

The Impact of Smoking on Oral Health: A Systematic Review

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ABSTRACT

The nexus between smoking and oral health is a significant concern in dental medicine, impacting millions worldwide. Smoking, often linked to various systemic health issues, also plays a critical role in the prevalence and severity of oral health conditions. These include but are not limited to tooth decay, periodontal disease, and the increased risk of oral cancer. The consequences of smoking on oral health extend beyond mere esthetics, affecting the success rates of dental implants, the healing process after teeth are removed, and contributing to conditions such as dry socket and dental caries. Understanding the comprehensive impact of smoking on oral health is vital for public health initiatives and individual preventive measures.

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I. INTRODUCTION

This systematic review delves into various dimensions of how smoking deteriorates oral health, elucidating the mechanisms of damage at the cellular and molecular levels. It highlights common oral health issues faced by smokers such as gum disease, dry socket, and the challenges encountered with dental implants. The article offers a comparative analysis with non-smokers, shedding light on the stark differences in oral health outcomes. Additionally, it explores the varied impact of different tobacco products, backed by case studies and clinical findings that underscore the grave consequences of smoking. In aiming to mitigate these impacts, the review also puts forth preventive measures and cessation techniques, while suggesting directions for future research to further understand and combat the effects of smoking on oral health.

II. Overview of Smoking and Oral Health

Smoking significantly impacts oral health, leading to a range of detrimental conditions. It is well-documented that tobacco use contributes to the development and progression of periodontal disease, commonly known as gum disease. Smokers exhibit a greater accumulation of plaque and tartar, which are key factors in the onset and progression of gum disease. This condition not only leads to inflammation and bleeding of the gums but can also result in the deterioration of the bone that supports the teeth.

Additionally, smoking is a major risk factor for oral cancer. The harmful chemicals in tobacco smoke can cause mutations in the cells of the oral cavity, potentially leading to the development of cancerous tumors. The risk of oral cancer increases with the duration and intensity of smoking.

Another significant concern is dry socket, a painful condition that can occur after having teeth removed. Smokers are at a higher risk of developing dry socket because smoking can impede the healing process by restricting blood flow to the affected area. This condition can lead to severe pain and slow the overall recovery process.

Smoking also affects the success rate of dental implants. Tobacco use can impair bone healing around the dental implant, reducing the likelihood of the implant successfully integrating with the bone. This can lead to implant failure and the need for additional procedures to address the issue.

In terms of dental caries, or tooth decay, smokers are at an increased risk due to the detrimental effects of tobacco on saliva production. Reduced saliva flow results in less protection for the teeth against the acids that cause tooth decay, making smokers more susceptible to cavities.

Overall, the impact of smoking on oral health is profound and multifaceted, affecting almost every aspect of dental wellness. It is crucial for smokers to be aware of these risks and consider cessation programs to mitigate the adverse effects of tobacco on oral health.

III. Mechanisms of Damage

Direct Effects on Oral Tissues

Tobacco smoke contains numerous toxicants, including N-nitrosamines and polycyclic aromatic hydrocarbons, which directly contact oral tissues causing cellular injury and initiating tumorigenesis 1. These compounds block DNA repair mechanisms and contribute to the development of mouth cancer, highlighting smoking as a primary cause of this severe condition 2. Furthermore, the presence of these toxicants leads to tooth staining and increases the risk of tooth loss 2.

Impact on Oral Microbiome

Cigarette smoke drastically alters the microbial ecology of the mouth. It increases the acidity of saliva and depletes oxygen levels, which can lead to a loss of beneficial oral species and increased pathogen colonization 3. This alteration in the oral microbiome is evidenced by a decreased abundance of aerobic metabolism pathways and an increase in pathways favoring anaerobic bacteria 3. The resulting environment promotes the growth of harmful bacteria such as *P. gingivalis*, which is known for its virulence factors that thrive in low-oxygen environments and contribute to periodontal disease 1.

Immune System Suppression

Smoking impairs the immune response in the oral cavity, particularly affecting the functionality of oral polymorphonuclear leukocytes. These cells are crucial for defending against pathogens, but their chemotactic mobility and phagocytic function are diminished in smokers 3. Additionally, smoking suppresses the periodontal vascular response to plaque, leading to a reduced bleeding response, which is a clinical conundrum since it presents decreased symptoms but increased susceptibility to periodontal diseases 4. This suppression of the immune system and alteration in inflammatory responses facilitates a pathogen-friendly oral ecosystem, increasing the risk for diseases such as periodontitis 3 4.

IV. Common Oral Health Issues Caused by Smoking

Gum Disease

Smoking is a major contributor to gum disease, also known as periodontal disease. Tobacco use leads to inflammation and recession of the gums, creating deep pockets between the teeth and gums where bacteria can accumulate and cause further damage 5. This condition significantly increases with the number of cigarettes smoked, intensifying the risk and severity of periodontal disease 6. Smokers are more likely to produce bacterial plaque, which exacerbates gum disease, as the lack of oxygen in the bloodstream prevents infected gums from healing effectively 2. Moreover, the immunosuppressive effects of smoking impair the body's ability to fight infections, making smokers less responsive to gum treatment and increasing the likelihood of severe periodontal disease 6.

Oral Cancer

Oral cancer is a dire consequence of smoking, with tobacco use accounting for about 90% of all cases 5. The carcinogens in tobacco, such as N-nitrosamines and polycyclic aromatic hydrocarbons, induce precancerous changes in the cells of the mouth, tongue, and throat, which can develop into malignant tumors 5. The risk of developing oral cancer escalates with the duration and intensity of smoking, but notably, quitting smoking can significantly reduce this risk over time 7. Oral cancer in smokers most commonly affects areas like the sides of the tongue, the floor of the mouth, and the lips, necessitating early diagnosis for effective treatment 8.

Tooth Loss

The adverse effects of smoking extend to increased risk of tooth loss. Chemicals in tobacco weaken the bone and connective tissue that anchor the teeth, enhancing the likelihood of their loss 5. Smokers face a higher risk of tooth loss due to the compounded effect of gum disease and the direct impact of tobacco on oral structures 5. Smoking not only increases the susceptibility to periodontal pathogens but also diminishes the success rates of treatments aimed at preserving natural teeth 6.

Comparison with Non-Smokers

Prevalence of Oral Diseases

Non-smokers exhibit significantly better oral health outcomes compared to smokers. The data reveals a stark contrast in oral hygiene index scores (OHI-S), with non-smokers scoring 1.15 ± 0.51 , significantly lower than

smokers who scored 2.19 ± 0.62 9. This indicates that non-smokers maintain better oral cleanliness, reducing their risk of developing dental diseases. Additionally, the gingival index (GI), which measures gum health, was also found to be significantly better in non-smokers 9. Smoking increases the prevalence of severe conditions like acute necrotizing ulcerative gingivitis, a painful condition leading to bad smell and taste in the mouth, which further highlights the detrimental effects of smoking on oral health 8.

Severity of Symptoms

Smokers experience more severe symptoms of oral diseases compared to their non-smoking counterparts. For instance, smokers are at a higher risk of developing deeper probing depths ranging from 4–7 mm and exhibit more significant clinical attachment loss (CAL), which are critical indicators of periodontal health 10. Furthermore, smokers show a higher percentage of teeth with mobility, recession, and furcation involvement compared to non-smokers, with statistically significant differences that underscore the severity of periodontal damage caused by smoking 10.

Treatment Outcomes

The response to periodontal treatments also varies significantly between smokers and non-smokers. Smokers generally respond less favorably to both non-surgical and surgical periodontal therapies. Clinical studies have shown that smokers exhibit less reduction in probing depth and less gain in CAL following treatments such as scaling and root planing 11. Moreover, the recurrence of periodontal disease is more frequent in smokers, and the outcomes of surgical interventions like the modified Widman flap are impaired in smokers due to the negative effects of smoking on wound healing 11. This is further evidenced by studies showing that smoking reduces the success rates of dental implants and increases the severity of marginal bone loss 11.

These findings collectively demonstrate that non-smokers not only have a lower prevalence of oral diseases but also experience less severe symptoms and better outcomes from treatment, highlighting the profound impact smoking has on oral health.

Impact of Different Tobacco Products

Cigarettes

Cigarette smoking, the most prevalent method of tobacco use, introduces 10-14 mg of nicotine per cigarette, with 1-1.5 mg absorbed by the body 12. This form of tobacco consumption is linked to a variety of oral health issues, including increased risks of gingival recession, oral carcinomas, and mucosal lesions such as oral leukoplakia and nicotine stomatitis 13. Additionally, cigarette smoke alters the oral microbiome, increasing the prevalence of bacteria like *Prevotella* and *Veillonella*, which are associated with periodontal disease 14.

Cigars

Cigar smoking, often perceived as a less harmful alternative to cigarettes, still poses significant oral health risks. The smoke from cigars contains similar toxic and carcinogenic compounds as those found in cigarettes,

contributing to oral cancers, periodontal disease, and tooth loss 13. The extended smoking duration of cigars also increases the exposure of oral tissues to harmful chemicals, exacerbating these health risks.

Smokeless Tobacco

Smokeless tobacco products, which include chewing tobacco, snuff, and snus, deliver nicotine at levels three to four times higher than smoked tobacco 12. These products are associated with distinct oral health issues such as oral cancer, gingival recession, and tooth wear due to their direct contact with oral tissues 13. The high nicotine content and the presence of carcinogenic chemicals significantly increase the risk of developing premalignant disorders and oral cancers, particularly in the buccal mucosa 15.

Electronic Nicotine Delivery Systems (ENDS)

Electronic Nicotine Delivery Systems, or ENDS, include products like e-cigarettes and heat-not-burn devices. These systems deliver nicotine in an aerosol form, which is less harmful than the smoke from traditional tobacco products. However, e-cigarettes are not without risks; they contain toxicants and carcinogens such as formaldehyde and acrolein, albeit at lower levels than those found in cigarette smoke 16. The aerosols from ENDS can induce oxidative stress and inflammatory responses in oral tissues, potentially leading to periodontal diseases and other oral health issues 16. Studies have shown that while the overall toxicity may be lower, the use of ENDS still poses significant health risks, particularly with long-term use 16.

The impact of various tobacco products on oral health varies, but all forms contribute to significant health challenges. Understanding these impacts is crucial for healthcare providers and users to make informed decisions about tobacco use and its implications for oral health.

Case Studies and Clinical Findings

Longitudinal Studies

A significant body of longitudinal research has highlighted the detrimental effects of smoking on oral health. For instance, a 3-year epidemiological surveillance open cohort study involving 22,009 patients found that 36.6% had dental caries, with smoking identified as a risk indicator for dental caries with an odds ratio of 1.84 (95% CI:1.64–2.07). The study also suggested that smoking prevention could lead to a 7% potential reduction in dental caries 12. However, most longitudinal studies, such as the one conducted by Bernabe et al., are cross-sectional and thus do not allow for definitive conclusions about causality; more research is needed to confirm these findings 17.

Cross-Sectional Studies

Cross-sectional studies provide insight into the immediate impacts of smoking on oral health. One study analyzed data from 1,127 adolescents, assessing relationships between smoking status and various oral health indicators. The findings revealed that current smokers had worse oral hygiene status, higher prevalence of dental caries, and more severe periodontal conditions compared to non-smokers 18. Another study highlighted a lack of awareness among smokers about the risks associated with tobacco use, particularly in

relation to gum disease and oral cancer. It was found that a considerable portion of smokers were not aware of the potential for smoking to cause gum disease (37.3%) and oral cancer (4.5%) 19.

Meta-Analyzes

Meta-analyzes have been instrumental in synthesizing data across studies to assess the overall impact of smoking on oral health. Two meta-analyzes focusing on the DMFT (Decayed, Missing, Filled Teeth) scores found a positive association between tobacco smoking and dental caries. The first meta-analysis included five studies and reported a mean difference of 1.20 (95% CI: 0.40–2.00), while the second, including two studies, found a mean difference of 1.88 (95% CI: 0.99–2.77). Both meta-analyzes demonstrated high heterogeneity and significant associations, underscoring the need for further research to explore these relationships 17.

These findings from various types of studies underscore the clear link between smoking and a range of detrimental oral health outcomes. Continual research and public health efforts are necessary to further elucidate these relationships and to inform effective prevention and treatment strategies.

Preventive Measures and Cessation

Dental Hygiene Practices

For individuals who smoke, adopting rigorous dental hygiene practices is crucial. Special toothpastes designed for smokers can help remove nicotine and tobacco stains. These toothpastes are generally more abrasive and contain stronger chemicals to combat the bacteria thriving from smoking 20. However, they should be used with caution and alternately with regular toothpaste as recommended by dental professionals 2. Additionally, smokers are advised to use high-quality toothbrushes, preferably electric ones, to effectively clean all areas of the mouth 20.

Regular use of mouthwashes is also recommended, especially those containing antibacterial agents like hydrogen peroxide, which help in killing bacteria and supporting teeth whitening while maintaining gum health 20. It is essential for smokers to engage in dental care activities such as brushing, flossing, and using a tongue cleaner at least twice daily to mitigate the growth of harmful bacteria 21.

Smoking Cessation Programs

Integrating oral health promotion into tobacco cessation programs has shown promising results. Programs like Oral Health 4 Life (OH4L), designed to be integrated into state quitline tobacco cessation programs, provide smokers with oral health counseling, brochures, and tools like toothbrushes and sugar-free gum 22. These resources not only aid in managing tobacco cravings but also emphasize the importance of maintaining oral health. Smokers participating in such programs have shown increased odds of quitting smoking, highlighting the effectiveness of addressing smoking and oral health concurrently 22.

Dental professionals play a significant role in smoking cessation. They can deliver effective advice using strategies like the 5As model (Ask, Advise, Assess, Assist, Arrange), which includes brief interventions,

behavior counseling, and prescribing cessation drugs like varenicline and bupropion 23. This approach has been recognized by the World Health Organization and is supported by evidence suggesting that dental settings are ideal for initiating smoking cessation conversations 23.

Regular Dental Visits

Regular dental check-ups are vital for smokers due to their increased risk of severe dental diseases. These visits allow for the removal of plaque and tartar buildup, early detection of gum disease, and screening for signs of oral cancer 24 20. Dental professionals provide guidance on proper brushing and flossing techniques and may recommend additional preventive measures such as fluoride treatments or dental sealants to protect against decay 24.

Bi-annual visits are recommended as smokers are more likely to have stained teeth and may require more frequent appointments with dental hygienists 2. During these visits, dentists can monitor the progression of any oral health issues and provide timely intervention, which is crucial for preventing the advancement of diseases like periodontitis and oral cancer 20 21.

Future Research Directions

Need for Long-Term Studies

The significance of long-term studies in understanding the full spectrum of oral health outcomes associated with tobacco use cannot be overstated. Current research often relies on cross-sectional studies, which, while informative, do not provide conclusive evidence about the long-term effects of tobacco use on oral health 25. Longitudinal studies are essential for establishing a clear timeline and causality between tobacco use and its adverse effects on oral health. These studies will also be crucial in evaluating the effectiveness of tobacco cessation counseling and resources in clinical practice over extended periods 25.

Focus on Emerging Tobacco Products

With the evolving patterns of tobacco use, particularly the rise in electronic nicotine delivery systems (ENDS) use, there is a pressing need to re-examine their associations with oral health. The health effects of non-cigarette tobacco products, including ENDS, remain a priority for regulatory bodies like the US Food and Drug Administration 25. Despite the growing popularity of these products, the literature on their oral health effects is limited and often inconclusive, with findings primarily from cross-sectional studies 25. Future research should focus on these emerging tobacco products to understand their health implications comprehensively.

Integration of Genetic and Environmental Factors

The interaction between genetic and environmental factors plays a critical role in the susceptibility to and severity of oral diseases like dental caries and periodontal disease. No single gene has shown as significant an impact on periodontal disease as environmental influences such as smoking 26. Future research directions include the replication and validation of genetic findings across diverse populations and the integration of

genetic information with clinical and environmental data 27. Understanding these gene-environment interactions could lead to personalized treatment strategies and more effective prevention methods tailored to individual genetic profiles 27.

V. Conclusion

Through this comprehensive review, we have underscored the profound and multifaceted impact smoking has on oral health, from increasing the risk of periodontal disease and oral cancer to affecting the outcome of dental treatments like implants. These adverse effects highlight the critical need for awareness and preventive measures among smokers. Moreover, the comparison with non-smokers vividly illustrates the degree to which tobacco use endangers oral wellness, further reinforcing the value of cessation programs and regular dental care in mitigating these risks.

As we look towards the future, it is evident that ongoing research and public health initiatives must prioritize not only the continuation of anti-smoking campaigns but also the exploration of the impacts of emerging tobacco and nicotine delivery products on oral health. Acknowledging the role of dental professionals in promoting cessation and integrating oral health counseling into comprehensive care can significantly contribute to reducing the prevalence of smoking-related oral health issues. Together, these efforts can pave the way for healthier communities, free from the detrimental effects of tobacco on oral health.

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