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HETEROGENEITY OF DENTAL CARIES IN ADULTS: MICROBIOLOGICAL, BEHAVIORAL, AND SOCIODEMOGRAPHIC PERSPECTIVES

HETEROGENEIDADE DA CÁRIE DENTÁRIA EM ADULTOS: PERSPECTIVAS MICROBIOLÓGICAS, COMPORTAMENTAIS E SOCIODEMOGRÁFICAS

HETEROGENEIDAD DE LA CARIES DENTAL EN ADULTOS: PERSPECTIVAS MICROBIOLÓGICAS, CONDUCTUALES Y SOCIODEMOGRÁFICAS

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Pedro Guimarães Sampaio Trajano dos Santos[1], Rosana Maria Coelho Travassos[2], Vanessa Lessa Cavalcanti de Araújo[3], Alexandre Batista Lopes do Nascimento[4], Josué Alves[5], Vânia Cavalcanti Ribeiro da Silva[6], Eliana Santos Lyra da Paz[7], Maria Regina Almeida de Menezes[8], Tereza Cristina Correia[9], Tereza Augusta Maciel[10], Verônica Maria de Sá Rodrigues[11], Priscila Prosini[12]

ABSTRACT

Objective: To analyze the heterogeneity of dental caries in adults by integrating microbiological, behavioral, and sociodemographic factors and to discuss how these interactions influence disease risk and progression.

Methodology: This narrative review included observational studies, clinical trials, and systematic reviews retrieved from PubMed, Scopus, and Web of Science. Studies addressing adult dental caries in relation to oral microbiota, hygiene habits, dietary patterns, access to dental care, and social determinants were considered.

[1] Undergraduate in Dentistry. Faculdade de Odontologia do Recife. Pernambuco, Brazil.
E-mail: pedroguimaraessampaio@gmail.com
[2] Dr. in Endodontics. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: rosana.travassos@upe.br
[3] Professor. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: vanessa.lessa@upe.br
[4] Dr. in Dentistry. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: Alexandre.nascimento1@upe.br
[5] Dr. Universidade de Pernambuco (UPE). Pernambuco, Brazil. E-mail: Josue.alves@upe.br
[6] Dr. in Dentistry. Universidade de Pernambuco (UPE). Pernambuco, Brazil. E-mail: vania.silva@upe.br
[7] Dr. in Biological Sciences. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: eliana.lyra@upe.br
[8] Dr. Universidade de Pernambuco (UPE). Pernambuco, Brazil. E-mail: regina.menezes@upe.br
[9] Dr. Universidade de Pernambuco (UPE). Pernambuco, Brazil. E-mail: tereza.correia@upe.com.br
[10] Master's Degree in Dentistry. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: tereza.maciel@upe.br
[11] Dr. in Dentistry. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: veronica.rodrigues@upe.br
[12] Dr. in Dentistry. Universidade de Pernambuco (UPE). Pernambuco, Brazil.
E-mail: priscila.prosini@upe.br

Results: Evidence indicates that adult dental caries is a multifactorial and heterogeneous condition. Variations in biofilm composition, particularly involving Streptococcus mutans and Lactobacillus spp., are linked to distinct risk profiles. Behavioral factors such as frequent sugar intake and poor oral hygiene, along with sociodemographic variables including education level and income, significantly influence caries prevalence and severity.

Conclusion: Dental caries in adults should not be regarded as a homogeneous disease. Preventive and therapeutic approaches must be individualized, integrating microbiological, behavioral, and social determinants to improve clinical and public health outcomes.

Keywords: Dental Caries. Adults. Oral Microbiota. Social Determinants of Health. Health Behavior.

RESUMO

Objetivo: Analisar a heterogeneidade da cárie dentária em adultos, considerando fatores microbiológicos, comportamentais e sociodemográficos, e discutir como essas interações influenciam o risco e a progressão da doença.

Metodologia: Trata-se de uma revisão narrativa da literatura baseada em estudos observacionais, ensaios clínicos e revisões sistemáticas publicados nas bases PubMed, Scopus e Web of Science. Foram incluídos estudos que abordaram cárie em adultos associada à microbiota oral, hábitos de higiene, dieta, acesso aos serviços de saúde e determinantes sociais.

Resultados: A literatura demonstra que a cárie dentária em adultos é uma condição multifatorial e altamente heterogênea. Diferenças na composição do biofilme, especialmente na predominância de Streptococcus mutans e Lactobacillus spp., estão associadas a distintos perfis de risco. Fatores comportamentais, como consumo frequente de açúcares e baixa adesão à higiene oral, bem como variáveis sociodemográficas, incluindo nível educacional e renda, exercem influência significativa na prevalência e severidade da doença.

Conclusão: A cárie dentária em adultos não deve ser compreendida como uma condição uniforme. Estratégias preventivas e terapêuticas devem ser individualizadas, incorporando aspectos microbiológicos, comportamentais e sociais para maior efetividade clínica e em saúde pública.

Palavras-chave: Cárie Dentária. Adultos. Microbiota Oral. Determinantes Sociais da Saúde. Comportamento em Saúde.

RESUMEN

Objetivo: Analizar la heterogeneidad de la caries dental en adultos, considerando factores microbiológicos, conductuales y sociodemográficos, y discutir cómo estas interacciones influyen en el riesgo y la progresión de la enfermedad.

Metodología: Se trata de una revisión narrativa de la literatura basada en estudios observacionales, ensayos clínicos y revisiones sistemáticas publicados en las bases de datos PubMed, Scopus y Web of Science. Se incluyeron estudios que abordaron la caries en adultos asociada a la microbiota oral, hábitos de higiene, dieta, acceso a los servicios de salud y determinantes sociales.

Resultados: La literatura demuestra que la caries dental en adultos es una condición multifactorial y altamente heterogénea. Las diferencias en la composición del biofilm, especialmente en la predominancia de Streptococcus mutans y Lactobacillus spp., se asocian con distintos perfiles de riesgo. Factores conductuales, como el consumo frecuente de azúcares y la baja adherencia a la higiene oral, así como variables sociodemográficas, incluyendo el nivel educativo y los ingresos, ejercen una influencia significativa en la prevalencia y la severidad de la enfermedad.

Conclusión: La caries dental en adultos no debe entenderse como una condición uniforme. Las estrategias preventivas y terapéuticas deben ser individualizadas, incorporando aspectos microbiológicos, conductuales y sociales para una mayor efectividad clínica y en salud pública.

Palavras-chave: Caries Dental. Adultos. Microbiota Oral. Determinantes Sociales de la Salud. Comportamiento en Salud.

1 INTRODUCTION

Dental caries remains one of the most prevalent chronic diseases worldwide and continues to exert a substantial burden on adult populations, even in countries with established preventive programs (Pitts et al., 2017; Kassebaum et al., 2015). Unlike childhood caries, adult caries reflect cumulative biological, behavioral, and social exposures throughout life, resulting in marked interindividual variability in disease onset, progression, and severity (Fejerskov & Nyvad, 2015).

From a biological standpoint, contemporary caries research has shifted from a pathogen-centered model to an ecological and dysbiotic perspective. Evidence suggests that caries development is driven by dynamic changes in the oral biofilm influenced by frequent sugar exposure, reduced salivary flow, and host-related factors, rather than the presence of specific microorganisms alone (Marsh, 2018; Takahashi & Nyvad, 2011). This paradigm helps explain why individuals with similar microbial profiles may exhibit distinct clinical outcomes.

Behavioral and sociodemographic determinants further contribute to the heterogeneity of dental caries in adults. Socioeconomic status, educational level, health literacy, dietary patterns, and access to dental care have been consistently associated with caries distribution and untreated disease (Peres et al., 2019; Watt et al., 2018). Understanding adult caries as a heterogeneous and socially patterned condition is essential for designing individualized preventive strategies and reducing oral health inequalities.

2 METHODOLOGY

This narrative review was conducted following established methodological recommendations for non-systematic reviews in health sciences (Grant & Booth, 2009). Electronic searches were performed in PubMed, Scopus, and Web of Science using keywords related to adult dental caries, oral microbiology, behavior, and social determinants.

Eligible studies included observational research, clinical trials, and systematic reviews published in English that addressed caries in adult populations. Studies focusing exclusively on pediatric samples or specific systemic diseases were excluded to maintain focus on general adult populations. Data extraction emphasized thematic synthesis rather than quantitative pooling, allowing integration of microbiological, behavioral, and sociodemographic findings. The selected literature was critically analyzed to identify patterns of heterogeneity and gaps in current knowledge.

3 RESULTS

3.1 MICROBIOLOGICAL HETEROGENEITY OF DENTAL CARIES IN ADULTS

The reviewed literature consistently demonstrates that dental caries in adults is associated with marked heterogeneity in oral biofilm composition. While Streptococcus mutans and Lactobacillus spp. remain strongly associated with active and cavitated lesions, several studies indicate that caries development cannot be attributed to single pathogens alone. Instead, adult caries reflects a dysbiotic shift within a complex microbial ecosystem driven by environmental and host-related factors (Takahashi & Nyvad, 2011; Marsh, 2018).

High-throughput sequencing studies have shown that adults with similar clinical caries experience may present distinct microbial profiles, with variations in acidogenic and aciduric species beyond traditional cariogenic bacteria. Genera such as Actinomyces, Bifidobacterium, Scardovia, and Veillonella have been implicated in root caries and coronal lesions in adults, particularly in the presence of reduced salivary flow or exposed root surfaces (Beighton et al., 2016; Simón-Soro & Mira, 2015). These findings support an ecological plaque hypothesis, highlighting the dynamic nature of the caries process and its heterogeneity among adult individuals.

3.2 BEHAVIORAL FACTORS INFLUENCING CARIES HETEROGENEITY

Behavioral determinants emerged as major contributors to the variability in caries prevalence and severity among adults. Frequent consumption of fermentable carbohydrates, especially between meals, was consistently associated with increased caries risk and higher lesion activity, independent of age or baseline oral hygiene status (Moynihan & Kelly, 2014).

Oral hygiene practices also showed heterogeneous patterns across populations. Adults with irregular toothbrushing habits and limited use of fluoride-containing products exhibited higher levels of plaque accumulation and caries progression, whereas consistent fluoride exposure was associated with lesion arrest and reduced disease activity (Featherstone, 2004; Twetman, 2016). Moreover, irregular dental attendance patterns—often characterized by symptom-driven visits—were linked to higher prevalence of untreated caries and tooth loss, reinforcing the role of preventive behaviors in modulating disease expression (Thomson et al., 2012).

3.3 SOCIODEMOGRAPHIC GRADIENTS AND INEQUALITIES IN ADULT CARIES

Strong and consistent sociodemographic gradients were observed across the included studies. Lower educational attainment and household income were significantly

associated with higher caries prevalence, greater number of untreated lesions, and increased tooth loss in adult populations (Schwendicke et al., 2015; Peres et al., 2019).

Population-based studies demonstrated that adults from socioeconomically disadvantaged backgrounds were more likely to experience cumulative caries burden over the life course, reflecting persistent exposure to risk factors such as limited access to dental care, unhealthy dietary patterns, and reduced health literacy (Broadbent et al., 2016). These inequalities were evident even in countries with well-established public dental health systems, underscoring the multifactorial and socially patterned nature of adult dental caries.

3.4 INTEGRATED PERSPECTIVE ON HETEROGENEITY

Taken together, the evidence indicates that adult dental caries is characterized by substantial interindividual and interpopulation heterogeneity resulting from the interaction between microbiological dysbiosis, behavioral patterns, and sociodemographic conditions. Rather than following a uniform trajectory, caries progression in adults reflects diverse risk profiles shaped by cumulative biological and social exposures across the life course (Fejerskov & Nyvad, 2015; Watt et al., 2018).

4 DISCUSSION

The findings synthesized in this review reinforce the concept that dental caries in adults is a heterogeneous and dynamic condition shaped by the interaction of biological, behavioral, and sociodemographic factors. Rather than a uniform disease entity, adult caries emerges as a spectrum of clinical presentations influenced by cumulative life-course exposures, adaptive changes in the oral microbiome, and individual behavioral patterns.

From a microbiological perspective, variations in biofilm composition appear to reflect ecological shifts driven by dietary habits, oral hygiene practices, and host-related factors. These variations help explain why similar microbial profiles may be associated with different clinical outcomes and why caries progression cannot be attributed to specific microorganisms in isolation. This ecological understanding challenges traditional pathogen-centered models and supports a more nuanced interpretation of caries risk.

Behavioral determinants play a central role in modulating this biological complexity. Frequent sugar intake, inconsistent oral hygiene, and irregular dental attendance contribute to the maintenance of a dysbiotic oral environment and sustained demineralization. Importantly, these behaviors are not randomly distributed across populations but are strongly influenced by sociodemographic conditions such as education, income, and health literacy.

The integration of sociodemographic perspectives further highlights that adult caries is deeply embedded within broader social and structural contexts. Inequities in access to preventive care and health-promoting resources exacerbate disease burden and contribute to persistent disparities in caries prevalence and severity. Consequently, purely biomedical approaches are insufficient to address the full complexity of adult caries.

Taken together, the evidence supports a shift toward individualized and context-sensitive approaches to caries prevention and management. Recognizing heterogeneity is essential for designing targeted interventions that account for microbial, behavioral, and social dimensions simultaneously.

5 CONCLUSION

Dental caries in adults should be understood as a multifactorial and heterogeneous condition rather than a homogeneous disease. Variability in microbiological profiles, health behaviors, and sociodemographic circumstances results in distinct risk trajectories and clinical outcomes across individuals and populations.

Effective prevention and management strategies must therefore move beyond standardized approaches and adopt individualized frameworks that integrate biological susceptibility, behavioral patterns, and social determinants of health. Such an approach has the potential to improve clinical effectiveness, enhance preventive outcomes, and reduce persistent inequalities in adult oral health at both individual and population levels.

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