

Gingival Inflammatory Response in Tobacco Smokers Compared to Vapers: A Scoping Review

Yulsa Inayahning Adhi¹, Indra Mustika Setia Pribadi², Amaliya Amaliya^{2*}

1. Dental Faculty, Universitas Padjadjaran, Bandung, Indonesia.

2. Dept. of Periodontology, Dental Faculty, Universitas Padjadjaran, Bandung, Indonesia.

Abstract

Tobacco smoking is one of the most important risk factors for periodontal disease as it alters the host response to bacterial plaque. Although the prevalence of tobacco smoking has declined in recent years, the use of novel nicotine products, particularly electronic cigarettes (vape) have become increasingly popular around the world. This systematic scoping review aimed to identify gingival inflammatory response in vapers compared to tobacco smokers

The term "(Gingivitis) AND (Gingival Inflammation) AND (Gingival Response) AND (Smoking) AND (Tobacco) AND (Cigarettes) AND (Vaping OR E-cigarettes)" were run in PubMed, EBSCOHost, and Google Scholar from inception to May 2021. From the 71 studies retrieved, 6 studies were included for this review.

After exclusion of articles not addressing the end point in question, 6 articles were included in this scoping review. Of the 6 articles, two were pilot studies, two were cross-sectional studies, one was case-control study, and one was observational study.

There was difference in gingival inflammatory response of tobacco smokers compared to vapers as seen from the bleeding on probing and gingival crevicular fluid volume as well as inflammatory mediators. Switching from combustible tobacco cigarette to vape may lead to increasing gingival bleeding and gingival crevicular fluid volume in a similar direction to that which occurs when smokers quit.

Tobacco smoking and vaping have different effects on the gingival inflammatory response. The inflammation in cigarette smokers may have been masked and vaping has the potential to replete the gingival response towards bacterial plaque, but this must be investigated further.

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Introduction

Inflammation is an essential part of defensive immune response of body tissues to eliminate or limit the harmful stimuli damaging the body.¹ It is characterized by five cardinal signs: pain (dolor), heat (calor), redness (rubor), swelling (tumor), and loss of function (functiolaesa).² In the oral cavity, inflammation affecting the gingiva is called gingivitis. As part of defensive immune response, gingival inflammation or the so-called gingivitis arises in

response to bacterial plaque accumulation. Gingival bleeding has been reported as the earliest clinical sign of gingival inflammation.³ In addition, bacterial plaque-induced gingival inflammation is also modified by various systemic and oral factors, such as poor nutrition, including vitamin C deficiency, systemic conditions, genetic factors (hereditary gingival fibromatosis) and local conditions such as poor oral care habits, poor dental restoration, dry mouth, crowded teeth, smoking and tobacco chewing.⁴

As a risk factor for periodontal disease, smoking has been demonstrated by a substantial body of evidence to have detrimental effect on periodontal health. The constant stimulation of cigarettes containing carcinogens and the heat released have an effect on plaque deposits, calculus, and tooth discoloration and triggers the occurrence of chronic inflammatory conditions of the gingiva. The prevalence and severity of

*Corresponding author:

Amaliya Amaliya,
Department of Periodontology, Dental Faculty, Universitas
Padjadjaran, Jalan Sekeloa Selatan no.
1 Bandung, West Java, Indonesia.
E-mail : amaliya@fkg.unpad.ac.id

periodontal disease as well as its progression rate are increased in smokers.⁵ Nevertheless, in cigarette smokers, the sign of gingival inflammation is often altered: a lower exudation rate and bleeding responsiveness have been reported, indicating that smoking suppresses the gingival inflammatory response.⁶ Several studies stated that chronic tobacco smokers can be associated with decreasing in the diameter of the gingival blood vessels, decreasing in the bleeding index, and decreasing in tissue redness.⁷ This impaired gingival inflammatory response results in a masking effect or masking of inflammatory features and further destruction of the gingiva and underlying periodontal tissue.⁸

Although the prevalence of tobacco smoking has declined in recent years, the use of electronic-cigarettes (vaping) has increased with various types and forms.⁹ This device is battery powered with a mechanism for converting liquid into vapor through a heating process.¹⁰ Vaping is proposed to reduce the craving for conventional cigarettes and being assessed as options in tobacco harm reduction due to their potential role in smoking reduction and smoking cessation.¹¹ However, the effect of switching from tobacco smoking to vaping on gingival responsiveness has not yet been widely investigated. Through this scoping review, we sought to identify gingival inflammatory response of vapers compared to tobacco smokers.

Materials and methods

This research was conducted using the scoping review method. The research statement was made based on the PCC, namely: criteria (P: Population) Tobacco smokers and vapers, (C: Concept) Gingival inflammatory response in vapers and tobacco smokers, (C: Context) Smokers and vapers of all ages, male and female. The collection and screening of articles follows the PRISMA-Scr guidelines. The article search strategy was carried out using three search engines, i.e. PUBMED, EBSCOHost, and Google Scholar by combining keywords in Boolean Operators as follows: (Gingivitis) AND (Gingival Inflammation) AND (Gingival Response) AND (Smoking) AND (Tobacco) AND (Cigarettes) AND ((Vaping OR E-cigarettes)). (Figure 1) shows the article selection process using the PRISMA-Scr diagram. Data collection techniques were carried out by (1) identifying

research questions, (2) identifying relevant literature sources according to research topics, (3) systematic literature selection according to established inclusion and exclusion criteria, (4) literature mapping and collection, (5) Preparation and reporting of analysis results, and (6) Consultation of results with competent parties.

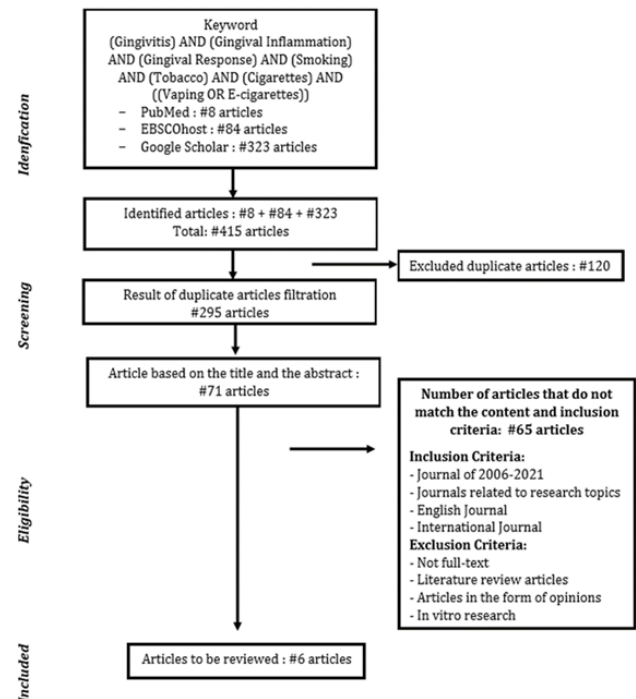


Figure 1. Preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews.

Results

Table 1 shows the detailed data for each article that has been reviewed. Studies on the types of inflammation experienced by vapers is still scarce, but in the present study the early signs of gingival inflammation in smokers and vapers were discussed. Early detection of gingival inflammation can be seen from the presence of gingival edema, gingival bleeding and an increase in gingival crevicular fluid. Several parameters such as bleeding on probing (BOP), gingival index, self-rated oral symptoms and GCF volume levels as well as inflammatory mediators in GCF are used in several related studies to see the inflammatory response that occurs in the gingiva of tobacco smokers and vapers.

After exclusion of articles not addressing the end point in question, 6 articles were included

in this scoping review. Of the 6 articles, two were pilot studies, two were cross-sectional studies, one was case-control study, and one was observational study.

Discussion

Inflammation is a normal body response against pathogens and other harmful stimuli. Previous research has shown that tobacco smoking can cause an acute and chronic inflammatory response in individuals who have smoked for years and have shown periodontal destruction.¹² Nevertheless, several studies demonstrated that inflammation was suppressed in tobacco smokers despite the rate of bacterial plaque accumulation and it is thus apparent that cigarette smoking masks the clinical signs of gingivitis and periodontitis and complicates the usual approach to the diagnosis of these diseases^{13,14} The reduced bleeding response in smokers has been attributed to gingival vasoconstriction induced by the actions of nicotine-stimulated adrenaline and noradrenaline on a1-adrenergic receptor.¹⁵

Bleeding on Probing

Bleeding on probing (BOP) is a parameter widely used to see the early signs of gingival inflammation.¹⁶ A contrary findings were demonstrated by Javed et al.¹⁷ that BOP was higher in vapers compared to tobacco smokers. This phenomenon is similar to condition when smokers quitting smoking, where gingival bleeding was higher manifested in non-smokers and individuals who quit smoking.¹⁸ This is supported by the theory of previous research which states that there is a 'masking effect' in chronic tobacco smokers.¹⁹ This suppression of bleeding is associated with nicotine-induced gingival vasoconstriction.²⁰ Although the gingiva does not appear to be bleeding, the inflammatory response changes and the damage process persists. Nicotine also stimulates IL-1 α which plays a role in keratinization.²¹ Keratinized gingiva may mask the appearance of inflammation and the bleeding response.²²

In addition, Ghazali et al found that the bleeding index in vape users was greater than in tobacco smokers.²³ Moreover, a study by Wadia et al. compared gingival inflammation in tobacco smokers who switched to vaping for two weeks. In this study, it was reported that there was an increase in BOP index.²⁴ This condition is similar

to someone who quits smoking (smoking cessation) or is a non-smoker. This inflammatory responses in switchers look like a normal inflammatory condition. This raises the question of why cigarettes have a 'masking effect' but not vapes, while both contain nicotine. This is likely due to the presence of tar from the combustion of tobacco cigarettes. Tar is a solid component in cigarette smoke which is a carcinogen.²⁵ Several studies have stated that tar has an impact on oral health such as tooth discoloration, the surface of the teeth becomes rough so that it can be more easily attached to plaque.²⁶ Research on tar and its effects on the gingiva needs further investigation.

The burning of tobacco cigarettes consists of two phases, those are the combustion phase and the pyrolysis or distillation phase. Oxygen from the air initiates carbonization and produces carbon monoxide and carbon dioxide during the combustion phase. Then distillation or pyrolysis produces smoke with a composition of gases, particles, and liquids.²⁷ Chemical compounds produced include hydrocarbons, nitrosamines, aldehydes and organic and inorganic components. Smoking has an impact on the gingival epithelium and connective tissue. There are studies showing that tobacco smokers experience epithelial changes similar to epithelial dysplasia and decreased inflammatory reactions.²⁸ A concept of tobacco harm reduction came from the statement that vape develop heated rather than combustible tobacco cigarettes.²⁹

Self-rated oral symptoms

This parameter is a measurement of general condition of oral health based on a self-assessment that helps in the diagnostic procedure. The assessment consisted of clinical and subjective assessment, clinical examination includes the assessment of cavities, missing teeth, gingival bleeding and subjective assessment consisting of pain in the oral cavity and in the context of this study is pain in the gingiva. The study of Vohra et al used questionnaires and found that bad breath and sore gums were reported more frequently in tobacco smokers than in vapers.³⁰ As for gingival bleeding, there was no significant difference in all groups, but it was more common among vapers than tobacco smokers. Previous studies have also suggested that there is a link between nicotine and the formation of bacterial biofilms

and their metabolic activity in the oral cavity, thus contributing to caries and bad breath.³¹

Gingival crevicular fluid (GCF) volume parameters and inflammatory mediators

GCF is an inflammatory exudate from periodontal tissue consisting of serum, inflammatory mediators and antibodies to bacteria in plaque.³² This fluid is present in both healthy and inflamed gingival sulcus. When inflammation occurs, GCF fluid increases as a form of host defence against foreign substances. BinShabaib et al stated that there was a greater increase in GCF volume in smokers than vape users and non-smokers.³³ However, Wadia et al stated that there was an increase in GCF volume in smokers who switch to vape.²⁴

In previous studies, it was also stated that smoking is associated with an increase in volume and inflammatory mediators such as IL-1 β , IL-6 and TNF- α in GCF.³⁴ Smoking tobacco also increases oxidative stress on periodontal tissues. In a study by Ye et al it was stated that several inflammatory mediators in GCF (En-RAGE, RAGE, MMP-9) were higher in tobacco smokers than vapers.³⁵

Inflammatory mediators are substances that initiate and regulate the inflammatory reaction. Cytokines such as TNF, IL-1, IL-6 are proteins secreted by many types of cells (lymphocytes, macrophages, dendritic cells, epithelial cells, endothelial cells, and connective tissue cells) that function to mediate and regulate immune and inflammatory reactions.³⁶ Oxidative stress is a cell abnormality induced by ROS or Reactive Oxygen Species belonging to a group of molecules known as free radicals.³⁷ These inflammatory mediators have an important role in the inflammatory process that can affect the oral health of smokers. Ye et al concluded that inflammatory mediators and oxidative stress caused by vaping are not as severe as in tobacco smokers.³⁵

The limitation of this present scoping review is only few studies observing gingival

response in smokers and vapers were discussed. The authors suggest conducting a literature search with various research designs, wider, comprehensive and in-depth, if time and resources allow. In addition, this form of literature review only maps and does not analyse analytically or does not calculate or examine directly the differences in inflammation of tobacco smokers and vapers.

Conclusions

Based on the present scoping review, tobacco smoking demonstrated a different effect on the gingival inflammatory response compared to vaping. Tobacco smoking has masking effect that disguises the sign of inflammation on gingiva, and vaping has the potential to reverse inflammatory response in the gingiva. It merits further study and experimental trial to confirm the repletion of normal gingival inflammatory response upon switching from tobacco smoking to vaping.

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Declaration of Interest

All authors declare has no conflict of interest on the publication of the research.

No.	Author (year)	Titles	Samples and research methods	Type and average duration of cigarettes/vape	Results
1	Wadia, R., Booth, K., Yap, H.F., Moyes, D.L. (2016) ¹⁸	<i>A pilot study of the gingival response when smokers switch from smoking to vaping</i>	Pilot study n(VU) = 20	Tobacco Cigarettes: ≥ 10 sticks/day, 5 years Vape (E-cigs): blu PRO TM e-cigarette kit 18 mg nicotine for 2 weeks	Tobacco smokers who switched to vaping for two weeks saw a significant increase in BOP and GCF.

2	Javed, F., Abduljabbar, T., Vohra, F., Malmstrom, H., Rahman, I., Romanos, G. (2017) ¹⁹	<i>Comparison of periodontal parameters and self-perceived oral symptoms among cigarette-smokers, individuals vaping electronic-cigarettes and never-smokers: a pilot study</i>	Pilot study n(CS) = 33 n(VU) = 31 n(NS) = 30	Tobacco Cigarettes: ≥5 sticks/day, ≥12 months Vapes (E-cigs): ≥12 months	Increased pain and swelling of the gingival of tobacco smokers compared to vaping users. Gum bleeding is more common in non-smokers.
3	Ghazali, A.F., Ismail, A.F., Faisal, G.G., Halil, M.H.M., Daud, A. (2019) ²⁰	<i>Oral health of smokers and e-cigarette users: a case-control study</i>	Case-control n(CS) = 40 n(VU) = 40 n(NS) = 40	NA	The bleeding index of vape users is higher than tobacco smokers and non-smokers
4	BinShabaib, M., AlHarthi, S.S., Akram, Z., Khan, J., Rahman, I., Romanos, G.E., Javed, F. (2019) ²¹	<i>Clinical periodontal status and gingival crevicular fluid cytokine profile among cigarette-smokers, electronic-cigarette users and never-smokers</i>	Cross-sectional n(CS) = 46 n(VU) = 44 n(NS) = 45	Tobacco Cigarettes: ≥5 sticks/day, ≥1 year Vapes (E-cigs): ≥1 puff daily, nicotine concentration: 3-6 mg/ml	BOP is higher in non-smokers. GCF volume and concentrations of IL-1β, IL-6, IFN-γ, TNF-α and MMP-8 were higher in tobacco smokers.
5	Vohra, F., Bukhari, I.A., Sheikh, S.A., Albaijan, R., Naseem, M. (2020) ²²	<i>Comparison of self-rated oral symptoms and periodontal status among cigarette smokers and individuals using electronic nicotine delivery systems</i>	Observational n(CS) = 28 n(VU) = 26 n(NS) = 26	Tobacco Cigarettes: ≥20 sticks/day Vapes (E-cigs): ≥1 puff/day	Pain in the gums, teeth and bad breath is more common in tobacco smokers than vaping users. Gingival bleeding is more common in vaping users than non-smokers.
6	Ye, D., Gajendra, S., Lawyer, G., Jadeja, N., Pishey, D., Pathagunti, S., Lyons, J., Veazie, P., Watson, G., McIntosh, S., Rahman, I. (2020) ²³	<i>Inflammatory biomarkers and growth factors in saliva and gingival crevicular fluid of e-cigarette users, cigarette smokers, and dual smokers: a pilot study</i>	Cross-sectional n(CS) = 12 n(VU) = 12 n(NS) = 12	NA	Several inflammatory mediators in GCF (En-RAGE, RAGE, MMP-9) were higher in tobacco smokers than vaping users. The level of oxidative stress (MPO) in GCF is higher in tobacco smokers than vaping users. The amount of prostaglandins in saliva is also higher in tobacco smokers.

Table 1. Data Extraction Results. *NS : Non-Smokers; CS : Cigarette Smokers; VU : Vape Users.

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