The Role of Oral Environmental Stresses in Inducing Resistance in Candida albicans Bi

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Introduction

Candida albicans is a major opportunistic fungal pathogen capable of forming highly structured biofilms on oral mucosal and prosthetic surfaces. Biofilm-associated cells exhibit markedly increased resistance to antifungal agents compared to planktonic counterparts (1). The oral cavity represents a dynamic microenvironment characterized by fluctuating pH, high dietary sugar exposure, oxidative stress, salivary alterations, inflammatory mediators, and antimicrobial pressure. These environmental stressors are believed to modulate adaptive resistance mechanisms and enhance biofilm persistence (2,3).

Materials and Methods

A narrative review was conducted using peer-reviewed articles published from 2015 onward and indexed in PubMed, Scopus, and Web of Science. Studies evaluating the impact of oral environmental stressors—including pH shifts, glucose concentration, oxidative stress, and antifungal exposure—on resistance mechanisms, gene regulation, and biofilm maturation were included.

Results

Recent evidence demonstrates that acidic pH and elevated glucose levels enhance biofilm biomass and extracellular matrix production (2). Oxidative and antifungal stress activate stress-response pathways and upregulate efflux pump genes, contributing to drug tolerance (3,4). Biofilm architecture further restricts antifungal penetration and promotes metabolic heterogeneity, increasing persistence and recurrence rates in oral candidiasis (1,5).

Discussion and Conclusion

Oral environmental stresses significantly contribute to adaptive antifungal resistance in biofilm-associated Candida albicans. These mechanisms are closely linked to treatment failure and recurrent infection, particularly in high-risk or immunocompromised individuals. Targeting stress-response signaling pathways and biofilm-specific resistance mechanisms may improve therapeutic outcomes. Further translational and clinical investigations are warranted to develop stress-modulating strategies for biofilm control.

Keywords

Oral Microenvironment; Candida albicans; Biofilm Resistance; Antifungal Resistance; Oxidative Stress; pH Fluctuation; Efflux Pumps; Oral Candidiasis; Microbial Dysbiosis.

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