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Tobacco Use and Its Effects on the Pulp and Periapical Tissues: An Integrative Review and Thematic Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. Authors LCTMCV and JESF conceptualized the study. Author LCTMCV led the data curation, formal analysis, investigation, methodology, and wrote the original draft. Authors JESF, BAA and FAG contributed to data curation, formal analysis, methodology, and reviewed and edited the manuscript. Author LPB assisted with data curation, formal analysis, investigation, and validation. Author CCPB supervised the project, managed administration, and contributed to conceptualization, data curation, formal analysis, methodology, and manuscript review and editing. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To conduct an integrative literature review investigating the association between tobacco use and pulpal and periapical alterations, rather than general periodontal disease.
Methodology: A literature search was performed in PubMed and Google Scholar for studies published between 2018 and 2024. Twenty-one studies met the inclusion criteria and were analyzed using an integrative review approach and thematic analysis. Four main themes were identified: (1) increased susceptibility to pulpal and periapical inflammatory diseases; (2) impaired healing and treatment outcomes; (3) contradictory findings on smoking and periapical lesions; and (4) methodological heterogeneity across studies.
Results: The majority of studies (80%) reported that smokers are more likely to develop pulpal necrosis and periapical lesions, experience delayed healing, and have poorer clinical outcomes in endodontic treatments. Tobacco use was associated with elevated inflammatory responses, larger lesion size, impaired tissue repair, and less predictable endodontic healing. Animal models demonstrated exacerbated pulpal and periapical inflammation with nicotine exposure, particularly when combined with alcohol. However, some studies (20%) reported no significant association, highlighting variability due to differences in diagnostic criteria, population characteristics, and follow-up periods.
Conclusion: Smoking is a critical risk factor for pulpal and periapical pathologies, negatively affecting tissue repair and treatment success. Integrating smoking cessation strategies into oral health programs is essential to mitigate both local and systemic effects of tobacco use and improve clinical outcomes.

Keywords: Tobacco; smoking; pulpal health; periapical lesions; oral health.

1. INTRODUCTION

Tobacco use remains a major public health concern worldwide, contributing to a wide range of systemic and oral diseases (Ríos-Osorio, 2022; Kirchmaier et al., 2023). Its impact on the oral cavity is well-documented, particularly in relation to periodontal disease, impaired wound healing, and reduced effectiveness of dental treatments (Newman & Carranza, 2020; Sopińska & Bołtacz-Rzepkowska, 2020). Despite extensive research on periodontal conditions, the specific influence of tobacco on pulpal and periapical tissues has received comparatively less attention, highlighting a critical gap in the literature (Kfouri et al., 2018).

Pulpal and periapical tissues are highly sensitive to environmental and behavioral factors, including tobacco exposure. Nicotine and other chemical compounds present in tobacco smoke induce vasoconstriction, impair tissue repair, and exacerbate inflammatory responses, increasing the risk of pulpal necrosis and periapical lesion development (Bernardes et al., 2013; Balto, 2019; Ríos-Osorio, 2022).

Previous studies suggest that smokers exhibit a higher prevalence and severity of periapical lesions compared to non-smokers. Tobacco use may reduce the success of endodontic treatments and contribute to peri-implant complications (Kirkevvang & Wenzel, 2003; Sopińska & Bołtacz-Rzepkowska, 2020). However, inconsistencies exist in reported outcomes due to variations in study design, sample characteristics, diagnostic criteria, and treatment protocols, underscoring the need for reviews that synthesize evidence and clarify the impact of tobacco use on pulpal and periapical health (Kfouri et al., 2018).

Integrating smoking cessation strategies into dental care programs is considered a key measure to mitigate tobacco-related oral health risks, improve treatment outcomes, and reduce the prevalence of periapical lesions among smokers (Bernardes et al., 2013; López-López et al., 2012). Therefore, this study aims to investigate the association between tobacco use and periapical alterations, contributing to the development of more effective preventive and therapeutic interventions in public oral health.

2. METHODS

2.1 Study Design

An integrative literature review was conducted to identify, evaluate, and synthesize evidence regarding the relationship between tobacco use and pulpal and periapical alterations. The review protocol followed the methodological framework proposed by Ganong (1987) for integrative reviews and incorporated a thematic analysis approach based on Braun & Clarke's (2006) six-phase framework, ensuring a comprehensive and interpretive synthesis of findings.

2.2 Research Guiding Question

The guiding question was formulated using the PCC framework (Population, Concept, and Context). In this review, the Population (P) refers to smokers; the Concept (C) covers pulpal and periapical alterations; and the Context (C) encompasses both national and international scientific literature. The research question was: "What does the literature report about the relationship between tobacco use and pulpal and periapical alterations?"

2.3 Search Strategy

The literature search was conducted between March 2024 and August 2024 in the PubMed and Google Scholar databases. Publications from 2018 to 2024 were considered, in both Portuguese and English, according to the guiding question. The following keywords were used: "smoking" and "periodontal diseases", combined with the Boolean operator AND to optimize retrieval of relevant literature.

2.4 Eligibility Criteria

Inclusion criteria comprised studies that explicitly addressed the relationship between tobacco use and pulpal or periapical alterations, regardless of study design (original research, narrative reviews, case reports, theses, or dissertations). Exclusion criteria were as follows: (i) studies on tobacco use without specific reference to periapical alterations; (ii) publications providing only general epidemiological data without direct association to the topic; (iii) studies focusing exclusively on tobacco cessation therapy; (iv) duplicated or redundant publications; (v) studies deemed irrelevant after title and abstract screening.

2.5 Study Selection

The search identified 48 publications. After title and abstract screening, 27 studies were excluded for not meeting the inclusion criteria. A total of 21 studies remained for full-text analysis. The study selection process followed the stages of the integrative review proposed by Ganong (1987) (Fig. 1).

2.6 Data Extraction and Analysis

Data extraction was performed by one researcher and cross-checked by another to ensure accuracy. Key characteristics of each study were compiled into a summary table, including author(s), year of publication, study design, research type, objectives, and thematic focus. The dataset was analyzed inductively following Braun & Clarke's (2006) six-phase thematic analysis procedure. This six-step analytical procedure comprised: (1) data familiarization, (2) initial coding, (3) theme identification, (4) theme review, (5) theme definition and naming, and (6) report production. This method facilitated the emergence of four major thematic categories grounded in the selected sources of evidence.

2.7 Collaborative Review and Manuscript Preparation

After data extraction and thematic analysis, the authors discussed the findings to reach consensus on themes and conclusions. The manuscript was prepared and revised jointly to ensure accuracy and clarity.

3. RESULTS

Among the 48 publications initially identified to address the first guiding research question, 27 articles were excluded because they did not provide relevant information—such as the relationship between tobacco use and periapical alterations, epidemiological data on the problem, or because they focused exclusively on tobacco cessation therapy. The remaining 21 articles met the inclusion criteria, which required an explicit examination of the association between tobacco use and periapical alterations. These studies were analyzed following the stages of the integrative review proposed by Ganong (1987) and the thematic analysis framework by Braun & Clarke (2006).

Table 1. Included studies addressing tobacco use and its impact on periodontal disease progression

Author and Year	Title	Type	Study Nature	Objective	Theme Addressed
Mamani Tintaya (2018)	Prevalencia de Lesiones de Furcación en Pacientes Fumadores y Post Fumadores de la Consulta Privada	Article	Quantitative	Determined the prevalence of furcation lesions in smokers and ex-smokers.	Influence of smoking on pulpal tissue physiology, metabolism, and changes
Balto et al. (2019)	Comparative analysis of prevalence of apical periodontitis in smokers and non-smokers using cone-beam computed tomography	Article	Qualitative	Compared prevalence and size of periapical lesions in smokers and non-smokers using cone-beam computed tomography (CBCT).	Prevalence and extent of periapical lesions
Di Murro et al. (2019)	The prevalence of peri-implant diseases in patients with metabolic syndrome: a case-control study on an Italian population sample	Article	Quantitative	Examined the correlation of peri-implantitis with smoking.	Susceptibility to oral inflammatory diseases
Mahmood et al. (2019)	The Effect of Smoking Habit on Apical Status of Adequate Endodontically Treated Teeth with and Without Periodontal Involvement	Article	Qualitative	Identified the effects of smoking on apical status in properly treated teeth with or without periapical lesions.	Effects of chronic tobacco use on apical periodontitis prognosis
Özdemir et al. (2019)	Effect of intracanal medicaments on matrix metalloproteinase-9 and vasoactive intestinal peptide secretion in periapical lesions of re-treated canals: a randomized controlled clinical study	Article	Quantitative	Evaluated the effect of calcium hydroxide and chlorhexidine gel in smoking patients.	No relationship between tobacco and periodontal disease
Aminoshariae (2020)	The association between smoking and periapical periodontitis: a systematic review	Article	Quantitative	Examined in adult patients whether the absence or presence of smoking influenced the presence of periapical periodontitis (PP).	Susceptibility to oral inflammatory diseases
Brignardello-Petersen et al. (2020)	Smokers may have a higher prevalence of apical periodontitis and root canal treatment than	Article	Quantitative	Evaluated the relationship between smoking and periapical changes.	No relationship between tobacco and periodontal disease

Author and Year	Title	Type	Study Nature	Objective	Theme Addressed
	nonsmokers, but this is not evidence that smoking is a risk factor for these outcomes				
Cheng (2020)	Smoking May Increase the Risk of Periapical Periodontitis	Article	Quantitative	Assessed the influence of smoking on the prevalence of periapical periodontitis.	Susceptibility to oral inflammatory diseases
Fan et al. (2020)	Prognostic Factors of Grade 2-3 Endo-Periodontal Lesions Treated Nonsurgically in Patients with Periodontitis: A Retrospective Case-Control Study	Article	Quantitative	Studied the prognosis of endo-periodontal lesions in tobacco users.	Susceptibility to oral inflammatory diseases
Pinto et al. (2020)	Effects of alcohol and nicotine consumption on the development of apical periodontitis in rats: a correlative micro-computed tomographic, histological and immunohistochemical study	Article	Quantitative	Assessed the effects of alcohol and nicotine, separately or combined, on the development of induced apical periodontitis in rats.	Association between alcohol and nicotine consumption and apical periodontitis development
Pinto et al. (2020)	Does tobacco smoking predispose to apical periodontitis and endodontic treatment need? A systematic review and meta-analysis	Article	Qualitative	Studied scientific evidence supporting the association between smoking and higher prevalence of apical periodontitis and root canal treatments.	Prevalence of apical periodontitis and root canal treatment in smokers
Sopińska et al. (2020)	The influence of tobacco smoking on dental periapical condition in a sample of an adult population of the Łódź region, Poland	Article	Quantitative	Analyzed the frequency of periapical changes in smokers and non-smokers.	Susceptibility to oral inflammatory diseases
Ladegaard et al. (2021)	The impact of oral diseases in cirrhosis on complications and mortality	Article	Quantitative	Examined the association between smoking and oral inflammation.	Increased treatment difficulty
Tapia Avendaño (2021)	El tabaquismo como factor de riesgo de enfermedades bucales	Dissertation	Qualitative	Evaluated smoking as a risk factor for periapical changes.	Susceptibility to oral inflammatory diseases
Ribeiro et al. (2021)	O tratamento da doença periodontal e a influência do	Article	Qualitative	Reported the influence of tobacco on healing potential of periapical	Increased treatment difficulty

Author and Year	Title	Type	Study Nature	Objective	Theme Addressed
	tabaco nas suas diversas formas de utilização			changes.	
Cavalcante (2022)	A influência dos cigarros convencionais e eletrônicos na reabilitação oral com implantes dentários	Dissertation	Qualitative	Compared the negative impact of smoking on peri-implantitis recovery.	Interference in connective tissue repair mechanisms
Ideo et al. (2022)	Prevalence of Apical Periodontitis in Patients with Autoimmune Diseases under Immunomodulators: A Retrospective Cohort Study	Article	Quantitative	Investigated the difficulty in treating periapical periodontitis in smokers (test group) and non-smokers (control group).	Increased treatment difficulty
González Donoso et al. (2022)	Asociación entre el hábito tabáquico, cotinina sérica y el tamaño de las lesiones periapicales en pacientes con periodontitis apical	Article	Quantitative	Investigated the progression of apical periodontitis in smokers and non-smokers.	No relationship between tobacco and periodontal disease
Segura-Egea et al. (2023)	Impact of systemic health on treatment outcomes in endodontics	Article	Qualitative	Analyzed the possible influence of systemic factors, such as smoking, on endodontic treatment outcomes.	Increased treatment difficulty
Majid (2023)	Dose-response association of smoking with delayed healing of apical periodontitis after endodontic treatment	Article	Qualitative	Examined and compared healing rates of apical periodontitis (AP) after endodontic treatment between smokers and non-smokers and assessed how smoking intensity and duration affect AP healing up to 1-year follow-up.	Influence of smoking on apical periodontitis healing after root canal treatment
Pinto et al. (2024)	Chronic alcohol and nicotine consumption as catalyst for systemic inflammatory storm and bone destruction in apical periodontitis	Article	Qualitative	Examined alveolar bone pattern and serum levels of pro-inflammatory cytokines, biochemical markers, and metabolites in rats subjected to chronic alcohol and nicotine consumption and induced apical periodontitis.	Susceptibility to periapical bone density loss and increased pro-inflammatory cytokines

3.1 Overview of Included Studies

A total of 21 studies addressing the relationship between smoking and periapical lesions were included (Table 1). Among these, 11 employed quantitative methodologies, while 9 used qualitative approaches, indicating methodological diversity. The majority of studies (80%) reported a direct association between smoking and either the prevalence or aggravation of periodontal and periapical diseases, whereas 3 studies (20%) found no such association. The years with the highest number of publications were 2020 and 2022, together accounting for 9 articles (60%). Geographically, the studies were conducted in the United States (8), Brazil (3), Spain (3), Portugal (2), Iraq (2), Italy (1), Poland (1), and Saudi Arabia (1) (Fig. 2).

3.2 Integrated Findings

Eight studies (Di Murro et al., 2019; Aminoshariae et al., 2020; Cheng, 2020; Fan et al., 2020; Pinto et al., 2020; Pinto et al., 2020; Sopińska et al., 2020; Tapia Avendaño, 2021). identified higher susceptibility of smokers to inflammatory oral diseases. Seven studies (Mahmood, 2019; Ideo et al., 2022; Ladegaard et al., 2021; Ribeiro et al., 2021; Segura-Egea et al., 2023; Majid, 2023; Pinto et al., 2024) documented greater difficulty in treating smokers. Four studies found no direct link between smoking and periapical lesions (Balto et al., 2019; Özdemir et al., 2019; Brignardello-Petersen et al., 2020; González Donoso et al., 2022).

3.3 Evidence Synthesis

Among the 21 studies, Aminoshariae et al. (2020) reported that smokers have a 67% higher likelihood of presenting periapical lesions. Sopińska et al. (2020) observed periapical lesions in 7.2% of smokers versus 5.2% of non-smokers, while Cheng (2020) found periapical periodontitis in 82% of smokers compared to 63% in non-smokers (González Donoso, 2002). Pinto et al. (2020), using animal models, demonstrated that nicotine increases inflammatory responses and lesion size, with more severe effects when combined with alcohol. Their meta-analysis confirmed that smokers have twice the risk of developing periapical periodontitis and/or requiring endodontic treatment.

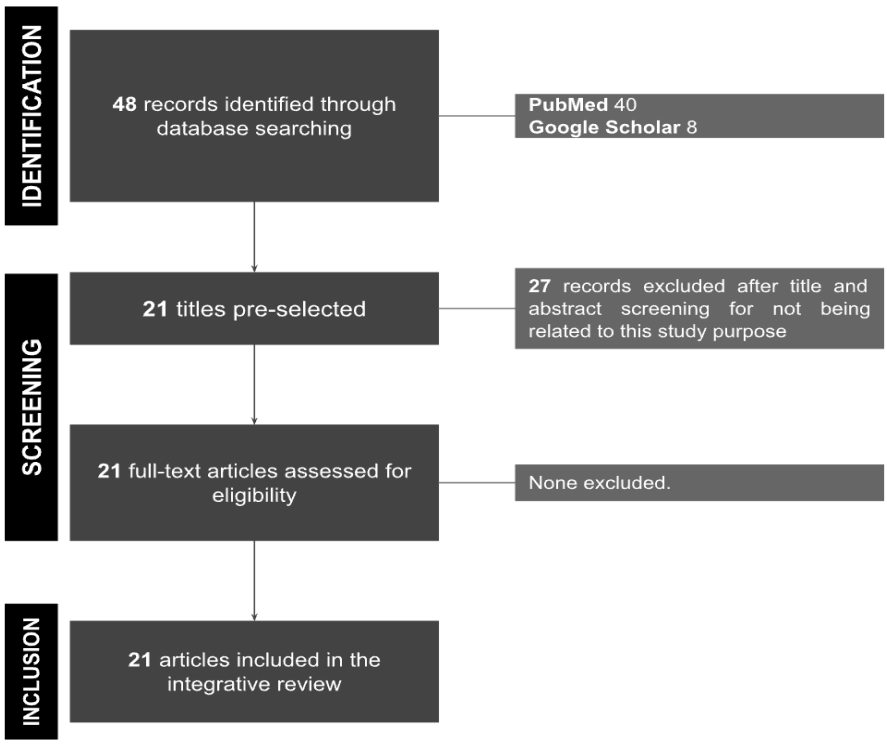

Fig. 1. Flowchart of study selection process

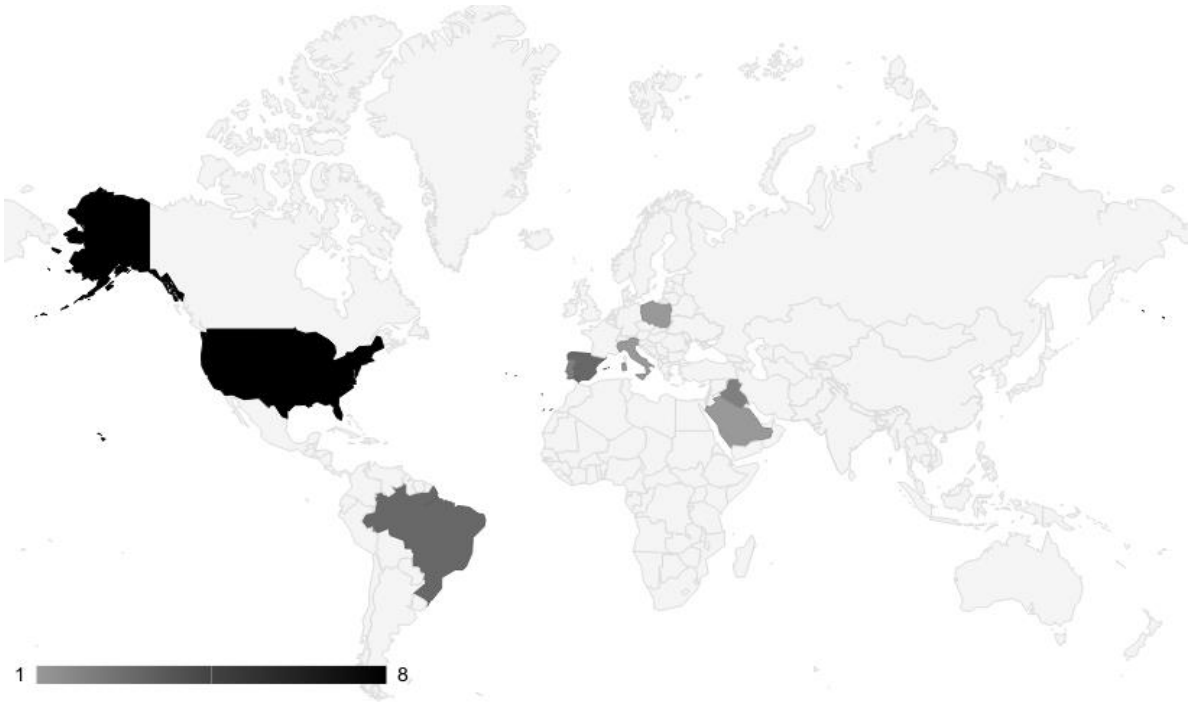

Fig. 2. Geographic distribution of the included studies

Ideo et al. (2022), Cavalcante (2022), and Segura-Egea et al. (2023) reported that smoking impairs connective tissue repair and healing of periapical lesions. Segura-Egea et al. (2023) linked smoking to lower root canal success rates and higher postoperative periradicular lesions. Ladegaard et al. (2021) observed delayed inflammatory recovery, while Ribeiro et al. (2021) reported faster periodontal disease progression and poorer treatment outcomes. Cavalcante (2022) and Di Murro et al. (2019) noted increased peri-implantitis risk and impaired tissue healing.

Fan et al. (2020) observed poorer prognosis for endo-periodontal lesions in smokers (39% good vs. 61% poor) compared to non-smokers (78% good vs. 22% poor). Mamani Tintaya (2018) found higher prevalence of furcation lesions among smokers and former smokers. Pinto et al. (2024) documented greater periapical bone destruction and systemic pro-inflammatory mediator production in rats chronically exposed to nicotine and alcohol. Ideo et al. (2022) noted treatment delays in 37% of smokers versus 14% of non-smokers. Majid (2023) reported slower healing of periapical lesions, while Mahmood et al. (2019) found worse prognoses proportional to tobacco consumption. Tapia Avendaño et al. (2021) emphasized smoking's role in promoting oral and systemic diseases.

Fan et al. (2020) and Sopińska et al. (2020) reported increased pulp tissue susceptibility in smokers. Conversely, Özdemir et al. (2019), Brignardello-Petersen et al. (2020), González Donoso et al. (2022), and Balto et al. (2019) found no significant differences in treatment outcomes or lesion prevalence between smokers and non-smokers.

3.4 Thematic Analysis

Four thematic groups emerged following Braun and Clarke's framework: (1) Increased susceptibility to inflammatory oral diseases; (2) Impaired healing and treatment outcomes; (3) Contradictory findings on smoking and periapical lesions; (4) Variation in findings and methodological heterogeneity.

3.5 Increased Susceptibility to Inflammatory Oral Diseases

Eight studies consistently identified higher susceptibility of smokers to inflammatory oral conditions, including periapical lesions, highlighting elevated inflammatory responses, increased lesion size, and higher prevalence compared to non-smokers (Di Murro et al., 2019; Aminoshariae et al., 2020; Cheng, 2020; Fan et al., 2020; Pinto et al., 2020; Pinto et al., 2020; Sopińska et al., 2020; Tapia Avendaño, 2021).

Animal models further demonstrated that nicotine, especially when combined with alcohol, exacerbates inflammation and tissue damage (Pinto et al., 2020).

3.6 Impaired Healing and Treatment Outcomes

Seven studies documented that smoking impairs tissue repair and negatively affects clinical outcomes in periapical and periodontal treatments (Mahmood et al., 2019; Ideo et al., 2020; Ladegaard et al., 2021; Ribeiro et al., 2021; Majid, 2023; Segura-Egea et al., 2023; Pinto et al., 2024). Delayed inflammatory recovery, reduced success rates in root canal therapies, and slower healing of periapical lesions were common. Smoking was also associated with increased risk of peri-implantitis and treatment delays, highlighting the detrimental influence of tobacco on regenerative processes and clinical prognosis.

3.7 Contradictory Findings on the Association between Smoking and Periapical Lesions

A minority of studies found no significant association between tobacco use and periapical lesion prevalence or treatment outcomes (Balto et al., 2019; Özdemir et al., 2019; Brignardello-Petersen et al., 2020; González Donoso et al., 2022), reflecting variability in study designs, populations, and protocols.

3.8 Smoking as a Promoter of Systemic and Local Oral Diseases

Smoking was further highlighted as a promoter of systemic and oral diseases, including furcation lesions and generalized bone destruction, reinforcing the need to integrate smoking cessation into comprehensive oral health strategies (Mamani-Tintaya, 2018; Tapia Avendaño, 2021; Pinto et al., 2024). This evidence supports the inclusion of smoking cessation measures within broader oral health management programs.

4. DISCUSSION

The studies consistently indicate that smoking contributes to elevated inflammatory responses, increased lesion size, and greater prevalence of periapical pathologies, with animal models showing that nicotine, especially when combined with alcohol, exacerbates inflammation and tissue damage (Pinto et al., 2020), highlighting smoking as a critical risk factor for the initiation and progression of oral inflammatory diseases.

Smoking also increases systemic inflammatory burden and complex oral pathologies, such as furcation lesions and generalized bone destruction (Mamani-Tintaya, 2018; Tapia Avendaño, 2021; Pinto et al., 2024), underscoring the importance of integrating smoking cessation into oral health strategies. While most studies confirmed adverse impacts, some found no significant association (Balto et al., 2019; Özdemir et al., 2019; Brignardello-Petersen, 2020; González Donoso et al., 2022), reflecting differences in study design, population, and treatment protocols.

Smoking impairs tissue repair and negatively affects clinical outcomes, including delayed healing, lower root canal success rates, increased postoperative lesions, higher peri-implantitis risk, and treatment delays (Di Murro et al., 2019; Fan et al., 2020; Ladegaard et al., 2021; Ribeiro et al., 2021; Ideo et al., 2022; Cavalcante, 2022; Segura-Egea et al., 2023; Majid, 2023).

This review has some limitations. Methodological heterogeneity among the 21 included studies, encompassing differences in design, population, and treatment protocols, may have contributed to variability, but this is expected in integrative reviews, which synthesize diverse evidence (Ganong, 1987; Braun & Clarke, 2006). Geographical diversity, although limited in some countries, provides insights into trends influenced by regional factors and highlights cross-territory patterns in smoking-related oral inflammatory outcomes.

To minimize potential regional biases and indexing limitations, a deliberate strategy was adopted in selecting databases. Only two sources were included: PubMed and Google Scholar, the latter of which aggregates multiple databases and helps reduce duplicates, thereby enhancing coverage without compromising the relevance of the findings.

In summary, the main limitations include methodological heterogeneity, temporal restrictions, geographical variability with low representation per country, and differences in study type. Despite these factors, the integrative approach allows identification of consistent trends across diverse populations and study designs, providing a robust synthesis of current

evidence on smoking's impact on pulpal and periapical health.

5. CONCLUSION

This review provides a comprehensive synthesis of current evidence, highlighting smoking as a critical risk factor for pulpal and periapical pathologies. Tobacco use exacerbates inflammatory responses, impairs tissue repair, and reduces treatment success rates. Most studies consistently show that smokers are more likely to develop periapical lesions, experience delayed healing, and present poorer clinical outcomes compared to non-smokers. These findings emphasize the importance of integrating smoking cessation strategies into comprehensive oral health programs to mitigate both local and systemic effects of tobacco use.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The authors acknowledge the use of AI (OpenAI's ChatGPT –GPT-4o, accessed in August 2025) solely to assist with correcting the English translation of the manuscript, which was originally written in Brazilian Portuguese. All AI-assisted content was carefully reviewed and edited by the authors for accuracy and clarity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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