *Candida* spp. colonization; this might be because of the elevated levels of estrogen that encourage yeast adherence and penetrating in the mucous membrane of the vagina **(10)**. This propensity appears to persist after birth, as evidenced by the observation made by Khadija, Abbasi **(11)** that postpartum females are more vulnerable to oral *Candida* spp. colonization, which demonstrates increased virulence features. Regarding the infants, conjecture is that *Candida* spp. colonization takes place in the initial hours following birth. Furthermore, a few numbers of research support the theory that isolates of fungi can be passed via mother to kid **(12)**. Simultaneously, subsequent fungal infections that frequently arise in children using diapers are commonly known in newborns as thrush in the mouth, is a common illness in children, especially until the sixth month of life **(13)**. Researchers showed that most carriers of oral Candida had blood group A, but the difference was not statistically significant (P>0.05). These results confirm the idea that there is no relationship between A, B, and O blood groups and their secretory forms with the number of Candida colonies **(9)**.

In Iraq/Kirkuk city, there is lack of studies about relation of blood groups (ABO) with oral *Candida* spp. colonization in infants. Therefore, this research was designed to identify the association between blood type antigens (ABO) and oral candidiasis in infants.

2. Materials and Methods

2.1. Data collection and Blood Group Identification

Specimens were taken from 110 individuals who had oral candidiasis symptoms, primarily from the Children's Hospital in Kirkuk City and a few outlying clinics. The samples included from infants aged between 1 month and 18 months. Using monoclonal antibodies against the human A, B, and Rh D antigens of the blood types, the direct hemagglutination technique was conducted to ascertain the newborns' ABO and Rh blood groups.

2.2. Sample Collection and *Candida* Isolation

Cotton swabs were used to gather oral specimens, which were subsequently streaked on Sabouraud dextrose agar (SDA) (Ibn Al-betar/ Iraq) plates supplemented with 0.005 g/L chloramphenicol to inhibit the development of bacteria. The incubation was conducted at 30ºC for 48 hr. Next, the isolates were inspected for the size, shape, color, and texture using both macroscopic and microscopic evaluations **(14)**. The genus Candida was characterized through its oval or oblong form and bipolar budding, an asexual method of development. The newly formed Candida cells were cream-white in color on culture medium. Their cells showed a diameter of three to six µm, and they occasionally form pseudohyphae **(15)**.

2.3. Species Identification by Biochemical Tests

2.3.1. Catalase Test

A small portion of a colony was added to a drop of hydrogen peroxide on a microscope slide. If bubbles or froth is formed, the organism is considered catalase-positive **(16)**.

2.3.2. Germ Tube Formation

Serum germ tube technique uses triplicate sets of the test tubes containing 0.5–1 mL of pooled human serum. The samples were inoculated with 2-3 colonies of each isolate. The tubes were incubated at 37°C for 3 hr. Then, a drop of each suspension was examined on the labeled microscope slide **(16)**.

2.3.3. Chromogenic Agar Candida (CAC)

Chromogenic Agar *Candida* (CAC) (Paris/France) was used to selectively develop the isolates with features characteristic of *Candida* spp **(16)**. After growing for 24

hr on SDA, a piece of the clean colony was plotted on CAC and incubated for 24 to 48 hr at 37ºC. The color of the communities helped identify the various species. According to the results of Brawner and Cutler, **(17)**, *C. albicans* is green, *C. glabrata* is pink to purple, *C. krusei* is dark pink, and *C. tropicalis* is blue.

2.4. Statistical Analysis

SPSS (Statistical Package for Social Science) Softwar e version 20 was used to analyze data. *Chi*–square test was utilized to compare differences at $P \leq 0.05$ level.

3. Results

3.1. Distribution of Participants Based on the Fungal Infection

The results of participants' distribution showed 65% of infants positive for oral candidiasis compared to the infants without oral candidiasis (35%) ($P<0.05$). Data are shown in Table 1.

Table 1. Distribution of infants according to the oral candidiasis.

Results	N	%	P value
Positive	72	65%	
Negative	38	35%	*P*<0.05**
Total	110	100%	

3.2. Distribution of infected infants based on the gender

Findings exhibited significant difference between males and females. The most infected infants were males (67%) compared to females (33%) ($P<0.05$) (See Table 2).

Table 2. Distribution of infants with oral candidiasis according to gender

Gender	N	%	P value
Males	48	67%	
Females	24	33%	*P*<0.05**
Total	72	100%	

3.3. Distribution of infected infants based on the age groups

The outcomes revealed the most infected infants at age groups 7-12 months (60%) and least of them at >1 years (10%). It showed significant differences ($P<0.05$) among age groups as summarized in Table 3.

Table 3. Distribution of infants with oral candidiasis according to age groups

Age groups	N	%	P value
1_6 moths	22	31%	
7_12 moths	43	60%	*P*<0.05***
>1 years	7	10%	
Total	72	100%	

3.4. Distribution of infected infants based on the *Candida* types

The results indicated that the most infected infants were positive for *C. albicans* (85%) that showed significant differences ($P<0.05$) with *C. glabrata* (8%), *C. krusei* (6%), and *C. tropicalis* (1%) (Table 4).

Table 4. Distribution of infants with oral candidiasis according to the *Candida* types

Candida types	N	%	P value
C. albicans	61	85%	
C. glabrata	6	8%	
C. krusei	4	6%	*P*<0.05***
C. tropicalis	1	1%	
Total	72	100%	

3.5. Distribution of infected infants based on the blood groups

The most infected infants were observed positive for O+ (46%) followed by A+ (26%) and B+ (19%). Few numbers were positive for A- (4%), B- (0), and O- (4%) with significant variation (*P*<0.05) among blood groups as shown in (Table 5).

Table 5. Distribution of infants with oral candidiasis according to the blood groups

Blood groups	N	%	P value
A+	19	26%	
B+	14	19%	
O+	33	46%	
A-	3	4%	*P*<0.05***
B-	0	0%	
O-	3	4%	
Total	72	100%	

3.6. Distribution of infected infants based on the Rh factor

Table 6 shows significant difference between the most infected infants positive for Rh (92%) compared to Rh- (8%) (*P*<0.05).

Table 6. Distribution of infants with oral candidiasis according to Rh factor

Rh factor	N	%	P value
Rh+	66	92%	
Rh-	6	8%	*P* <0.05***
Total	72	100%	

4. Discussion

The present study aimed to diagnosis the correlation between blood type antigens (ABO) and oral candidiasis in infants in Kirkuk city. The diagnosis of oral candidiasis is often made by the microscopic evaluation of the mouth mucosa specimen exhibiting diagnostic discoveries, as well as visual inspection of detachable white plaques or erythema tissues in the mouth. The genus *Candida* is characterized through its oval or oblong form and bipolar budding, an asexual method of development. The newly formed *Candida* cells are cream-white in color on culture medium. Their cells have a diameter of 3-6 µM and they occasionally form pseudohyphae **(15)**.

Moreover, medical and microbiological testing may be used to diagnose the oral candidiasis **(18)**. According to the previous investigation, oral candidiasis was found in 72 (65%) out of the 110 oral swabs when examined under the light microscope. Although the regional distribution of *Candida* strains varies, a prior study found that their prevalence was 35% **(19)**. These results were lower (35%) than those of the current study, which highlighted 65% of the oral swabs with Candida.

Nevertheless, in a prior investigation, it was primarily found in seniors, irrespective of genders, aged 60 or older, and the frequency of oral candidiasis

was not clearly associated with those who had a dry mouth, drinking or smoking, wearing dentures, or having hormonal imbalances **(20)**. Generally speaking, these variables are risk factors for developing oral candidiasis.

According to Keyvanfar, Najafiarab **(21)** oral candidiasis is uncommon in the initial week after birth but can be developed in newborns and neonates. Due presumably to the emergence of host immunity, it is less prevalent in babies who are older than six months and more frequent around the 4th week of life. The current results, which indicate a significant incidence of oral candidiasis in babies older than six months, do not align with these outcomes. The low immunological state of newborns and babies is linked to the increased occurrence of oral candidiasis in such children.

Cook, Ferreras-Antolin **(22)** results, which mirrored the current data, revealed that oral candidiasis was more common in men (55%) than in women (45%). However, Chuey Chuan, Daniel **(23)** found that oral candidiasis was more common in women (61%) than in men (39%). The host immunological state and sample size are the factors that influence the study differences.

Even though there is a significantly higher amount and more variety of *Candida* species on the breastbones of nursing women, the researchers discovered a strong correlation between bottle feeding and a higher likelihood of respiratory illnesses as well as gastrointestinal tracts (GIT) illnesses. Additionally, they discovered that only a fraction of breastfed infants suffered this kind of the yeast colonized in their mouths, which supports the theory that defense variables such as mother's milk offer security toward the *Candida* genus colonizing in the dental cavities of exclusively breastfed infants **(24)**.

A recent study indicates that maternal transmission plays a significant role in the oral acquisition of *C. albicans* in young children. It may be possible to stop fungal transfer in the early stages of infancy by including detection for mother fungal-oral carriers and putting in place oral health awareness initiatives throughout the perinatal period **(12)**.

Almost 40% of the healthy people have commensal (or invading) *Candida* in their tooth cavities. Relative to the healthy people, immunosuppressed persons have been observed to have a higher incidence of *Candida* spp in their dental cavities. It shows that mouth yeasts were present in the salivary of 55% of hospitalized individuals with advanced cancers have *Candida* spp **(25)**.

Cook, Ferreras-Antolin **(22)** mentioned that *C. albicans* showed the highest prevalence in neonates (35%), followed by *C. glabrata* (5%), and *C. tropicalis* (2%). These outcomes were close to present findings. Additionally, Cook, Ferreras-Antolin **(22)** mentioned that most of the *Candida* strains were resistant to fluconazole. Another study showed *C. albicans* with high prevalence in oral infants (67%), followed by *C. tropicalis* (30%), *C. parapsilosis* (15%), and *C. krusei* (17%) **(26)**.

According to the present study findings, newborns with candidiasis had higher percentages of blood types O+ and A+ than other blood groups. These findings were exactly in line with those of Thanomsridetcha, Tanakittiyakul **(27)**, who found that the largest percentage of newborns with candidiasis had A+ blood group. Numerous studies have demonstrated a correlation between individual's ABO blood type and their vulnerability to certain illnesses, such as candidiasis. Nonetheless, contradictory findings have been documented by several researchers, and there is currently no solid evidence linking ABO blood type antigens to oral candidiasis **(28)**. The primary component of fungal development is iron, which may be transferred from the host through a variety of pathways and affect hyphae creation by influencing the development of hyphae consequences in different blood groups **(29)**. According to a recent study, blood group A individuals had a greater germ tube development rate than blood groups B, AB, and O, and they may be more susceptible to *C. albicans* infection, and contain more severe cases than those in various blood groups **(27)**.

A prior investigation revealed significant difference between blood type O persons with high frequency of *C. albicans* colonies in their saliva versus other categories. Furthermore, Hajimaghsoodi, Jafari Nodoushan **(30)** found no statistically significant difference in the number of *C. albicans* colonies between O+ and O- blood types.

Oral candidiasis is more prevalent in newborns belonging to blood types O+, A+, and Rh+. This is associated with the immunological state and sampling community of those persons. According to a prior study, O blood type may be more resistant to illness because of their innate immunity, but non-O blood groups may have the necessity for blood transfusions more frequently **(31)**.

5. Conclusion

The prevalence of oral candidiasis in infants in Kirkuk City, Iraq is related to their impaired immune status. Thus, the weak immune system is positively associated with the occurrence of opportunistic fungal infections. Most infections were presented in males within 7-12 months with A+, O+, and Rh+ blood groups. *C. albicans* scored the highest prevalence in infants compared to

the other *Candida* types due to the highest pathogenicity of this yeast.

6. Declarations

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Ethical Considerations

This research work was approved by the Ethics Committee in College of Science at University of Kirkuk (code No. ScB20).

Authors' Contributions

Conceptualization and Data curation: Bari Lateef Mohammed and Iman Tajer Abdullah, Methodology: Asoda M. Noori, Bari Lateef Mohammed and Iman Tajer Abdullah, Project administration: Asoda M. Noori, Resources: Bari Lateef Mohammed and Shakhawan Beebany, Validation: Bari Lateef Mohammed, Writing–original draft: Iman Tajer Abdullah, and Shakhawan Beebany Writing–review & editing: Iman Tajer Abdullah and Shakhawan Beebany.

Conflict of Interest

The authors declare no conflict of interest.

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