Review

Comparison of the Links between Tobacco Smoking, Use of Smokeless Tobacco and Periodontal Health: A Scoping Review

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Comparison of the Links between Tobacco Smoking, Use of Smokeless Tobacco and Periodontal Health: A Scoping Review

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Abstract: The aim of the scoping review was to map out studies that compared the effect of smoking tobacco and smokeless tobacco on periodontal health. The review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) framework. The search for articles was conducted in five electronic databases namely: Scopus, CINAHL, Web of Science, Medline, and PubMed. The search yielded two eligible articles for full-text screening. The two studies were cross-sectional in design, conducted in India and they both used bivariate analysis for comparison of the effects of tobacco smoking and the use of smokeless tobacco on the health of the periodontium without adjusting for confounders. The two studies used 10 measures to assess the health of the periodontium namely: Periodontal probing depth, clinical attachment level, gingival index, and periodontal index, plaque index score, debris index score, calculus index score, gingival inflammation, bleeding on probing and pocket depth. Periodontal probing depth, periodontal index, calculus index score and pocket depth worse for tobacco smoking when compared with smokeless tobacco users. Both studies seem to concur on worse pocket depths for tobacco smokers than for users of smokeless tobacco.

Keywords: tobacco smoking; smokeless tobacco; periodontal health

1. Introduction

Periodontal health, which refers to the health and condition of the structures supporting the teeth, including the gums, periodontal ligament, and alveolar bone, is of utmost importance for dental well-being[1–3] and the overall health(Kane, 2017; Sabbah et al., 2019). The gums and supporting structures play a vital role in maintaining the stability and integrity of teeth. Neglecting periodontal health can lead to conditions like gum disease (periodontal disease)[4,5] which can result in gum inflammation, bleeding, pain, and even tooth loss if left untreated. Proper periodontal care is essential for preventing gum disease. Gingivitis, the earliest stage of gum disease, is characterized by swollen, red, and bleeding gums[6]. If not managed, it can progress to periodontitis, which involves deeper infection and potential loss of bone around the teeth[6]. Periodontal diseases are linked to systemic health issues, including cardiovascular disease and diabetes[7,8]. The gums and supporting structures help anchor teeth securely in place. When periodontal health is compromised, the risk of tooth mobility and eventual tooth loss increases[9].

Smoking tobacco significantly undermines the health of the periodontium, fostering a range of oral problems and escalating the vulnerability to periodontal diseases[10,11]. The repercussions are multifaceted, arising from restricted blood flow, curtailing the immune system's efficacy, and

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impeding the body's healing capacities. Reduced blood flow diminishes the immune system's capacity to combat bacterial infections, rendering smokers more susceptible to periodontal infections[12]. Moreover, the altered immune response fosters increased vulnerability to bacterial colonization within the gingiva[13,14]. In addition, Smoking impedes wound healing, prolonging recovery periods after dental interventions or gum disease treatment[15]. Smoking also increases the risk for gingival recession, thereby exposing the roots of the teeth, intensifying tooth sensitivity and susceptibility to cavities[16–18], and exacerbating bone loss around teeth, culminating in tooth mobility and potential loss[19,20]. Furthermore, smoking worsens the severity and magnitude of periodontal diseases[4]. The treatment of periodontal diseases is compromised among smokers, rendering interventions like deep cleaning less effective. Smoking also masks gum disease symptoms, impeding timely awareness of the need for treatment[21].

Smokeless tobacco was adopted as a healthier alternative to tobacco smoking. However, smokeless tobacco also has a detrimental impact on periodontal health[22,23]. The abrasive texture and high levels of nicotine and other harmful chemicals in smokeless tobacco products contribute to gingival irritation, recession, and inflammation[24,25]. These products also impede blood flow to the gum tissues, hindering the body's ability to combat infections and heal damaged tissue[26]. Prolonged use of smokeless tobacco increases the risk of periodontal diseases and tooth loss[27–31]. Additionally, the oral environment becomes conducive to the growth of harmful bacteria, exacerbating periodontal issues[32].

Although tobacco smoking and the use of smokeless tobacco are both associated with poorer periodontal health when compared with individuals who do not smoke[33,34], there is little known about the comparative safety of smokeless tobacco and tobacco smoking on the health of the periodontium. There is suggestive evidence that the use of smokeless tobacco may be less hazardous to the health of the periodontium than tobacco smoking. A study conducted by Folayan et al[35] during the COVID-19 pandemic indicated that although tobacco smoking and the use of smokeless tobacco was associated with gingival inflammation, the odds of gingival inflammation was higher for tobacco smoking (AOR: 4.044) than it is for e-cigarette use (AOR: 1.507). The aim of the review, therefore, was to map out studies that compared the effect of smoking tobacco and smokeless tobacco on periodontal health.

2. Materials and Methods

The current study is a scoping review that was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) framework[36].

2.1. Research Question

The review was guided by the following questions: What is the published evidence reporting on the differences in the effect of smoking tobacco and the use of smokeless tobacco on the health of the periodontium?

2.2. Article Identification

The search for articles was initiated in August 2023. The search for articles was that which compared the effects of tobacco smoking and the effects of smokeless tobacco use on the health of the periodontium was conducted in five electronic databases namely: Scopus, CINAHL, Web of Science, Medline, and PubMed. The search strategies are outlined in detail in Appendix A. No formal protocol was published for this review.

2.3. Eligibility Criteria

Studies that comparatively assessed the effect of smokeless tobacco and smoking on the periodontal health in a population but not same sample of respondents were included for the study.

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Studies that independently reported the effect of either exposure on the periodontal health were excluded from the study.

2.4. Article Selection

The literature obtained through database searches was imported into the reference management software Riyyan. In Riyyan, duplicates were removed using the "duplicate items" function. Three independent reviewers (MT, OA, and OR) conducted title and abstract screening, following the eligibility criteria set for this review. Full-text review of the remaining publications was then completed independently by four researchers (MT, OR, OA, and FT). disagreements were resolved by consensus between the four reviewers. No attempts were made to contact authors or institutions to find additional sources.

2.5. Data Charting

From the publications included in this review, information extracted were the paper identifiers (author, year of publication and title), study objective, study design and country where the study was conducted, reported link between tobacco smoking and the health of the periodontium, reported link between use of smokeless tobacco smoking and the health of the periodontium, and the differences in the effects of tobacco smoking and the use of smokeless tobacco on the health of the periodontium. The extracted information was compiled and summarized in Table 1.

Table 1. Characteristics of included studies on the differences in the effects on tobacco smoking and use of smokeless tobacco on periodontal health.

S/N	Author year of publication)	Title	Study Design and study location	Study objective	Periodontal health in tobacco smokers	Periodontal health in smokeless tobacco users	Comparative outcome
1	Akanksha et al, 2020 [37]	Comparative study on the severity of periodontal destruction in chronic periodontitis patients with habits of smoking tobacco versus chewing smokeless tobacco	cross-sectional. No adjustment for confounders INDIA	Evaluate and compare the severity of periodontal destruction in chronic periodontitis patients who were tobacco smokers and tobacco chewers in a South Indian population.	Periodontal probing depth: 3.4± 0.9 mm Clinical attachment level: 4.7± 1.1 mm Gingival Index: 1.1 ± 0.1mm Periodontal Index: 1.6 ± 0.3 mm	Periodontal probing depth: 2.65 ± 0.5 mm Clinical attachment level: 4.2 mm ± 0.5 mm Gingival Index: 0.9 ± 0.2mm Periodontal Index: 1 ± 0.5 mm	Periodontal probing depth (P = 0.03) and periodontal index (p=0.003) were significantly higher in tobacco smokers than smokeless tobacco users. No significant difference in the clinical attachment level and gingival index between the two groups.
3	Kulkarni et al., 2015 [38]	Comparison of clinical periodontal status among habitual smokeless-tobacco users and cigarette smokers	cross-sectional No adjustment for confounders INDIA	Not defined	Plaque index score (%): Score 0: 4.95 Score 1: 26.44 Score 2: 41.34 Score 3: 27.47 Debris index score (%): Score 0: 5.20 Score 1: 27.70 Score 2: 42.21 Score 3: 25.30 Calculus index score(%): Score 0: 5.78 Score 1: 29.75 Score 2: 39.66 Score 3: 24.79 Gingival inflammation(%) No: 8.26 Mild/Moderate: 58.67 Severe: 33.05 Bleeding on probing (%) Present: 91.73 Absent: 8.26 Pocket depth (%) No pocket: 6.61 <4mm: 30.57 4-6-6mm: 34.71 >6mm: 28.09	Plaque index score (%): Score 0: 7.63 Score 1: 18.51 Score 2: 45.67 Score 3: 28.39 Debris index score (%): Score 0: 6.20 Score 1: 17.50 Score 2: 46.30 Score 3: 30.00 Calculus index score(%): Score 0: 6.17 Score 1: 22.22 Score 2: 44.44 Score 3: 27.16 Gingival inflammation(%) No: 13.58 Mild/Moderate: 62.96 Severe: 23.45 Bleeding on probing (%) Present: 85.18 Absent: 14.81 Pocket depth (%) No pocket: 9.87 <4mm: 22.16 4-6-6mm: 14.38 >6mm: 13.58	Plaque index score was not statistically significantly higher among smokeless tobacco users than among cigarette users. Debris index score was not statistically significant between groups. Calculus index score was significantly higher among cigarette smokers than in the smokeless tobacco users (P ≤ 0.01). Gingival inflammation scores between groups were not statistically significant, although it showed a tendency to be higher for the smokeless tobacco users. Smokeless tobacco users had higher percentage of sites with pocket depth > 6 mm compared with the cigarette smokers.

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3. Results

The search resulted in 501 records. After de-duplication, 489 records remained. After reviewing titles and abstracts, screening, seven articles were eligible for full-text screening. On screening the full articles, five articles were excluded for reasons ranging from no results on the differences in the comparison of outcomes between tobacco smoking and the use of smokeless tobacco (n=1), no report on the effect on the periodontal health (n=3) and one of the studies being a doctoral thesis (n=1), leaving two articles [37,38] for this review. Figure 1 shows the flow diagram of the publication screening process.

The two studies were cross-sectional in design. They were both conducted in India and they both used bivariate analysis for comparison of the effects of tobacco smoking and the use of smokeless tobacco on the health of the periodontium without adjusting for confounders. The two studies used 10 measures to assess the health of the periodontium namely: Periodontal probing depth, clinical attachment level, gingival index, and periodontal index [28]. Others were plaque index score, debris index score, calculus index score, gingival inflammation, bleeding on probing and pocket depth [29].

The measures of periodontal health that differed between tobacco smoking and the use of smokeless tobacco were periodontal probing depth [28], periodontal index [28], calculus index score [29] and pocket depth [29]. All the measures were worse for tobacco smoking when compared with smokeless tobacco users. Both studies seem to concur on worse pocket depths for tobacco smokers than for users of smokeless tobacco.

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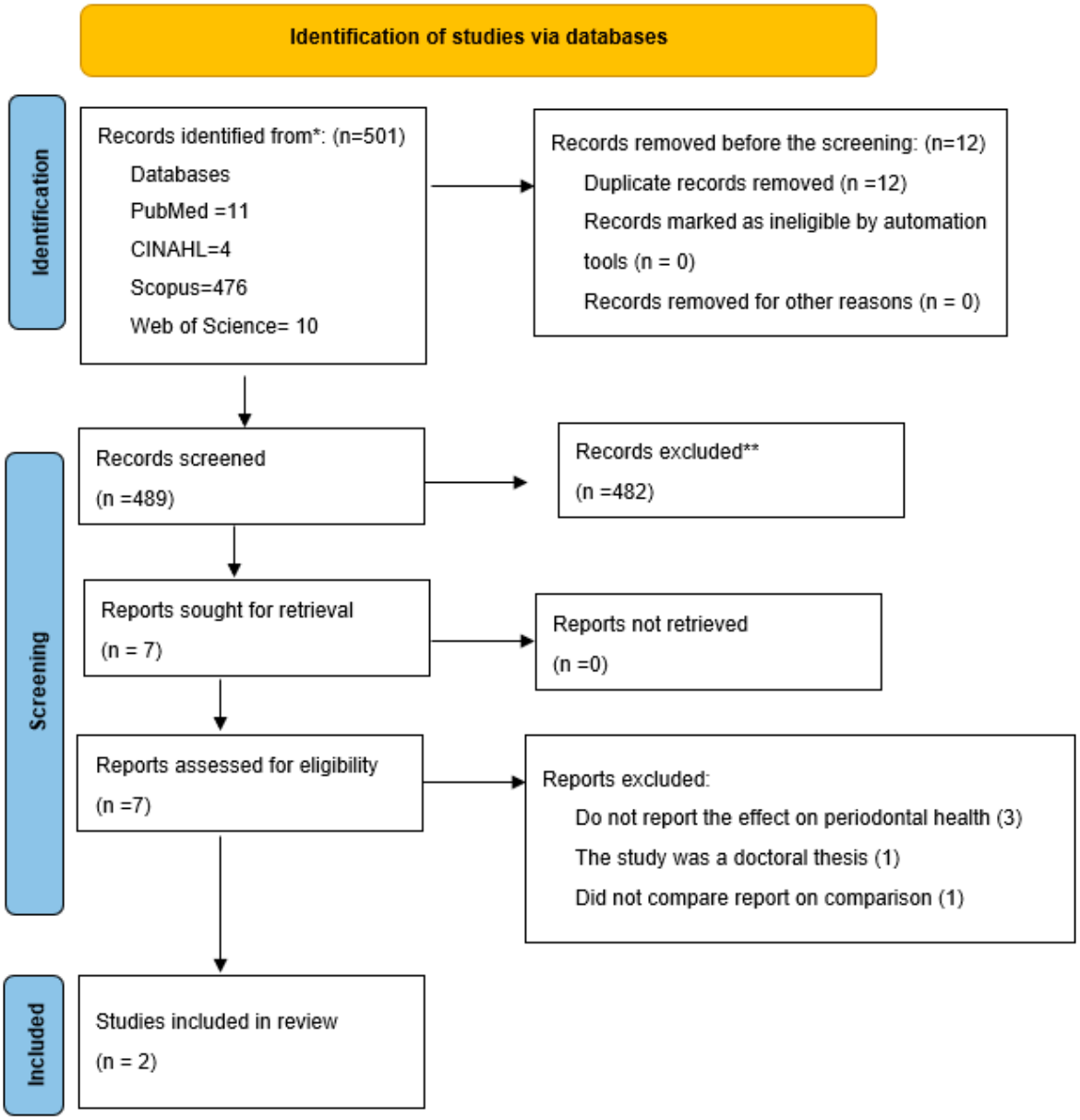

Figure 1. Study Flowchart showing the flow of studies from retrieval to the final included studies.

4. Discussion

The present scoping review offers suggestive evidence regarding the potential varying impacts of tobacco smoking and smokeless tobacco use on periodontal health. It is notable that despite the significance of this topic, only two studies have explored the comparative effects of these two forms of tobacco use on periodontal health. Both studies adopted a cross-sectional design and did not account for potential confounding factors such as age, comorbid conditions like diabetes, gender, and prior dental visits. Despite the limitations inherent in the study design, both investigations indicated that some and not all aspects of periodontal health appeared to be worse in tobacco smokers compared to users of smokeless tobacco. The evidence generated suggests that in both studies the pocket depths were worse for tobacco smokers than it was for users of smokeless tobacco.

One of the strengths of this scoping review lies in the multiple data search that allowed for extensive coverage of the literature on the subject matter. This enabled the research teach the ability to pinpoint gaps within the existing literature concerning the distinctions between the associations of tobacco smoking, smokeless tobacco use, and periodontal health. This identification of gaps serves as a valuable resource for guiding future empirical research efforts [39]. Despite the diversity in the

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source of literature for this review, we had language restrictions which may have resulted in some publications not been included in the studies. In addition, both studies were conducted in India despite knowing that smoking and the use of smokeless tobacco transcends age, sex and cultural boundaries and often starting in early adolescence. The few studies thereby limited the ability of the map the literature based on age, sex and geographical diversity thereby limiting the power to generalize the study findings. Furthermore, the inconsistency in the methodologies for assessing for the health of the periodontium and the absence of a randomized controlled trial limited the ability to compare the outcomes of interest. Despite these limitations, this review has generated some new and insightful findings.

First, there was consensus from the results of the two studies that most people who smoke tobacco and who use smokeless tobacco have poorer periodontal health. What the two studies however seem to suggest is that the periodontal health is poorer for those who smoke tobacco than for those who use smokeless tobacco. This finding seems to corroborate prior suggestions of this differential effect[40–43].

Our hypothesis posits that tobacco smoking elevates the risk of calculus formation, subsequently rendering the periodontium more vulnerable when compared to the use of smokeless tobacco. This vulnerability is manifested in the form of increased pocket depth, which affects both periodontal probing depth and the periodontal index. Previous research has identified tobacco smoking as a contributing factor to the development of subgingival calculus[44]. Subgingival calculus serves as a local pathogenic element in the context of periodontitis[45]. Sterile calculus has the potential to induce widespread inflammation and the generation of granulation tissue[46]. It is also a significant predictor of inflammation within the soft tissue lining of deep periodontal pockets[47]. Furthermore, when phagocytosed by connective tissue cells, it can lead to cellular death through a process known as pyroptosis[48–50]. While there is a consensus that plaque and its associated microbial communities as the primary risk factor for periodontal diseases[51]. it may be worthwhile to investigate the role of calculus as a distinct pathophysiological pathway. This pathway may contribute to a unique manifestation of periodontal disease severity in individuals who engage in tobacco smoking and the use of smokeless tobacco.

Additionally, this study noted that the risk of developing periodontal pockets appears to be more pronounced among individuals who smoke tobacco when compared to those who use smokeless tobacco. Tobacco smoking leads to the degradation of the tooth-supporting tissues, leading to both bone loss and detachment of the periodontium[44]. The process of pocket formation induced by tobacco smoking is intricately linked to a combination of factors, including compromised immunological responses and the localized impact of smoke[52]. The altered local temperature environment, promoting the formation of dental plaque [ditto]. The absence of heat with the use of smokeless tobacco may reduce the risk for pocket formation with the use of smokeless tobacco, though the nicotine content can still compromise the immunological responses[53]. Further studies are needed to explore this suggestive finding.

The limited studies to highlight age, sex, and geographical differences in the profile of associations between tobacco smoking, use of smokeless tobacco and periodontal health limits effective context-specific responses to the global growing pandemic in the use of smokeless tobacco. Smokeless tobacco use is blurring the prior existing divide in age, gender and geographical differences observed with tobacco smoking[54]. Also, the impact of tobacco smoking and smokeless tobacco on health seem to differ between geographical locations. Currently, there is a lot more data on tobacco use and periodontal health from the United States[42,55,56], India[37,38,57–59] and Sweden[10,44,60–62], and underrepresentation of reports from other countries and continent. Therefore, having robust data to determine age, sex, and geographical differences in the associations between tobacco smoking, use of smokeless tobacco and periodontal health will be helpful for policy formulation and program design and implementation.

5. Conclusions

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In conclusion, this scoping review was able to identify two studies on that compared the effects of tobacco smoking and use of smokeless tobacco on the health of the periodontium. Both studies identified that tobacco smoking had higher odds of having worse periodontal health outcomes than the use of periodontal effect. Though the two studies used different measures to assess periodontal health there seems to be concurrence on the worse periodontal pocket depth among tobacco smokers than users of smokeless tobacco. Further studies are needed to understand the epidemiology and pathophysiology of the different impact of tobacco smoking and the use of smokeless tobacco on the health of the periodontium.

Author Contributions: M.T.O. conceptualized the review; M.T.O and O.R conducted the literature search; O.R and M.T.O. conducted the screening; M.O.T and M.O.T drafted the manuscript; M.O.T reviewed and edited the manuscript. M.T.O supervised the entire review process. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Not applicable

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Web of Science and Medline Database
Search Outcome= 10 outcomes

S/N	Key words	Search trend
	Smoking	(TS=(Cigar Smoking)) OR TS=(Cigarette Smoking) and Preprint Citation Index (Exclude – Database)
	Smokeless tobacco:	((((((((((((((((((((TS=(Smokeless Tobacco)) OR TS=(Tobaccos, Smokeless)) OR TS=(Gutka)) OR TS=(Gutkas)) OR TS=(Gutka Tobacco)) OR TS=(Gutka Tobaccos)) OR TS=(Tobacco, Gutka)) OR TS=(Tobaccos, Gutka)) OR TS=(Snus)) OR TS=(Dipping Tobacco)) OR TS=(Dipping Tobaccos)) OR TS=(Tobacco, Dipping)) OR TS=(Tobaccos, Dipping)) OR TS=(Oral Tobacco)) OR TS=(Tobacco, Oral)) OR TS=(Chewing Tobacco)) OR TS=(Chewing Tobaccos)) OR TS=(Tobacco, Chewing)) OR TS=(Tobaccos, Chewing)) OR TS=(Snuff)) OR TS=(Mint Snuff)) OR TS=(Snuff, Mint) and Preprint Citation Index (Exclude – Database)
	Periodontium	((((((((((TS=(Periodontiums)) OR TS=(Tooth Supporting Structures)) OR TS=(Structure, Tooth Supporting)) OR TS=(Structures, Tooth Supporting)) OR TS=(Supporting Structure, Tooth)) OR TS=(Supporting Structures, Tooth)) OR TS=(Tooth Supporting Structure)) OR TS=(Parodontium)) OR TS=(Parodontiums)) OR TS=(Paradentium)) OR TS=(Paradentiums) and Preprint Citation Index (Exclude – Database)
	Health	(((((TS=(Individual Health)) OR TS=(Health, Individual)) OR TS=(Normality)) OR TS=(Normalities)) OR TS=(Normalcy)) OR TS=(Normalcies) and Preprint Citation Index (Exclude – Database)

CINAHL Database
Search Outcome = 4

S/N	Keyword	Search terms
1	Smoking	TI smoking OR TI (tobacco or smoking or nicotine or cigarettes) OR TI tobacco smoking

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2	Periodontium	TI periodontium OR TI (parodontitis or periodontitis or tooth loss) OR TI Tooth Supporting Structure OR TI Paradentium OR TI (periodontitis or periodontal disease)
3	Smokeless Tobacco	TI smokeless tobacco OR TI (smokeless tobacco or gutka)
4	Health	

	Pubmed Database Search Outcome= 11	
S/N	Keyword	Search terms
1	Smoking	"Smoking"[Title/Abstract] OR "cigar smoking"[Title/Abstract] OR "cigarette smoking"[Title/Abstract]
2	Smokeless Tobacco	"smokeless tobacco"[Title/Abstract] OR (("Tobacco"[MeSH Terms] OR "Tobacco"[All Fields] OR "tobacco products"[MeSH Terms] OR ("Tobacco"[All Fields] AND "products"[All Fields]) OR "tobacco products"[All Fields] OR "Tobaccos"[All Fields] OR "tobacco s"[All Fields]) AND "Smokeless"[Title/Abstract]) OR "Gutka"[Title/Abstract] OR "Gutkas"[Title/Abstract] OR "gutka tobacco"[Title/Abstract] OR (("tobacco, smokeless"[MeSH Terms] OR ("Tobacco"[All Fields] AND "Smokeless"[All Fields]) OR "smokeless tobacco"[All Fields] OR "Gutka"[All Fields]) AND "Tobaccos"[Title/Abstract]) OR "tobacco gutka"[Title/Abstract] OR (("Tobacco"[MeSH Terms] OR "Tobacco"[All Fields] OR "tobacco products"[MeSH Terms] OR ("Tobacco"[All Fields] AND "products"[All Fields]) OR "tobacco products"[All Fields] OR "Tobaccos"[All Fields] OR "tobacco s"[All Fields]) AND "Gutka"[Title/Abstract]) OR "Snus"[Title/Abstract] OR "dipping tobacco"[Title/Abstract] OR (("dipped"[All Fields] OR "Dipping"[All Fields] OR "dippings"[All Fields]) AND "Tobaccos"[Title/Abstract]) OR "tobacco dipping"[Title/Abstract] OR (("Tobacco"[MeSH Terms] OR "Tobacco"[All Fields] OR "tobacco products"[MeSH Terms] OR ("Tobacco"[All Fields] AND "products"[All Fields]) OR "tobacco products"[All Fields] OR "Tobaccos"[All Fields] OR "tobacco s"[All Fields]) AND "Dipping"[Title/Abstract]) OR "oral tobacco"[Title/Abstract] OR "tobacco oral"[Title/Abstract] OR "chewing tobacco"[Title/Abstract] OR "chewing tobaccos"[Title/Abstract] OR "tobacco chewing"[Title/Abstract] OR "tobaccos chewing"[Title/Abstract] OR "Snuff"[Title/Abstract] OR "mint snuff"[Title/Abstract] OR (("tobacco, smokeless"[MeSH Terms] OR ("Tobacco"[All Fields] AND "Smokeless"[All Fields]) OR "smokeless tobacco"[All Fields] OR "Snuff"[All Fields] OR "snuffs"[All Fields]) AND "Mint"[Title/Abstract])
3	Periodontium	"Periodontium"[Title/Abstract] OR "Periodontiums"[Title/Abstract] OR "tooth supporting structures"[Title/Abstract] OR (("structural"[All Fields] OR "structurally"[All Fields] OR "structurals"[All Fields] OR "structuration"[All Fields] OR "structurations"[All Fields] OR "Structure"[All Fields] OR "structure s"[All Fields] OR "structured"[All Fields] OR "Structures"[All Fields] OR

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		"structuring"[All Fields]) AND "tooth supporting"[Title/Abstract]) OR (("structural"[All Fields] OR "structurally"[All Fields] OR "structurals"[All Fields] OR "structuration"[All Fields] OR "structurations"[All Fields] OR "Structure"[All Fields] OR "structure s"[All Fields] OR "structured"[All Fields] OR "Structures"[All Fields] OR "structuring"[All Fields]) AND "tooth supporting"[Title/Abstract]) OR (("support"[All Fields] OR "support s"[All Fields] OR "supported"[All Fields] OR "supporter"[All Fields] OR "supporter s"[All Fields] OR "supporters"[All Fields] OR "Supporting"[All Fields] OR "supportive"[All Fields] OR "supportiveness"[All Fields] OR "supports"[All Fields]) AND "structure tooth"[Title/Abstract]) OR "supporting structures tooth"[Title/Abstract] OR "tooth supporting structure"[Title/Abstract] OR "Parodontium"[Title/Abstract] OR "Paradentium"[Title/Abstract] OR "Paradentiums"[Title/Abstract]
4	Health	"Health"[Title/Abstract] OR "individual health"[Title/Abstract] OR "health individual"[Title/Abstract] OR "Normality"[Title/Abstract] OR "Normalities"[Title/Abstract] OR "Normalcy"[Title/Abstract] OR "Normalcies"[Title/Abstract]
	Scopus Database Search Outcome = 476	
S/N	Keyword	Search terms
#1	Smoking	smoking OR cigar AND smoking OR cigarette AND smoking
#2	Smokeless tobacco	smokeless AND tobacco OR chewing AND tobacco OR snuff OR oral AND tobacco
#3		#1 OR #2
#4	periodontal health	periodontal AND health
#5		#3 AND #5

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