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Oral Candida Colonization and Its Role in Dental Caries Among Adults

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Abstract

The present review examined the current literature on the topic of adult oral Candida colonization and then briefly discusses how Candida can cause dental caries from a perspective of biofilm action, microbial interaction, and host-related conditions. Several aspects are covered in the analysis including the biofilm aspect, microbial interaction, and the role of host-related conditions. According to recent studies, Candida albicans is usually regarded as an oral commensal, but its possible to see a certain shift towards pathogenesis once conditions have changed. Additionally, there is experimental evidence as well as clinical evidence that Candida and cariogenic bacteria might form a collaboration, enhance mixed biofilms, tolerate low pH, and survive in mouths where there is reduced saliva protection. For adults, there is some evidence suggesting that presence of Candida is related to caries experience in certain populations, although not every case proves this relationship. Differences can result from sampling procedures, methods used in the laboratory, different ages, and saliva status. The oral candida colonization may be viewed as some form of ecological factor in adult cariology. It is improbable that the oral candida colonization is the sole agent responsible for caries. However, it may contribute to pushing dysbiosis to the point where the disease progresses further.

Introduction

The prevalence of dental caries remains a major issue within the sphere of global oral health, and the existing statistics demonstrates that oral diseases continue to affect sizable populations in various areas and even in certain age groups. Clinically, caries may be considered a multifactorial disease in which a combination of such factors as host, diet, saliva, and microbial ecology play a role rather than just a disease associated with a specific microorganism [1,2]. Simultaneously, there have been developments in the field of microbiology. While the focus on Streptococcus mutans could explain part of the picture, it failed to describe the dynamics within plaque that are now becoming evident to researchers. Based on contemporary studies, it appears that caries occurs because of dysbiosis in organized plaque where there are interactions between bacterial populations, and where alterations in the levels of pH, nutrients, or substrates become important for the development of the disease [3,4].

Another example of microorganisms which should be considered within this scope includes Candida species such as Candida albicans. The mentioned species can be isolated from healthy mouths but can behave opportunistically due to slight changes in the local environment and the mentioned pathogenic activity is linked to its adhesion, morphological changes, extracellular matrix production, and persistency [5,6].

The rationale for Candida being involved in cariogenic processes can be described as straightforward and biological in nature in relation to the pathogenesis of dental diseases. Specifically, Candida can form mixed-species biofilms, contributes to the formation of matrix-rich communities, tolerates acid stress, and interacts with cariogenic bacteria, potentially promoting enamel demineralization. Recent mechanistic studies make the role of such interactions more evident, particularly within root-surface carious lesions and mixed communities in the mouth [7-9].

Research on adults becomes essential since the oral environment in adults is affected by more accumulated risk factors compared to children. Parameters such as salivary flow, medications, smoking habits, chronic diseases, dentures, and prolonged exposure to dental plaques will determine the pathogenic role of Candida as

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either a commensal or a part of cariogenic ecosystem. The inconsistency of the results of adult research becomes evident as some studies establish an association between Candida carriage and caries while others observe no obvious disease-related signs of Candida presence in an individual. Thus, the clinical importance of Candida remains debatable [10-15]. Patients with beta-thalassemia major show a significantly higher rate of oral *C. albicans* colonization (73.33%) compared to thalassemia minor patients (40%) and healthy control groups (6.67%) [16]. Saliva of both hyperthyroidism and hypothyroidism have a higher count of *C. albicans* and *lactobacillus* compared with the control group [17]. Molecular study of virulence genes correlated with biofilm *C. albicans* show that HWP1, ALS1, ALS3, SAP5, PLB1 and LIP8 genes were detected in 100% of *C. albicans* from vaginal and oral infection [12] show black and green tea aqueous extracts have antifungal activity against salivary *C. albicans.* The counting and colonization of *C. albicans* and *streptococcus mutans* were significantly higher in cleft palate patients than those with normal plate [18].

The purpose of this literature review is to examine the latest research regarding oral colonization by Candida in adults and discuss possible pathways through which Candida may be associated with dental caries in adults.

Oral Candida Species in the Human Oral Cavity

Candida is somewhat an inherent resident of the oral cavity in many adults, and its occurrence alone does not necessarily signal disease. In a healthy host, the organism typically maintains itself in some sort of balance with the local microbiome and the host defense system. Its clinical significance occurs only after a change in the ecosystem takes place, such as a decrease in salivary protection, changes in immunity, or even disruptions to biofilms [9].

Out of those who carry yeast in their mouths, Candida albicans is still the most prevalent species. However, the former is not necessarily the only one that deserves attention. Recent research into adult oral colonizers has revealed that C. albicans is often accompanied by other species, including C. guilliermondii, C. lusitaniae, and C. parapsilosis. Such findings seem to support the claim that oral candidal ecology is much more diverse than a one-species concept could possibly account for [5].

The latest research on the oral mycobiome indicates that there are changes in the oral Candida population under disease conditions and after the administration of antifungal therapy and thereby explains the significance of reporting at the species level in cariology. The following table attempts to provide an overview of the different species of oral Candida mentioned in the recent literature along with their broad clinical importance, wherein C. albicans has been repeatedly noted as the most common oral isolate [19].

Species	**Broad oral relevance**	**Typical clinical note**
C. albicans	Most common oral species	Strong biofilm former; most often linked with cariogenic behavior [5,19].
C. tropicalis	Less frequent oral isolate	Appears in mixed oral mycobiota and opportunistic infection profiles [19].
C. parapsilosis	Occasional oral colonizer	Detected in healthy carriers and oral disease cohorts [5,19].
C. dubliniensis	Oral-associated species	Frequently discussed alongside *C. albicans* in oral candidosis studies [19].
C. glabrata	Opportunistic oral yeast	More likely to matter in altered-host environments and biofilm persistence [20].

What is clinically significant is not just the species present in the mouth, but whether the species distribution is reflecting either a consistent commensal environment or one that is more dysbiotic. This distinction is quite vital in adult patients, because the oral mycobiome changes with time, depending on age, therapies received, dry mouth, and numerous other systemic factors [21].

Dental Caries and Oral Microbiome

The process by which dental caries develops involves an ecological shift involving biofilms rather than one organism alone. In situations where there are more fermentable carbohydrates present and where the plaque is left undisturbed, aciduric microorganisms thrive, and pH remains low for extended periods; therefore, the demineralization process eventually surpasses remineralization [22].

The importance of biofilm formation is crucial to this process. The significance of Candida here is its ability to form biofilms within mixed communities, facilitate the organization of the extracellular matrix, and survive in environments not conducive for other life forms. In recent years, mechanistic studies regarding the interaction between Candida and Streptococcus mutans have shed light on how the physiology of fungi may affect cariogenesis directly [23].

Cariotherapy research has expanded its view of oral pathology from that of a disease resulting from a single pathogen to one that is viewed as a community-level problem. Adult Candida carriage has been associated with dental caries through cross-sectional research. Furthermore, wider profiles indicate an association between higher Candida levels with altered oral microbiota composition and poor oral health status. Therefore, Candida is involved in the causation of caries, even though it may not be the sole cause for lesions [24,25].

From a practical point of view, the relationship between Candida and caries should be regarded as symbiosis in dysbiosis, where Candida may reinforce the same environment that predisposes one to caries, i.e. acidic pH, thick biofilms, less salivary flow, and continuous nutrient substrates. This explains why the mere determination of "presence/absence" in adult patients misses the ecological aspect of the Candida–caries connection [24].

Mechanisms Linking Candida to Dental Caries

Biofilm formation

The involvement of Candida in caries biology is attributed to its capability to form biofilms. The biofilms formed enable the organism to adhere to the site and survive in its matrix form, which protects it and even other microbes around, making the entire microbial community stable and difficult to disperse. In terms of oral fungal biology, this ability of biofilm formation by Candida is among the essential factors making it clinically relevant in dental caries [20].

Acidogenic and aciduric properties

Candida is perfectly adapted to survive under acidic stress conditions, because acidic pH is an environmental hallmark of this disease. Experimental studies about the biofilm made up of Candida and S. mutans have already been conducted, which emphasize the role of fungi's metabolism in the creation of cariogenic environment including acid adaptation and V-ATPase function [23].

Interaction with *Streptococcus mutans*

Perhaps the most extensively studied case of fungus-bacterium interaction in cariology is that of C. albicans and S. mutans. This relationship may result in increased strength of the biofilm, facilitate symbiosis, and amplify the cariogenic nature of the microflora. In addition to adult evidence showing that lowering oral Candida levels leads to decreased S. mutans, supporting the idea of cross-kingdom interaction rather than separate colonization [25].

Adhesion to tooth surfaces

This process is important because the fungi need to adhere to the tooth surfaces or early biofilm partners before contributing to

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infections. It has been shown through experiments on human tooth surfaces that the fungus is adapted to its new environment and interacts with other pathogenic bacteria, thus confirming that tooth infection is unique from mucosal carriage [22].

Salivary changes and host factors

Saliva is one of the most potent hosts that control Candida proliferation. The decreased flow of saliva is associated with weakened mechanical cleansing properties, as well as weakened resistance to Candida owing to reduced effects of salivary anti-microbial substances. In consequence, the persistence of Candida infections among individuals suffering from xerostomia or a certain type of salivary hypofunction can be expected. This conclusion has been reached by means of recent reviews as well as clinical trials, which state that increased Candida infection rates correlate directly with lower salivary activity, which explains, for example, prevalence of Candida in elderly and patients suffering from stomatitis [26,27].

Current Evidence from Adult Studies

There appear to be some adult data that hint towards a trend which is quite suggestive rather than definitively so: Candida colonization appears to have its impact magnified in conditions where the oral environment itself is somehow unstable and cannot maintain stability. In older individuals, the most definitive correlations can be found through those involving decreased salivary output, frailty, stomatitis, and dysbiosis, but in relation to caries, this has been much less consistently documented in contrast to pediatrics [11].

Table 1. Adult evidence relevant to oral Candida colonization and caries-related ecology

Author/Year	Sample	Main finding
Buranarom et al., 2020	53 independent dentate elders	Hyposalivation was associated with higher oral Candida colonization and poorer oral health indices [11].
Fluitman et al., 2021	356 community-dwelling older adults	High *Candida albicans* abundance tracked with oral ecology variables in aging, but not with a simple caries endpoint [28].
Asakawa et al., 2024	159 elderly adults receiving support/home care	Higher fungal density was associated with dysbiotic bacterial communities and poorer health status [21].
Lee et al., 2025	Stomatitis patients	Oral candidiasis was more strongly related to salivary hypofunction than to aging alone [26].
Cadavid et al., 2025	Hospitalized adults with oral candidiasis	Adult candidiasis risk was shaped by host and clinical factors, reinforcing the importance of context rather than carriage alone [28].

The supportive evidence will appear more convincing once Candida is tested amid a broader picture of ecological disturbance. According to Buranarom et al., hyposalivation in independent dentate elderly was associated with increased Candida colonization rates, and Asakawa et al. noted that elderly individuals characterized by fungal-dominant oral profiles exhibited dysbiotic bacterial communities and poor health conditions; therefore, considering both findings together, it can be said that Candida becomes more relevant under conditions of decreased salivary immunity and an emerging disturbance in the oral ecosystem [11].

The non-supportive or mixed results have great significance, as well, as they help prevent exaggeration. For instance, Fluitman et al. concluded that increased levels of C. albicans in older people may coexist with the indicators of reduced taste, smell, and appetite, but there is no direct connection between increased Candida presence and caries progression; in addition, recently conducted systematic reviews of oral aging also indicate that Candida belongs to the pool of factors contributing to tooth decay [29].

In summary, from the literature on adults, it appears that the role of Candida in caries susceptibility is likely through ecological interaction, rather than a lone process. This is consistent with the more recent cross-kingdom biofilms research, demonstrating that Candida species and bacteria may interact in ways that influence disease processes, but it still accounts for potential differences among adult populations and sample sites [24].

Clinical Implications

In adult individuals, Candida might serve as a valuable biomarker for assessing their susceptibility to oral conditions particularly when considered in tandem with salivary hypofunction, xerostomia, frailty, and associated mucosal symptoms. Research on salivary biomarkers among the elderly population reveals the ability to objectively define oral hypofunction and interpret candidal load within the context of a wider salivary risk profile rather than simply an objective laboratory value [30].

Thus, any preventive and therapeutic efforts ought to concentrate on the oral microecosystem rather than simply suppressing antifungals since such a paradigmatic approach will require evaluating the effects of drugs lowering salivary production, enhancing dental plaque control, and cleaning dentures while restricting antifungal treatments only to patients with clinical candidiasis or high-risk microbiota. Indeed, recent research into candidiasis among the elderly and hospitalized patients reinforces the importance of a context-based approach to the condition since candidal load typically correlates with increased host vulnerability and mouth dryness better than patient age does [27].

Limitations of Current Evidence

One of the primary issues associated with the existing body of research is that there is a relatively low number of adult studies, and most of them rely on cross-sectional designs. Most research findings pertain to elderly individuals, denture-wearers, and patients suffering from various medical conditions; therefore, it becomes challenging to separate the impact of age-related changes from the influence of salivary, systemic, and behavioral confounding factors. This explains why the contemporary adult research literature is characterized by associations rather than causations between the discussed phenomena [11].

Another problem relates to sampling and diagnostic heterogeneity. First, some researchers collect saliva samples, while others opt for tongue swabs or plaque samples, and second, the methods of measuring Candida species vary greatly. Specifically, the techniques include, among other things, culture testing and the use of qPCR or sequencing. It is important because fungal "signal" may be noticeably different depending on the microhabitat and the methodology applied.

Future Perspectives

The next step is longitudinal adult studies. While cross-sectional studies may reveal the presence of associations, they cannot determine whether the presence of Candida

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precedes the activity of caries or persists once the environment in the oral cavity has already undergone dysbiosis. Longitudinal collection of samples from plaque and root surfaces could clarify this matter, especially in cases of elderly patients suffering from xerostomia or who have more complicated medical histories [31,32].

Moreover, salivary biomarkers seem to require panel analyses rather than individual markers, which is the case at present. Recent reviews seem to have established that saliva is a reliable media for the detection of caries, as well as personalized oral diagnostics. However, the results seem to be more valid if evaluated in terms of flow rate, buffering capacity, inflammation, and microbial burden. The use of these techniques is relevant for adults, especially when Candida indicates host vulnerability in addition to microbial burden [32,33].

Molecular techniques are expected to provide further clarification. Molecular techniques, such as ITS sequencing, qPCR, and multiomics, are expected to provide a better representation of fungal diversity as well as the interactions between fungi and bacteria as compared to culture only. This analysis approach will most probably be more informative than mere presence/absence analysis in the case of adult caries risk assessment [3,34,35].

Conclusion

The phenomenon of oral Candida colonization seems to be a true ecological factor in dental caries development among adult individuals. This factor should not be considered the only causative factor for caries development; on the contrary, it plays an integral role in dysbiosis development.

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