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REVIEW

Impact of Gram-negative bacteria on oral health

Impacto de las bacterias gramnegativas en la salud bucal

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ABSTRACT

Introduction: a good state of oral health provides the individual with a state of well-being and physical, mental and social satisfaction; It is due to the ability of the mouth, especially the teeth, to transmit emotions such as joy through a smile.
Objective: to describe the impact of gram-negative bacteria on oral health.
Method: the information search was carried out in the databases: Scielo, PubMed and SCOPUS, in addition to other data sources such as search engines and institutional repositories. Selection criteria were applied for the selection of bibliographic sources. 23 sources were used for the development of the research.
Development: oral health in general is considered an important factor in the analysis of the health situation of countries. The mouth is home to the second most diverse microbial community in the body (after the intestine), with more than 700 species of bacteria. Likewise, it is valid to emphasize that these bacteria are potentially greater in virulence than viruses. Odontogenic infections can spread rapidly and compromise neurovascular structures and airway patency; They are not caused by a single organism; instead, they are polymicrobial in nature. Gram-negative bacteria have special relevance in the development of oral diseases. One of the peculiarities of this group of biological agents is their high capacity for antimicrobial resistance.
Conclusions: Gram-negative bacteria have a variable impact on oral health. There are many bacterial species and etiological agents that can influence the development of oral conditions. These are made up of diseases such as cavities, gingivitis until they evolve over time without adequate treatment or with a poor response to periodontitis. In turn, gram-negative bacteria provide extensive resistance to the treatment of these pathologies, which is why they require special attention in their management and monitoring due to the multiple systemic complications that can develop.

Keywords: Bacteria; Gram-Negative Bacteria; Cavities; Periodontal Disease; Gingivitis; Oral Health.

RESUMEN

Introducción: un buen estado de salud bucal proporciona al individuo un estado de bienestar y satisfacción física, mental y social; se debe a la capacidad de la boca en especial los dientes de trasmitir emociones como la alegría mediante una sonrisa.
Objetivo: describir el impacto de las bacterias gramnegativos en la salud bucal.
Método: la búsqueda de la información se realizado en las bases de datos: Scielo, PubMed y SCOPUS, además de otras fuentes de datos como motores de búsqueda y repositorios institucionales. Para la selección de las fuentes bibliográficas se aplicaron criterios de selección. Se empelaron 23 fuentes para el desarrollo de la investigación.

Desarrollo: la salud bucal en general se considera un factor importante en el análisis de la situación de salud de los países. La boca alberga la segunda comunidad microbiana más diversa del cuerpo (después del intestino), con más de 700 especies de bacteria. De igual manera, es válido recalcar que etas bacterias son potencialmente mayores en virulencia que los virus. Las infecciones odontogénicas pueden propagarse rápidamente y comprometer las estructuras neurovasculares y la permeabilidad de las vías respiratorias; no son causadas por un solo organismo en cambio, son de naturaleza polimicrobiana. Especial relevancia tienen las bacterias gramnegativos en el desarrollo de las afecciones bucodentales. Una de las particularidades de este grupo de agentes biológicos es su alta capacidad de resistencia antimicrobiana.
Conclusiones: las bacterias gramnegativos impactan de forma variable en la salud bucal. Son amplias las especies de agentes etiológicos bacterianos que pueden influir en el desarrollo de afecciones bucales. Estas se integran por enfermedades como caries, gingivitis hasta evolucionar en el tiempo sin un tratamiento adecuado o con mala respuesta al mismo a la periodontitis. A su vez, las bacterias gramnegativos aportan amplia resistencia al tratamiento de estas patologías por lo que requieren especial atención en su manejo y seguimiento por las múltiples complicaciones sistémicas que pueden desarrollar.

Palabras clave: Bacterias; Bacterias Gramnegativos; Caries; Enfermedad Peridontal; Gingivitis; Salud Bucal.

INTRODUCTION

Health and hygiene are broad; they cover every aspect of the individual's life and relationship with the surrounding environment. Health is understood as a state of physical, mental, and social well-being and balance, not only the absence of disease; for this reason, health and health status are seen as one, an integrated whole in constant relationship with the environment. Within this state of health, the promotion of oral health and hygiene is key to the prevention of diseases; a good state of oral health provides the individual with a state of well-being and physical, mental, and social satisfaction; it is due to the ability of the mouth, especially the teeth, to transmit emotions such as joy through a smile.

For this reason, since 2012, the General Assembly of the FDI World Dental Federation has been developing a campaign to raise awareness of oral health and its importance.[1] Despite these efforts, the number of people suffering from oral diseases is high and tends to increase. It is estimated that since 2015, the number of patients diagnosed with any oral disease exceeded 3,5 million cases, with a higher incidence in people of advanced ages, which has been pointed out as one of the main risk factors. In turn, it is estimated that more than 530 million children suffer from dental caries, mainly in milk teeth, equivalent to 15,4 % of the cases of oral diseases and about 10 % of the world population.[2] multiple risk factors influence the development of poor oral hygiene, which should be analyzed and addressed from primary health care.

Among these factors or determinants, we can mention low household income and socio-demographic conditions (which have been related as one of the causes or determinants in approximately 80 % of the conditions). These include bad dental hygiene habits, nutritional deficit, systemic diseases (chronic or immunological), and infections, among other factors.[2,3,4] In turn, proper oral health is key to preventing both local and systemic diseases. Poor oral hygiene has been associated with the development of conditions such as psychological discomfort, facial disfigurement, and even death, in addition to general diseases such as cardiovascular conditions, impact on the renal system, and others.

Special attention should be given to chronic renal disease and its relationship with periodontitis because high uremia values in the blood decrease the patient's immunological response capacity and, consequently, his response to bacterial infections.[2,5] Bacteria are a wide group of biological agents responsible for multiple health conditions. Among these conditions are those related to health services, which constitute an important group. Gram-negative bacteria stand out in this group, responsible for most diseases due to their antimicrobial resistance mechanism, which has generatively affected and influenced health and all medical specialties.[6] Regarding the participation of bacteria in oral health, authors such as Santaella Palma et al.[7] state in their research that approximately 15 to 35 % of the bacteria isolated in patients with oral diseases are beta-lactamase producers and, therefore, resistant to commonly used drugs such as penicillin V and aminopenicillins. Among the bacteria with demonstrated resistance are *Streptococcus mutans, Porphyromonas gingivalis, Fusobacterium nucleatum, Aggregatibacter actinomycetemcomitans*, *Prevotella Intermedia*, *Treponema dentícola*, *Tannerella Forsythia*, *Enterococcus faecalis* and *Actinomyces*. In turn, he describes that the main mechanism of antimicrobial resistance of bacteria in the oral cavity is the formation of biofilms or biofilm, typical of gram-negative bacteria.

In turn, the study conducted by Coaquira Cutipa[8] exposes the relationship between the Sliness and O'leary indexes aimed at determining the formation of bacterial plaque to determine the degree of oral hygiene. The authors showed alarming results by establishing a more than 57 % relationship about the association between a

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low score in the indexes analyzed (indicative of poor oral hygiene) and the presence of bacterial oral diseases.

The capacity of antimicrobial resistance of bacteria in the oral cavity, especially gram-negative bacteria, has been related to several factors, including the excessive use of drugs, especially antibiotics.[9] based on the above, the importance of monitoring oral and dental conditions, especially those of bacterial origin, is understood as a consequence of the repercussions they can have on oral health and, in turn, on the state of health in general. For this reason, the present review aims to describe the impact of gram-negative bacteria on oral health.

METHOD

A review of the published literature on the impact of gram-negative bacteria on oral health was carried out about the research topic and the objective. We worked with the terms Bacteria, Gram-negative bacteria, Caries, Periodontal disease, Gingivitis, and Oral health and their equivalents in English. The search for information was carried out using the following databases: Scielo, PubMed, and SCOPUS, in addition to other data sources such as search engines and institutional repositories. Selection criteria were applied for the selection of bibliographic sources, such as research related to the topic to be developed (about the title, abstract, and text of the work) and the fact that these should be located in sources of scientific value. Works that did not comply with these aspects were excluded. A total of 40 papers were found, and 23 sources were used to develop the research.

DEVELOPMENT

Oral health, in general, is considered an important factor in the analysis of the health situation of countries, as well as an indicator of the state of well-being. Undoubtedly, as previously expressed, this condition acts and influences each of the spheres of life from the psychological and emotional level to its influence on the overall health status of the individual. It is also a strong determinant in interpersonal relationships. The mouth is home to the second most diverse microbial community in the body (after the gut), with more than 700 species of bacteria. When the labile balance of the oral ecosystem is disrupted, dysbiosis occurs.

This allows disease-promoting bacteria to manifest themselves and cause caries, gingivitis, and periodontitis. The main characteristics of bacterial plaque are that it is associated with a surface, produces a localized infection, and can tolerate antimicrobial treatments. Caries and periodontitis are the two most common human dental diseases and are caused by dysbiosis of the oral flora.[10,11] It should also be noted that these bacteria are potentially more virulent than viruses. They also present large phage communities, which implies a greater capacity for molecular diversity and, therefore, develop greater evolutionary mechanisms.[12] Odontogenic infections can spread rapidly and compromise neurovascular structures and the permeability of the respiratory tract. These infections can be classified as simple or complex depending on the severity and extent of the infectious process. Simple infections are usually limited to a single site and have a slower progression, whereas complex infections involve multiple tissues and structures, can spread rapidly through fascial spaces, and involve upper airways. A single organism does not cause[13] odontogenic infections; it is polymicrobial.

These infections consist of various facultative anaerobes, such as *Streptococcus anginosus* group, *Streptococcus viridans* group and strict anaerobes, especially anaerobic cocci, such as *Peptostreptococcus*, *Prevotella*, *Fusobacterium species* and *Bacteroides*, which contribute to inflammation since they can colonize and proliferate in anaerobic environments, such as periodontal and periapical abscesses, contributing to abscess formation, tissue degradation and disease progression.[13] There are multiple efforts aimed at prevention and, therefore, good oral health, or oral health as it may be known. According to the research conducted by León-Quenguan et al.[14], several programs are aimed at undertaking actions, especially from primary health care, to promote good habits and proper oral health.

These programs include different spheres for the practice of the family physician and the stomatologist. They range from addressing the risk factors or determinants of health status to implementing specialized care for each sector of the population to achieve full coverage.[14] The importance of studying oral diseases has gained interest among researchers. This broad group of pathologies has been associated with systemic diseases with wide repercussions on the individual's health status. One of the most common forms of presentation and with the greatest impact on the health of patients is periodontal disease.[15]

Periodontal disease is present in approximately 11,2 % of the general population and is the most severe form of presentation of oral diseases. Its wide spectrum of conditions is the main cause of tooth loss and negatively impacts the individual's health. Its main etiology responds to a dysbiosis of bacterial origin. The bacteria involved in the pathogenesis of periodontitis contribute directly and indirectly to a systemic inflammatory state. Numerous epidemiological, experimental, and interventional studies have established links between periodontitis and cardiovascular diseases, diabetes, pregnancy complications, respiratory diseases, and rheumatoid arthritis.[16,17]

The main biological links between periodontitis, local pathologies, and systemic diseases are bacteremia, endotoxemia, and low-grade systemic inflammation. Bacteria of the dysbiotic oral microbiome and their

products can disseminate in the organism through the bloodstream, becoming a source of infection at a distance or acting indirectly, amplifying the inflammatory response. This aspect determines the high capacity of bacteremia and the development of affections in the different systems of the organism.[15] It is a silent disease; it begins with gingivitis or non-painful inflammation of the gums; with time, as local irritants such as calculus and soft bacterial plaque increase, it destroys the supporting bone of the teeth and evolves into periodontitis.[10]

Together with periodontal diseases, caries, and malocclusion are one of the most frequent pathologies among oral diseases, together with periodontal disease. It is estimated that their influence is present in both developed and developing countries. In particular, dental caries is present in about 60 % of the population. *Streptococcus mutans* is accepted as the main cariogenic agent, and there is substantial knowledge about the specific virulence factors that make the organism pathogenic.[18] Dental abscesses are a type of infectious pathology that derives from non-infectious pathologies. Therefore, it is necessary to understand that the proliferation of the natural microbiota of the mouth evolves to produce an infectious pathological process as a result of a series of non-infectious pathologies. This type of pathology is annoying and very painful, so it is usual for patients to seek quick and efficient remedies. However, despite being an infectious pathology, antibiotherapy, i.e., treating these pathologies with antibiotics, is controversial.[19] Gram-negative bacteria are particularly relevant in developing oral diseases. One of the peculiarities of this group of biological agents is their high capacity for antimicrobial resistance. These resistance mechanisms are due to genetic and adaptive mechanisms.[20] One of the interesting ones is the formation of biofilms or biofilms. The biofilm is a population of cells that grow attached to a surface enveloped in an exopolysaccharide matrix that protects them from antibiotic attack. Biofilms cause more than 60 % of all microbial infections; the increased resistance of these communities to antimicrobials involves several mechanisms, including the inactivation of antibiotics by extracellular polymers or enzymatic modification, decreased growth rate due to nutrient limitation, phenotypic changes in bacterial cells as a result of the acquisition of resistance genes within the biofilm, and the persistence of a small group of cells in the bacterial community.[21]

One of the forms of treatment developed for managing bacterial infections in oral diseases, especially those of resistant strains, is chlorhexidine. This broad-spectrum compound is a topical antiseptic with great utility on the oral mucosa. It can be used as a substance for mouthwashes in gingivitis. In addition to its use in protocols to maintain control over bacterial conditions that can suffer blood dissemination.[22]

Other therapeutic alternatives are based on the application and compliance of healthy diets to avoid ingesting foods with cariogenic properties. Among the foods suggested for the control of caries formation are fatty acids, proteins, and polyphenols. These foods can act on the barrier or bacterial plaque that forms the agents in the oral cavity or act directly on the infectious agent.[18] Similarly, using ozonated vegetable oils has demonstrated an antimicrobial and regenerative action due to the direct oxidation action that influences the destruction of the bacterial wall. However, its main effect has been demonstrated for gram-positive bacteria, unlike gram-negative bacteria, which are still under study with some encouraging results.[23]

CONCLUSIONS

Gram-negative bacteria have a variable impact on oral health. Many bacterial species and etiological agents can influence the development of oral diseases. These are integrated by diseases such as caries and gingivitis to evolve over time without adequate treatment or with poor response to periodontitis. In turn, gram-negative bacteria provide ample resistance to the treatment of these pathologies and, therefore, require special attention in their management and follow-up due to the multiple systemic complications that can develop.

REFERENCES

1. Abreu E de los ÁG, Adam MRS. El deber de actuar por la salud bucal y la felicidad. Rev Cuba Estomatol [Internet]. 18 de diciembre de 2020 [citado 4 de agosto de 2024];58(1):3360. Disponible en: https://revestomatologia.sld.cu/index.php/est/article/view/3360

2. Arteaga BAS, Pacheco EJS, Granizo YVÁ, Espinoza JAL. Generalidades actuales de la salud bucodental. RECIAMUC [Internet]. 11 de febrero de 2023 [citado 4 de agosto de 2024];7(1):568-75. Disponible en: https://reciamuc.com/index.php/RECIAMUC/article/view/1049

3. Martinez LYR, Oquendo CDL, Arango WAP, Mejía JA, Suárez AAA. Salud bucal y determinantes sociales en escolares con limitación visual en Medellín. Rev Cuba Estomatol [Internet]. 30 de septiembre de 2020 [citado 4 de agosto de 2024];57(4):2985. Disponible en: https://revestomatologia.sld.cu/index.php/est/article/view/2985

4. Witt GFV, Acosta RAM, Arteaga GLV, Albán JSL. La nutrición como factor de riesgo para la progresión de la

enfermedad periodontal. RECIMUNDO [Internet]. 14 de agosto de 2023 [citado 4 de agosto de 2024];7(2):423-31. Disponible en: https://recimundo.com/index.php/es/article/view/2070

5. Bertrán Herrero G, Pérez Borrego A, Bertrán Herrero G, Pérez Borrego A. Enfermedad renal crónica y periodontitis. Acta Médica Cent [Internet]. septiembre de 2023 [citado 4 de agosto de 2024];17(3):594-601. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S2709-79272023000300594&lng=es&nrm=iso&tlng=es

6. Loor SC, Solórzano JWP, Loor JJG. Bacterias Gram-negativas productoras de carbapenemasas aisladas de pacientes hospitalizados del Hospital General Portoviejo, Ecuador. QhaliKay Rev Cienc Salud ISSN 2588-0608 [Internet]. 15 de enero de 2023 [citado 29 de julio de 2024];7(1):43-50. Disponible en: https://revistas.utm.edu.ec/index.php/QhaliKay/article/view/5221

7. Palma LES, Quinteros MJB, Sánchez KMR. Impacto de la resistencia bacteriana en la elección de antibióticos en odontología: una revisión de las tendencias actuales. Más Vita [Internet]. 6 de abril de 2024 [citado 4 de agosto de 2024];6(1):55-72. Disponible en: http://acvenisproh.com/revistas/index.php/masvita/article/view/694

8. Coaquira Cutipa EL. Concordancia entre dos índices de placa bacteriana para determinar la higiene oral en pacientes del Centro de Salud Cabanillas, 2023. 20 de mayo de 2024 [citado 4 de agosto de 2024]; Disponible en: https://repositorio.uancv.edu.pe/handle/UANCV/1168

9. Bascones Martínez A, Aguirre Urízar JM, Bermejo Fenoll A, Blanco Carrión A, Gay-Escoda C, González Moles MA, et al. Documento de consenso sobre el tratamiento antimicrobiano de las infecciones bacterianas odontogénicas. Av En Odontoestomatol [Internet]. diciembre de 2005 [citado 4 de agosto de 2024];21(6):311-9. Disponible en: https://scielo.isciii.es/scielo.php?script=sci_abstract&pid=S0213-12852005000600004&lng=es&nrm=iso&tlng=es

10. Cantizano MJ, Barrios M. Diseño de un programa para el manejo integral de Periodontitis del adulto desde el primer nivel de atención, en el centro de salud el Poblado de Metrosalud. Medellin, 2024. 15 de junio de 2024 [citado 4 de agosto de 2024]; Disponible en: https://repository.ces.edu.co/handle/10946/8556

11. Díaz Mayta AA, Sernaque Calderon K, Roque Gallardo NA, Martínez Cadillo EE, Mattos-Vela MA. Streptococcus dentisani una promesa de probiótico bucal. Revisión de literatura. Rev Soc Científica Parag [Internet]. 31 de mayo de 2023 [citado 4 de agosto de 2024];28(1):156-68. Disponible en: http://sociedadcientifica.org.py/ojs/index.php/rscpy/article/view/240

12. Cruz Quintana SM, Díaz Sjostrom P, Arias Socarrás D, Mazón Baldeón GM. Microbiota de los ecosistemas de la cavidad bucal. Rev Cuba Estomatol [Internet]. marzo de 2017 [citado 5 de agosto de 2024];54(1):84-99. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0034-75072017000100008&lng=es&nrm=iso&tlng=pt

13. Ramírez Sánchez KM, Santaella Palma LE, Chávez González KL. Infecciones odontogénicas y su implicancia en el desarrollo de Endocarditis Bacteriana. Rev Multidiscip Investig Contemp [Internet]. 2024 [citado 5 de agosto de 2024];2(2):117-43. Disponible en: https://dialnet.unirioja.es/servlet/articulo?codigo=9623922

14. Quenguan JML, Guisao AET, Hincapié JDC, Jaramillo LMC, Suárez AAA. Planes, políticas públicas y estrategias de salud bucal en Latinoamérica y el Caribe (1991-2018). Rev Cuba Estomatol [Internet]. 29 de enero de 2021 [citado 4 de agosto de 2024];58(2):3175. Disponible en: https://revestomatologia.sld.cu/index.php/est/article/view/3175

15. Enfermedad periodontal y salud general. EMC - Tratado Med [Internet]. 1 de marzo de 2022 [citado 4 de agosto de 2024];26(1):1-8. Disponible en: https://www.sciencedirect.com/science/article/abs/pii/S1636541022460430

16. Peña Sisto M, Peña Sisto L, Díaz Felizola Á, Torres Keiruz D, Lao Salas N. La enfermedad periodontal como riesgo de enfermedades sistémicas. Rev Cuba Estomatol [Internet]. marzo de 2008 [citado 4 de agosto de 2024];45(1):0-0. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0034-75072008000100006&lng=es&nrm=iso&tlng=es

17. Rodríguez Núñez I, López Castro G, Leyes Borrajo JL, García Varela L, Gallas Torreira M. Periodontal disease and its potential repercussion on the risk of prematurity. Rev Esp Pediatr. 2004;60(4):303-6.

18. Villagómez MSH. Polifenoles del arándano, arma natural contra las enfermedades bucales. Rev CIENTÍFICA Espec ODONTOLÓGICAS UG [Internet]. 2023 [citado 4 de agosto de 2024];6(1). Disponible en: http://portal.amelica.org/ameli/journal/611/6113971007/

19. Vega Castelló S. Microbiología de los abscesos dentales [Internet]. [España]: Universidad de la Laguna; 2018 [citado 5 de agosto de 2024]. Disponible en: https://riull.ull.es/xmlui/bitstream/handle/915/10253/Microbiologia%20de%20los%20abscesos%20dentales.pdf

20. García Castellanos T, Castillo Marshal A, Salazar Rodríguez D. Mecanismos de resistencia a betalactámicos en bacterias gramnegativas. Rev Cuba Salud Pública [Internet]. marzo de 2014 [citado 4 de agosto de 2024];40(1):129-35. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0864-34662014000100013&lng=es&nrm=iso&tlng=pt

21. Mendoza MTH. El papel del biofilm en el proceso infeccioso y la resistencia. NOVA [Internet]. 31 de diciembre de 2004 [citado 28 de julio de 2024];2(2). Disponible en: https://revistas.unicolmayor.edu.co/index.php/nova/article/view/25

22. Lipari DMNA, Bordelois MI. Microbiota bucal y cepillado dental en personas con discapacidad. Rev Científica Higía Salud [Internet]. 30 de diciembre de 2023 [citado 4 de agosto de 2024];9(2). Disponible en: https://revistas.itsup.edu.ec/index.php/Higia/article/view/968

23. Alvarez-Hernández JC, Fernández-González OL, Machado-Cano MJ, Pérez-García LM, Alvarez-Hernández JC, Fernández-González OL, et al. Aceites vegetales ozonizados y sus propiedades antimicrobianas en el tratamiento de afecciones bucodentales. Rev Cienc Médicas Pinar Río [Internet]. febrero de 2024 [citado 5 de agosto de 2024];28(1). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S1561-31942024000100029&lng=es&nrm=iso&tlng=pt

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CONFLICT OF INTEREST

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Research: Nairobi Hernández Bridon.
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