Asian Journal of Dental Sciences

Volume 6, Issue 1, Page 367-375, 2023; Article no.AJDS.110535

The Use of E-Cigarettes and its Influence on the Onset of Gingivitis in Young Adults in Georgetown, Guyana

Jedia Jeffrey [a], Theresa Deoroop [b], Sirpaul Jaikishun [a*] and Nazia Khan [b]

[a] Department of Biology, Faculty of Natural Sciences, University of Guyana, Turkeyen Campus, Guyana.
[b] Cheddi Jagan Dental School, Dental Division, Ministry of Health, Guyana.

Authors' contributions

This work was carried out in collaboration among all authors. Authors JJ, TD, and NK designed the study and prepared the first draft of the manuscript. Authors JJ and SJ managed the analyses of the study. Authors JJ, TD, and SJ managed the literature searches. All authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/110535

Original Research Article

Received: 01/10/2023
Accepted: 07/12/2023
Published: 15/12/2023

ABSTRACT

Periodontal disease is a common oral inflammatory condition, and it is attributed to specific risk factors that negatively impact periodontal tissues. This study seeks to investigate whether there is a significant association between the use of electronic cigarettes and the prevalence of periodontal disease, specifically plaque-induced gingivitis, in young adults. Our key goals include assessing how common e-cigarette usage and evaluating whether there is any correlation between vaping and its impact on the prevalence of plaque-induced gingivitis is among young adults aged between 18 and 35. Additionally, an oral examination and the Turesky plaque index scoring scheme to identify any existing correlation between the use of e-cigarettes and its potential relationship with the prevalence of plaque-induced gingivitis amongst young adults.

**Corresponding author: Email: sirpaul.jaikishun@uog.edu.gy;*

Keywords: Electronic cigarettes; periodontal disease; plaque-induced gingivitis; Turesky plaque index; vaping.

1. INTRODUCTION

Periodontal disease is defined as an inflammatory disease that affects the periodontium, which comprises the gingiva, alveolar bone, cementum, and periodontal ligament [1]. It is considered the most common oral condition affecting the human population [2]. Periodontal disease is associated with several risk factors, including modifiable factors such as the use of nicotine, diabetes mellitus and poor dental hygiene, as well as non-modifiable factors such as age and heredity [2]. Periodontal disease is caused by a dysbiosis of the commensal oral biofilm commonly known as dental plaque, which consequently interacts with the host's immune defenses, resulting in inflammation. This pathophysiological state remains during periods of activity and inactivity until the affected tooth is removed or the microbial biofilm is removed by a dental professional [1,3].

Dental plaque is a complex biofilm that is adhered to the teeth. The acquired pellicle is the initial stage in the formation of this oral biofilm [4]. When saliva encounters the tooth's surface, salivary proteins bind to create the acquired salivary pellicle. The development of common oral conditions such as dental caries and periodontal disease is linked to the acquired salivary pellicle [5]. The salivary pellicle works as a natural barrier to protect the tooth's surface from direct contact with acids and erosive demineralization. It also protects the oral cavity against periodontal disease by inhibiting the colonization of pathogens [5].

There are around 800 types of bacteria found in the oral cavity, making it the second-largest microbiome in the human body. Periodontal disease is caused by an intricate combination of bacterial infection and host response [2,6]. The proliferation of gram-negative organisms is generally considered to be the major cause of periodontal disease. These species include *Porphyromonas gingivalis, Tannerella forsythia, Treponema denticola,* and *Aggregatibacter actinomycetemcomitans.* Additionally, the etiology of periodontal disease is influenced by gram-positive species such as *Filifactor alocis, Parvimonas micra,* and *Eubacterium nodatum* [7-9]. Gingivitis is the mildest and most common form of periodontal disease [1]. Gingivitis is commonly caused by microbial plaque deposits that are found in or around the gingival sulcus. The disease is limited to the gingival epithelium and connective tissue [10,6]. The clinical signs of gingivitis include gingival inflammation, erythema, irritation, a glossy appearance of the gingiva, and bleeding after moderate probing. Since gingivitis seldom results in spontaneous bleeding and rarely hurts, many people go undiagnosed and without treatment [11,6].

Electronic cigarettes or e-cigarettes are battery-powered devices that are used to vape. Electronic cigarettes go by a variety of names. They are also known as "e-cigarettes," "e-hookahs," "mods," "vape pens," "vapes," "tank systems," and "endless nicotine delivery systems (ENDS)" [12]. The Centre for Disease Control and Prevention reports that e-cigarettes are the most popular nicotine product among young adults. In the U.S., approximately 380,000 middle school students, and 2.14 million high school students use one of the above-mentioned forms of e-cigarettes [12,13]. Vaping is a form of smoking that does not use tobacco. The e-cigarettes emit a mist that is breathed deeply into the lungs, simulating the sensation of smoking traditional cigarettes. Since the advent of e-cigarettes in the early 2000s, they have become increasingly popular, especially among teenagers and young adults [14,15]. The ingredients in e-cigarettes include tobacco-specific nitrosamines (TSNAs), solvent carriers (propylene glycol and glycerol), aldehydes, metals, volatile organic compounds (VOCs), phenolic compounds, polycyclic aromatic hydrocarbons (PAHs), flavourings, tobacco alkaloids, and medicines [16-18]. Vaping electronic cigarettes alters the oral environment and has a significant impact on the colonization of complex microbial species like *P. gingivalis*, increasing the risk of oral inflammation and infection [15]. This research looks at the relationship between vaping and the development of gingivitis in young adults.

2. MATERIALS AND METHODS

The use of e-cigarettes, and the incidence of gingivitis in young adults through examination of the oral cavity using the plaque index scoring method and data collection through questionnaires. To achieve a conclusive statement, an online questionnaire composed of

20 questions was sent to various contacts and they were encouraged to share the questionnaire.

The questionnaire collected 72 responses that were submitted anonymously and the contact information from persons willing to participate in an oral examination was documented. These persons were contacted, and appointments were made for the persons to meet in the following weeks. The oral examination began on Wednesday 22nd March 2022 and was completed on Thursday 25th May 2023. The researcher met with the participants at the University of Guyana Campus, East La Penitence Clinic, and the Golden Grove Clinic.

Each participant's oral cavity was examined under the supervision of a trained dental clinician. The researcher explained the nature of the oral examination and then instructed the participant to read through an agreement of confidentiality before agreeing and confirming with a signature on the document. The participant was then presented with a plaque-disclosing tablet and was instructed to chew the tablet until it was fully dissolved, then spit once in the waste bin. Once the participants completed this, their oral cavity was examined for signs of plaque build-up. The facial and lingual surfaces of the lateral incisor (12), first molar (16), first bicuspid (24), lateral incisor (32), first molar lower right (36) and first bicuspid lower left (44). Dental mirrors were used to efficiently view the surfaces where a plaque was found and provide a score for each surface [19]. A score of one means there is no visible plaque present. A score of two means there is a thin continuous band of plaque with a width of approximately 1 mm, present at the cervical margin of the tooth. A score of three means there is a band of plaque wider than 1mm present, but it is less than one-third of the crown of the tooth. A score of four means that plaque is covering at least one-third but not more than two-thirds of the crown of the tooth. A score of five means that plaque covers two-thirds or more of the crown of the tooth. The Turesky Plaque Index was calculated by dividing the total plaque score by the number of tooth surfaces [20]. The formula that was used is as follows: Total Index = Total score /Number surfaces examined [21,20]. For this research, the total score was recorded from both the facial and lingual surfaces of a tooth [21,20].

Table 1. A qualitative value to each participant's plaque index

0.0 – 1.0	Excellent oral hygiene
1.0 – 1.5	Good oral hygiene
1.5 – 2.0	Fair oral hygiene
2.0 – upwards	Poor oral hygiene

2.1 Data Analysis

Both qualitative and quantitative data were collected during the research phases. The Shapiro-Wilke test was used to examine how closely the plaque indices of e-cigarette users' data fit a normal distribution at p=0.05 assumed to normal distribution. The statistical software RStudio: Integrated Development for R. RStudio (Version 2, PBC, Boston, MA, and the Statistical Package for Social Sciences (Version 21 for Windows, SPSS Inc., New York, NY, USA) were used to perform the analyses.

3. RESULTS

Out of 72 respondents, 70.8% were 18-23 years old, 26.4% were 24-29 years old, and 2.8% were 30-35 years old. There was a total of 51 female respondents and 21 male respondents (Fig. 1). One significant result to note was that 56.9% of the participants did not vape, while 43.1% of them did. This trend can also be seen in the number of people who participated in oral examinations. From the minority group of vapers (31 persons), a small percentage (6.1%) vaped regularly, while 9.1% vaped every day and 84.8% vaped infrequently.

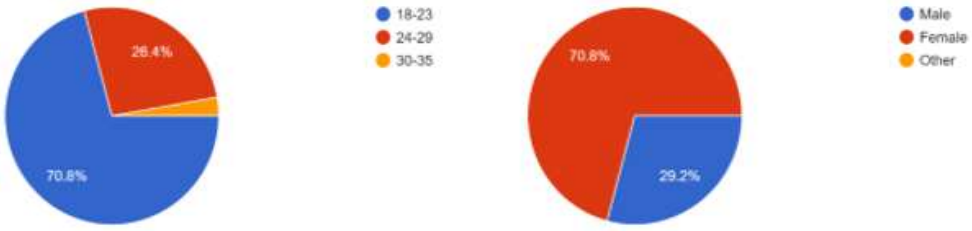

Fig. 1. Demographics of the respondents

The most popular delivery method for vaping was hookah (72.7% of vapers), followed by vape pens (60.6% of vapers), and vape mods (18.2% of vapers) (Fig. 2).

It was found that 9.4% of vapers developed their vaping habits more than 4 years ago, while 15.6% started vaping within the last 3-4 years, 43.8% started vaping 1-2 years ago, 18.8% started within the last year and 12.5% started vaping within the last 6 month (Fig. 3 (a)). The strength of the vape juice refers to the nicotine concentration per ml. 51.7% of vapers use or prefer the 6 mg/ml concentration in vapes. Further, 24.1% of vapers use the 3 mg/ml concentration, and 10.3% use the 20 mg/ml concentration. 10.3% use the 12mg/ml concentration, and 3.4% use the 0 mg/ml concentration (Fig. 3 (b)). Only 11.1% of respondents brush their teeth more than two times daily, 11.1% brush their teeth once daily, and 2.8% brush their teeth every other day (Fig. 3 (c). Out of 72 respondents, 11.1% never floss, while 19.4% flossed daily, and most of the respondents (69.4%) only floss occasionally. Most of the respondents (76.4%) reported that they do use mouthwash/oral rinse. Also, 23.6% of respondents do not use mouthwash/oral rinse (Fig. 3 (d)).

Sensitivity to hot/cold is a common symptom of poor oral health. Only 40.3% of the respondents experienced sensitivity to hot/cold while 59.7% did not. Out of 27 responses, 96.3% of respondents have not experienced sensitivity to hot/cold since they started vaping (Figs. 4 (a) and (b)). Only 3.7% of the respondents have experienced sensitivity to hot/cold since they started vaping. Out of 72 responses, 59.7% only visit the dentist in the case of an emergency, 34.7% visit the dentist every six months, and 5.6% visit the dentist once every 3-4 months (Fig. 4 (c)). Out of 72 responses, 50% were aware of the potential effects of vaping while 50% were unaware. Out of 72 responses, 0.11% of participants had no current medical condition. The most popular medical condition was diabetes. Various medical conditions like depression, hypothyroidism, asthma, polycystic ovarian syndrome, eczema, high cholesterol, and acid reflux were reported. 0.11% of respondents also reported no familial history of medical conditions. Hypertension and diabetes were the most common historical medical conditions reported.

The most popular reasons for dental visits/appointments were cleaning, teeth whitening, cavity filling and tooth extraction (Fig. 5). Most of the respondents were open to discussing the potential effects of using e-cigarettes. However, when asked if they knew the overall effects would have a negative impact on their oral health, most persons expressed that they would stop using e-cigarettes, but some individuals stated they would not as it helps them to relieve stress and it is very addictive.

Their plaque scores from the clinical examinations were recorded, and an independent t-test was used to analyze the data. The 11 participants who did not vape (M = 1.09, SD = 1.22) compared to the 13 participants who did vape (M =1.94, Ss = 1.83) demonstrated significantly lower plaque indices, t = 5.54, the p=0.00001 (p <0.05). After analyzing the data, it became evident that people who vaped had a considerably higher plaque index than those who did not (p= 0.05). The findings support prior studies in this field and add to the hypothesis that there is a significant association between vaping and the development of dental plaque and plaque-induced gingivitis.

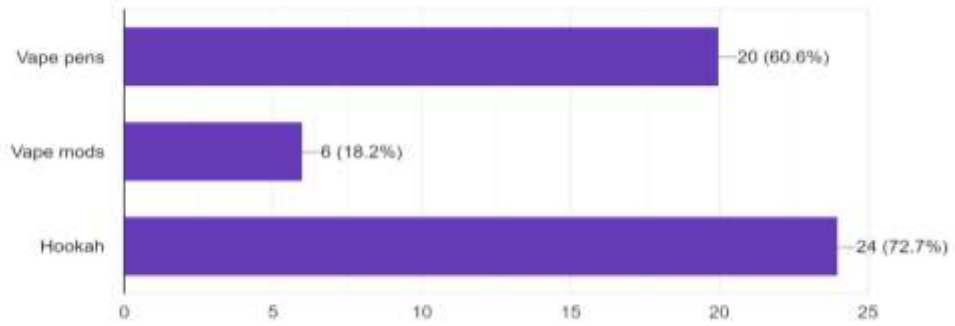

Fig. 2. Method of vaping

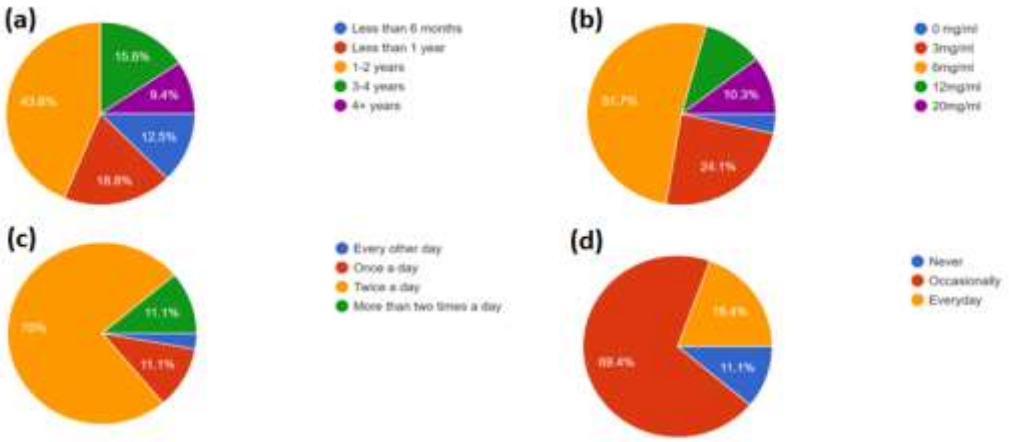

Fig. 3. (a) Vaping period (b) concentrations of nicotine in vape (c) vaping frequency (d) flossing frequency responses based on the questionnaire

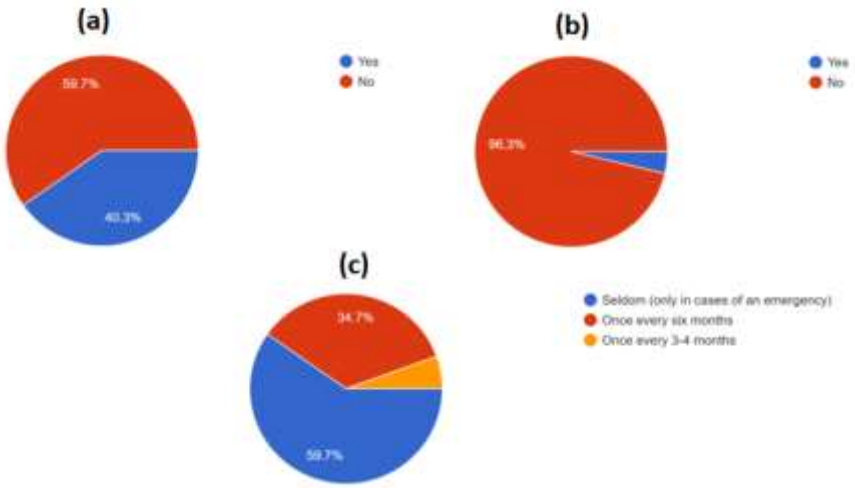

Fig. 4. (a) Sensitivity to hot/cold before vaping (b) sensitivity to hot/cold after vaping (c) frequency of visits to the dentist

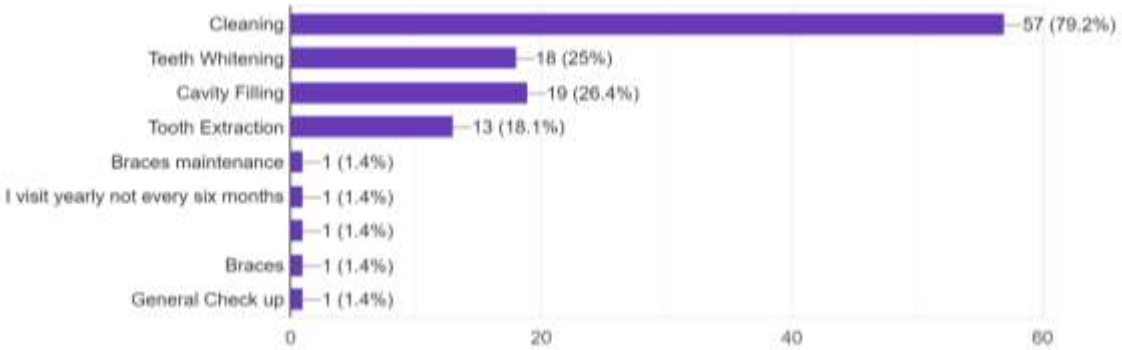

Fig. 5. Form of treatment most likely visit the dentist for

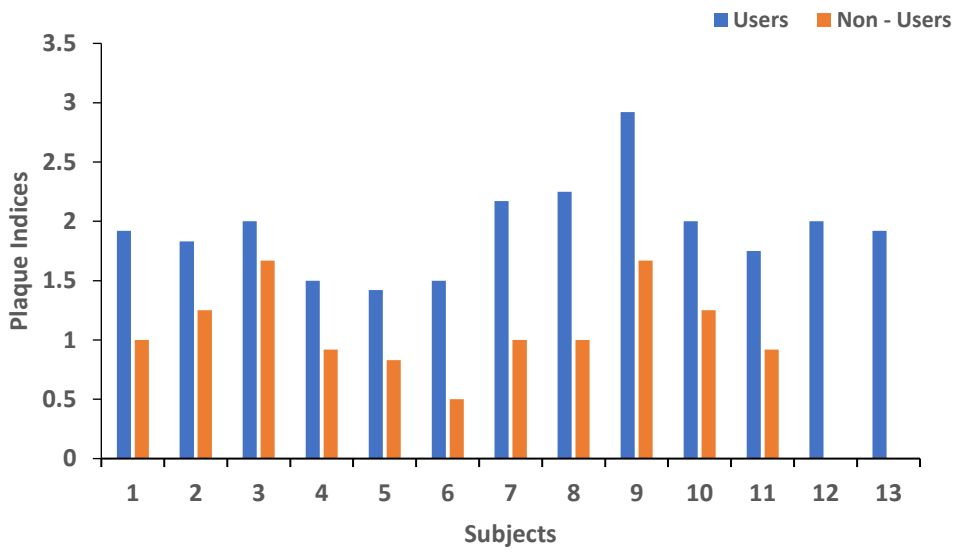

Fig. 6. Plaque indices of users and non-users of vapes

4. DISCUSSION

With the advent of electronic cigarettes as the newest form of recreational activity, research into the potential effect on our health and well-being is paramount. Ebersole et al. [22] offer important details about the harmful chemicals generated by electronic cigarettes and their potential influence on oral health. Their findings underline the need for more research into the potential negative effects these substances may have on the tissue inside the mouth and highlight the hazards related to them. Similarly, Andrikopoulos et al. [23] explore the importance of electronic nicotine delivery systems, such as e-cigarettes, in relation to dental health. The report highlights the significance of comprehending the possible oral health effects of ENDS use and urges thorough investigation in this area. Al-Aali et al. [24] looked at peri-implant parameters, tumour necrosis factor-alpha, and interleukin-1 beta levels in e-cigarette users to support the findings of increased plaque and periodontal disorders. Their research emphasizes the potential involvement of inflammatory indicators and provides more proof of the detrimental effects of vaping on dental health. Ismail et al. [25] offer insightful information about the gradual decline in periodontal health among e-cigarette users over six months. However, this study has limitations due to the study's brief time and other confounding variables that may not have been sufficiently considered. To demonstrate a clearer causal link between vaping and deteriorating periodontal health, further longitudinal research with bigger sample numbers is required.

Jeong et al. [17] looked at the relationship between periodontal disease and traditional and electronic cigarette smoking in South Korean individuals. Their findings highlight the possible risks presented by e-cigarettes on oral health by showing a strong association between the usage of both forms of cigarettes and periodontal disease. The limitations of self-reported data and any confounding variables that might affect the observed correlation should be considered even if their findings add to the body of evidence. To demonstrate a stronger causal relationship, more research that includes objective clinical evaluations and controls for confounders is required.

Furthermore, Atuegwu et al. [26] investigated the link between routine usage of electronic nicotine products and self-reported periodontal disease state. In contrast to non-users, frequent e-cigarette users had a greater probability of developing periodontal disease, indicating a negative effect on periodontal health from long-term e-cigarette use. Additionally, a cross-sectional analysis of tobacco usage trends and self-reported oral health outcomes. It revealed that e-cigarette users were nearly three times more likely to report gingival disease compared to people who neither smoke nor use e-cigarettes, adding to the mounting evidence of

the harm e-cigarette usage causes to oral health [27].

AlQobaly et al. [28], investigated the incidence of self-reported periodontal disease and e-cigarettes. Their results showed that e-cigarette users had higher rates of self-reported periodontal disease. Unlike the current research project, this study had the strength of a large population sample that can be used to represent the study area's entire population. However, since the samples were from self-reported cases of periodontal disease, the results may be biased. Tishchenko et al. [6] highlight the possible influence of e-cigarettes on the oral microbiota, which is crucial for sustaining oral health, even if it is not directly associated with results for plaque and periodontal health. They looked at the impact of smoking heating tobacco products and e-cigarettes on the oral microbiota but did not specifically address plaque and periodontal health outcomes. However, changes in the oral microbiota have been linked to several oral health issues, thus more research into how e-cigarettes affect oral microbial ecosystems is necessary [6]. Xu [29] posited that patients with the same stage of periodontal disease, smokers of traditional cigarettes, and users of electronic cigarettes all had identical oral bacterial compositions. Smoking e-cigarettes may have a comparable effect as smoking cigarettes over time in terms of changing the bacterial makeup of saliva, which might increase the relative abundance.

5. CONCLUSION

In conclusion, the findings show a significant relationship between vaping and an increase in plaque deposits that can lead to plaque-induced gingivitis. While further study is needed to confirm causation and better understand the underlying processes, our findings highlight the significance of educating Guyanese about the possible oral health hazards associated with vaping. To lessen the effects of vaping on oral health, dental professionals, public health officials, and researchers should work together to create effective preventative methods and treatments.

CONSENT

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENT

The authors are grateful to the University of Guyana, Turkeyen Campus for the facilities and consumables used in this research. We are also thankful to all the participants who volunteered their time to the completion of this research. Furthermore, I would like to thank the dental professionals Dr. Narine and Nurse Angela who organized the recruiting process.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Gasner NS, Schure RS. Necrotizing periodontal diseases. In Stat Pearls. Stat Pearls Publishing Copyright © 2023, StatPearls Publishing LLC; 2023.
2. Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. International journal of health sciences. 2017;11(2): 72.
3. Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. Nature Reviews Disease Primers. 2017;3(1):1-14.
4. Cappelli DP, Mobley CC. Prevention in clinical oral health care. Elsevier Health Sciences; 2007.
5. Chawhuaveang DD, Yu OY, Yin IX, Lam WYH, Mei ML, Chu CH. Acquired salivary pellicle and oral diseases: A literature review. Journal of Dental Sciences. 2021; 16(1):523-529.
6. Tishchenko OV, Kryvenko LS, Gargina VV. Influence of smoking heating up tobacco products and e-cigarettes on the microbiota of dental plaque. Polski Merkuriusz Lekarski: Organ Polskiego Towarzystwa Lekarskiego. 2022;50 (295):16-20.
7. Engen SA, Rørvik GH, Schreurs O, Blix IJ, Schenck K. The oral commensal Streptococcus mitis activates the aryl hydrocarbon receptor in human oral epithelial cells. International Journal of Oral Science. 2017;9(3):145-150.

8. Könönen E, Wade WG. Actinomyces and related organisms in human infections. Clin Microbiol Rev. 2015;28(2):419-442. Available:https://doi.org/10.1128/cmr.00100-14
9. Marsh PD. Dental plaque as a biofilm and a microbial community–Implications for health and disease. BMC Oral Health; 2006.
10. Salim A, Angelova S, Roussev B, Sokrateva T, Kiselova-Kaneva Y, Peev S, Ivanova D. Salivary Interleukin-6, Interleukin-1β, and C-Reactive protein as a diagnostic tool for plaque-induced gingivitis in children. Applied Sciences. 2023;13(8):5046. Available:https://www.mdpi.com/2076-3417/13/8/5046
11. Murakami S, Mealey BL, Mariotti A, Chapple IL. Dental plaque–induced gingival conditions. Parodontologiya. 2019; 24(3):244-252.
12. CDC. Quick facts on the risks of e-cigarettes for kids, teens, and young adults; 2022.
13. Herrin S. Improving vaping knowledge among teens through a school-based prevention program; 2023.
14. Kuo T, Kuo A, Roy S, Friederichsen PG, Whelan P. Addressing the dangers of increased e-cigarette use among youth: A call to action for clinicians; 2019.
15. Vu GT, Stjepanović D, Sun T, Leung J, Chung J, Connor J, Thai PK, Gartner CE, Tran BX, Hall WD. Predicting the long-term effects of electronic cigarette use on population health: A systematic review of modelling studies. Tobacco Control; 2023.
16. Guillemin AF, Labarbe B, Cervenka I, Aurouet P, Gallopel-Morvan K, Reyes-Guzman C, Foucaud J. Perceptions of e-cigarettes and e-liquids flavours harmfulness in the general population: Results of a French nationally representative survey. Tobacco Prevention & Cessation. 2023;9(Supplement).
17. Jeong W, Choi DW, Kim YK, Lee HJ, Lee SA, Park EC, Jang SI. Associations of electronic and conventional cigarette use with periodontal disease in South Korean adults. Journal of Periodontology. 2020;91 (1):55-64.
18. National Academies of Sciences E, Medicine Health, Medicine D, Board on Population H, Public Health P, Committee on the Review of the Health Effects of Electronic Nicotine Delivery, S. In D. L. Eaton, L. Y. Kwan, & K. Stratton (Eds.), Public Health Consequences of E-Cigarettes. National Academies Press (US). Copyright by the National Academy of Sciences. All rights reserved; 2018. Available:https://doi.org/10.17226/24952
19. Slot D, Valkenburg C, van der Weijden F. Mechanical plaque removal of periodontal maintenance patients: A systematic review and network meta-analysis. Journal of Clinical Periodontology. 2020;47:107-124. Available:https://doi.org/10.1111/jcpe.13275
20. Figuero E, Herrera D, Tobías A, Serrano J, Roldán S, Escribano M, Martín C. Efficacy of adjunctive anti-plaque chemical agents in managing gingivitis: A systematic review and network meta-analyses. Journal of Clinical Periodontology. 2019;46(7):723-739. Availablehttps://doi.org/https://doi.org/10.1111/jcpe.13127
21. Erbe C, Klees V, Ferrari-Peron P, Ccahuana-Vasquez RA, Timm H, Grender J, Cunningham P, Adam R, Farrell S, Wehrbein H. A comparative assessment of plaque removal and toothbrushing compliance between a manual and an interactive power toothbrush among adolescents: a single-center, single-blind randomized controlled trial. BMC Oral Health. 2018;18(1):130. Available:https://doi.org/10.1186/s12903-018-0588-1
22. Ebersole J, Samburova V, Son Y, Cappelli D, Demopoulos C, Capurro A, Pinto A, Chrzan B, Kingsley K, Howard K. Harmful chemicals emitted from electronic cigarettes and potential deleterious effects in the oral cavity. Tobacco Induced Diseases. 2020;18.
23. Andrikopoulos IG, Farsalinos K, Poulas K. Electronic nicotine delivery systems (ENDS) and their relevance in oral health. Toxics. 2019;7(4):61.
24. Al-Aali KA, Alrabiah M, ArRejaie AS, Abduljabbar T, Vohra F, Akram Z. Peri-implant parameters, tumour necrosis factor-alpha, and interleukin-1 beta levels in vaping individuals. Clinical Implant Dentistry and Related Research. 2018;20(3):410-415.
25. Ismail AF, Ghazali AF, Daud A. Effect of electronic cigarette usage on oral health: A 6-month prospective study. Indian Journal

of Public Health Research & Development. 2019;10(6).
26. Atuegwu NC, Perez MF, Oncken C, Thacker S, Mead EL, Mortensen EM. Association between regular electronic nicotine product use and self-reported periodontal disease status: population assessment of tobacco and health survey. International Journal of Environmental Research and Public Health. 2019; 16(7):1263.
27. Vora MV, Chaffee BW. Tobacco-use patterns and self-reported oral health outcomes: A cross-sectional assessment of the Population Assessment of Tobacco and Health study, 2013-2014. The Journal of the American Dental Association. 2019;150(5):332-344. e332.
28. AlQobaly L, Abed H, Alsahafi Y, Sabbah W, Hakeem FF. Does smoking explain the association between use of e-cigarettes and self-reported periodontal disease? Journal of Dentistry. 2022;122:104164.
29. Xu F, Pushalkar S, Lin Z, Thomas SC, Persaud JK, Sierra MA, Vardhan M, Vasconcelos R, Akapo A, Guo Y, Gordon T, Corby PM, Kamer AR, Li X, Saxena D. Electronic cigarette use enriches periodontal pathogens. Molecular Oral Microbiology. 2022;37(2):63-67.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/110535