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Oral-Gut Microbiome and Bone Health: Exploring Interplay

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Abstract

This review provides a comprehensive analysis of the intricate interplay among the gut microbiome (GM), bone health, interleukins, chronic periodontitis, and COVID-19 within a concise 300-word limit. It begins by exploring the symbiotic relationship between the GM and bone health, delineating their composition, functions, and influencing factors. The discussion seamlessly transitions to the interaction between the GM and bone metabolism, emphasizing nutrient absorption, microbial metabolites, specific bacteria, and immune modulation. Experimental evidence highlights the significant impact of the GM on bone health, elucidating the roles of microbial metabolites and bacterial strains. The analysis further investigates the complex nexus between interleukins, chronic periodontitis, and COVID-19, underscoring genetic variations and immune responses shaping susceptibility and severity in viral infections. Chronic periodontitis emerges as a crucial focal point for understanding systemic dysbiosis, with genetic factors, dysbiosis, and therapeutic approaches offering insights into risk assessment and potential interventions. The proposed shift in therapeutic strategies centers on addressing dysbiosis, immune dynamics, and endocrine balance to manage degenerative and infectious diseases effectively. In conclusion, this review navigates the intricate landscape of human physiology, weaving together diverse elements to provide a holistic understanding. It underscores the importance of ongoing research to unravel the complex interplay of genetics, immune responses, and systemic health, emphasizing the need for continued exploration in this field.

Keywords: Bone health, Gut microbiome, Oral microbiome, Chronic periodontitis, Dysbiosis, gastrointestinal tract, Archaea, Predominant phyla, Actinobacteria, Proteobacteria, Bacteroidetes, biomarkers

Introduction

The human body functions as a complex web of various systems and organs, with recent research shedding light on the intricate relationship between GM and bone health [1-4]. The GM, a vast community of microorganisms residing in the gastrointestinal tract, has been recognized for its crucial role in influencing several physiological processes crucial to maintaining overall health (Figure1) [5-8]. This review explores the multifaceted connections between GM and bone health, examining the composition and importance of GM, the fundamentals of bone health, and emerging evidence indicating a mutualistic relationship between the two [9-13].

Discussion

GM is a complex and dynamic ecosystem residing in the gastrointestinal tract, comprising trillions of microorganisms, including bacteria, viruses, fungi, and archaea [14-18]. This microbial community plays a crucial role in maintaining overall health and homeostasis within the human body [19-23]. The composition of the GM is diverse and varies among individuals, shaped by numerous factors including genetics, diet, age, lifestyle, and environmental exposures [24-28]. Predominant phyla in the GM include Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria. Each individual's microbiome is unique, resembling a fingerprint that reflects their own genetic heritage and distinct life experiences [29-33]. The functions of the GM are multifaceted [34-40].

Recently, microbiome research is focusing on issues related to genetics, oral dysbiosis, bacteraemia, and chronic periodontitis (Figure 2) [41-47].GM actively participates in the digestion and absorption of nutrients, breaking down complex carbohydrates and producing enzymes that the human body cannot generate on its own [48-50]. Additionally, the GM contributes to the

synthesis of certain vitamins, such as B vitamins and vitamin K, which are essential for various physiological processes [51-57]. When discussing the relationship between our gut and bones, we delve into a complex and fascinating world [58-64]. This interaction, often referred to as the gut-bone axis, is influenced by a wide range of factors concerning our dietary choices, lifestyle, medications we take, and even our environmental exposures [65-70]. Understanding these factors is crucial for comprehending how the gut microbiota influences bone health and for identifying possible avenues for positive intervention [71-77].

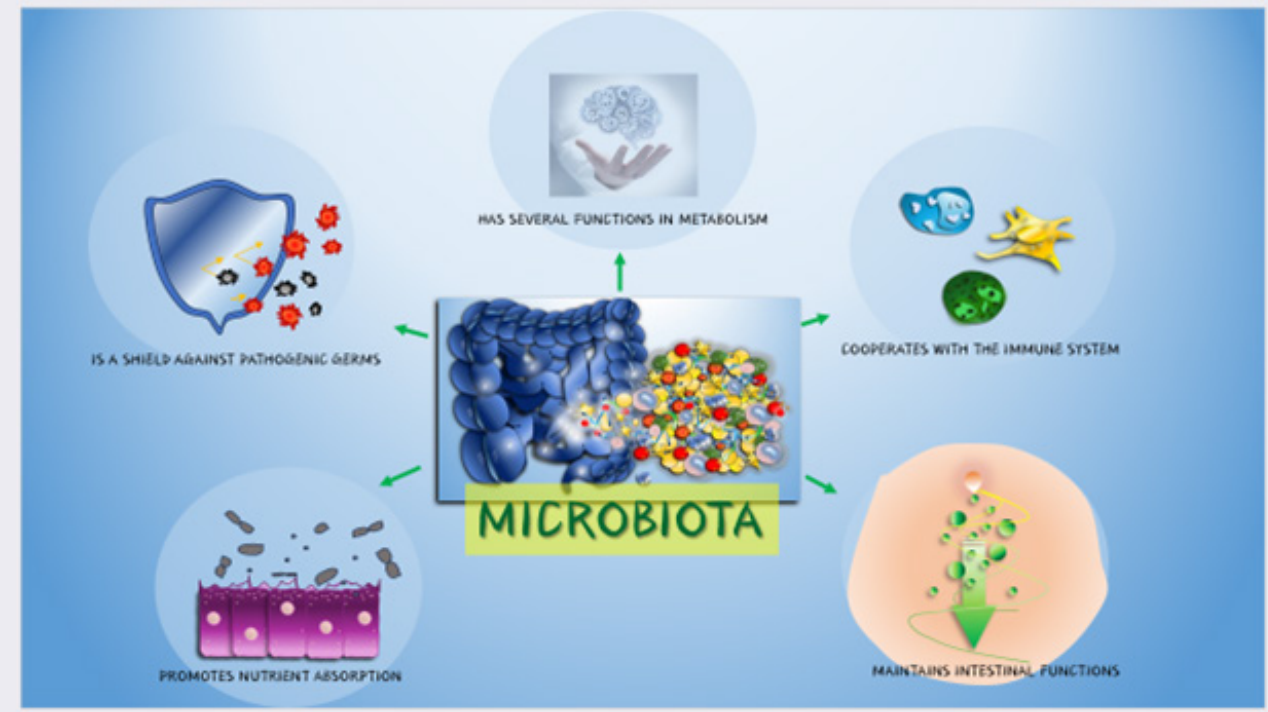

Figure 1: Role of the GM in the human body.

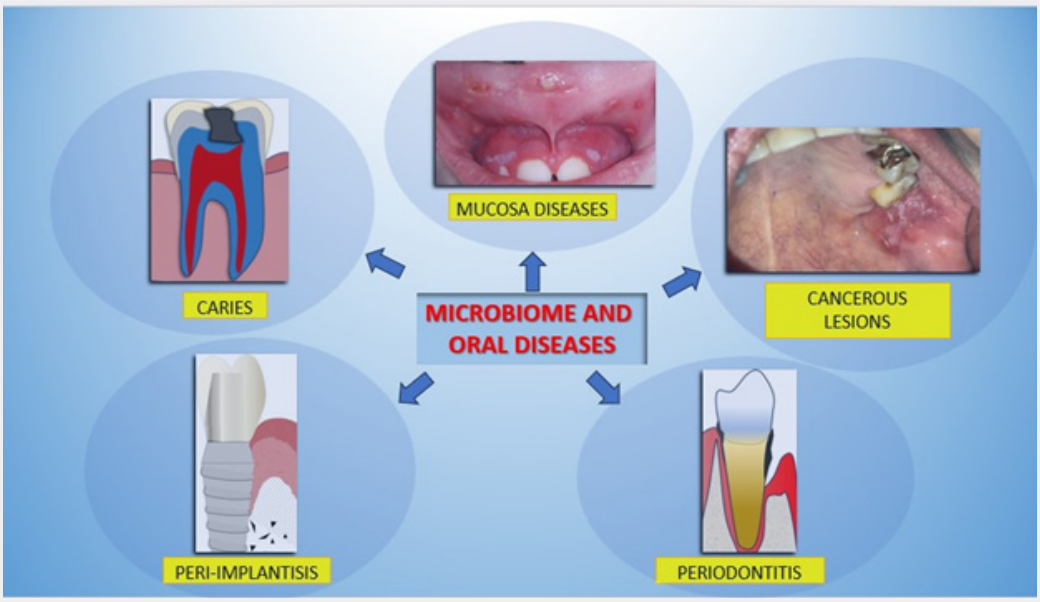

Figure 2: Oral diseases caused by alterations in the microbiome.

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Let's start with diet and nutrient intake, two fundamental pillars for bone health [78-83]. Calcium and vitamin D are essential, and our gut microbiota plays a crucial role in absorbing these nutrients [84-90]. A balanced diet promotes microbial diversity and optimal nutrient utilization. Moving on to antibiotic use, we see how these medications, although essential for treating bacterial infections, can have a significant impact on our microbiota [91-98]. Broad-spectrum antibiotics can alter the microbial balance, potentially influencing bone metabolism [99-105]. Lifestyle factors are equally important. Regular physical activity and weight-bearing exercises benefit bone health [106-112]. Physical activity may contribute to greater microbial diversity, influencing the gut-bone axis through the release of exercise-influenced factors [113-115]. We cannot overlook age and hormonal changes, which have a significant impact on bone health [116-118]. Postmenopausal women, for example, experience a decrease in estrogen levels, leading to increased bone resorption [119-123]. These hormonal changes may also affect the gut microbiota, creating an intricate interplay between aging, hormones, and bone health. Medications represent another important piece of the puzzle [74,124-126].

Drugs that alter gastric acidity, such as proton pump inhibitors and antacids, can affect calcium absorption in the intestine, with potential consequences for bone health in the long term [118]. Stress and mental health also play a role in the broader picture. Chronic stress may contribute to influence inflammatory responses that could affect bone health through their interaction with the gut-brain axis [127-132]. Disease states, such as inflammatory bowel disease and celiac disease, can have a negative impact on gut microbiota health and nutrient absorption, with implications for bone density [133-137]. Finally, we cannot underestimate the importance of genetic factors and early environmental exposures in shaping our gut microbiota and, consequently, our bone health throughout life [18,138-140].

This growing understanding of the interaction between the microbiota and bone health has significant clinical implications, paving the way for potential therapeutic interventions aimed at optimizing skeletal well-being [141-144]. The use of probiotics and prebiotics, for example, represents a promising option for modulating the microbiota and positively influencing bone metabolism. Personalized approaches are becoming increasingly relevant, considering the variability in microbiota composition among individuals. Microbiota analysis can guide tailored therapeutic interventions, taking into account each individual's unique microbial landscape. Dietary recommendations are crucial to support bone health and microbial diversity [33,145-146]. Nutrient-rich diets containing calcium, vitamin D, and prebiotic fibers are crucial, as well as the inclusion of fermented foods that introduce beneficial probiotic microorganisms[147]. Physical exercise and lifestyle modifications can be a powerful tool in promoting bone health and microbial diversity. Responsible antibiotic use and awareness of their potential effects on the microbiota must be integral to clinical practices [148-150]. Regular clinical monitoring and the development of specific biomarkers for the gut-bone axis can help identify early issues and adopt targeted interventions [141,4]. Educating patients about the importance of gut health for skeletal well-being can promote active participation in managing their health [151-153]. Finally, therapeutic innovation, multidisciplinary involvement, and ongoing research are crucial for translating this knowledge into effective and personalized clinical interventions that improve patient outcomes and prevent skeletal-related disorders [101,154,155]. This holistic view, considering both the microbiota and bone health, offers extraordinary opportunities to improve people's health and quality of life, and continuing to study and test these insights is essential for the success of these innovative strategies [101,156].

Conclusion

The gut and microbiomes are interconnected and mutually influence overall health. Integrated therapeutic approaches considering both microbiomes are emerging as promising strategies to improve overall health. Future research should delve deeper into this complex relationship to develop increasingly effective and personalized therapies for preventing and treating a wide range of pathological conditions, both intestinal and oral.

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