International Journal of Community Medicine and Public Health
Bamani MS et al. Int J Community Med Public Health. 2023 Jan;10(1):357-361
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20223564

Review Article

Effect of e-cigarettes on oral health and the development of periodontitis

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Received: 05 December 2022
Accepted: 27 December 2022

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ABSTRACT

Tobacco cigarette smoking is a well-established risk factor for oral diseases, especially periodontal diseases. Over the past few years, electronic cigarettes (or "E-cigarettes") have gained popularity. There is some evidence that e-cigarettes may play a role in helping people quit smoking, and they are occasionally seen as a less dangerous alternative to tobacco use. However, there are worries about their effects on health, notably in terms of oral health and the emergence of periodontal disease. Limited information is available regarding the effect on oral disease. E-cigarettes come in a variety of nicotine strengths and flavoring combinations, all of which have been associated with detrimental oral health issues. A growing body of research supports the idea that vaping or using electronic cigarettes may increase the chance of developing oral health problems such as tooth decay, gum disease, periodontal disease, cracked or broken teeth, and pain in the tongue or inside of the cheek. Even if e-cigarettes were less harmful, they still could lead to the development of periodontal diseases through the decreased antioxidant capacity of saliva, the inflammatory effect, cell injury, and impaired reparability. High levels of nicotine content and menthol-favoring additives increase risk of periodontal damage in e-cigarette users. However, conflicting study results are also published for smokers who transitioned to e-cigarettes. Even though benefits or value of e-cigarettes as a substitute for tobacco cigarettes are still unknown, their impact on periodontal and general health status is still prominent.

Keywords: E cigarettes, Periodontal, Oral health

INTRODUCTION

Electronic cigarettes (e-cigarettes) are battery-powered electronic devices that are available in different sizes and shapes with various flavors. Electronic cigarettes (also referred to as "e-cigs," "vapes," "e-hookahs," "vape pens," and "electronic nicotine delivery systems") are a broad category of products that enable users to inhale an aerosol, usually containing nicotine, into their lungs. E-cigarette use has rapidly expanded in some worldwide

markets, including Russia, Germany, and the United States, since they became commercially available in Europe and the United States in 2006.[1] These devices are extensively pushed as smoking cessation aids, with claims that they are healthier, more affordable, and more acceptable in society than ordinary cigarettes.[2]

The 3 primary categories of components included in e-cigarettes are carrier solution (propylene glycol and/or vegetable glycerin), nicotine (some e-cigarettes are nicotine-free), and flavorings.[3] E-cigarettes have proven to be contentious, and possible risks and advantages of using them have been hotly disputed in several health and social care fields. Conventional cigarette smoking has been shown to cause deleterious effects on oral and periodontal health.[4] It has established that e-cigarettes contain fewer toxic chemicals and are therefore less hazardous to the user's health. However, probable impacts of e-cigarettes on oral health have been extensively questioned in recent years in dentistry research.

Numerous studies have been undertaken in the last few years to investigate the effects of these factors on oral health, including in vitro, microbiological, and epidemiological investigations. The majority of research conducted thus far has been small-scale and typically cross-sectional in nature. Given the various populations that have been studied and the ongoing development of new products, it might be difficult to interpret the results of e-cigarette research. According to recent findings, the most frequent repercussions of e-cigarette use on oral health are mouth and throat discomfort and periodontal disease. The current review examines new data on the harmful consequences of e-cigarettes on oral health.

LITURATURE REVIEW

This review summarizes the evidence from scientific publications related to the interaction of e-cigarettes with the oral cavity and the possible promotion of oral disease, and especially the development of periodontal disease, with the use of e-cigarettes. Peer-reviewed articles between 2014 and 2022 were chosen for this project utilizing a variety of search phrases and databases. The following keyword groups were used to conduct searches in PubMed, Science Direct, Cochrane Review, and Google Scholar: electronic cigarette, e-cigarette, vaping, nicotine replacement treatment, periodontal disease, gingival disease, dental caries, and oral health.

DISCUSSION

Oral health effects of e-cigarettes

The relationship between conventional cigarette smoking and various oral health diseases has long been established in scientific literature.[5,6] E-cigarettes contain varying nicotine concentrations and a wide range of flavor additives, all of which have been linked to harmful oral health conditions. A large sample study revealed that the combined use of cigarette smoking and e-cigarettes were related to self-reported poor oral health conditions.[7] Another earlier pilot study investigators found that a significant increase in gingival inflammation occurred when smokers switched from smoking to vaping over two weeks.[8] Though research on potential oral health changes following e-cigarette exposure is limited and there is some conflicting evidence about the safety of e-cigarette use, some findings prove that e-cigarettes are safe for oral cells,[9] even though some have reported that daily vaping is associated with poor oral health.[10] Emerging evidence supports the hypothesis that electronic cigarettes or vaping may be a risk factor for poor oral health outcomes, including gum disease or periodontal disease and tooth decay, as well as cracked or broken teeth and tongue and/or inside-cheek pain.[11,12]

The actual cariogenic potential of vaping has not been sufficiently studied. However, a few anecdotal cases of vaping-related rampant caries have been reported, and limited in vitro studies have been conducted. E-liquids and some classes of chemicals in sweet flavors may increase the risk of cariogenic potential.[13] In a case report study by Irusa et al they explain three cases of unusual patterns of dental caries, all of which involved regular vape users.[14] Their findings and clinical considerations indicate that vaping formulations may be highly cariogenic, especially those with sweet flavors. The aerosols created during vaping are thick and viscous, and they may also contain significant amounts of sucrose. Propylene glycol, a carrier product found in e-cigarettes, is particularly toxic to enamel and soft tissue; additionally, it causes tissue desiccation by "dry mouth," which has been linked to an increase in cavities, gum disease, and other oral health issues. Another dangerous component of e-cigarettes is the combination of vegetable glycerin and flavoring agents. As per studies, flavorings and the viscosity of liquids together promote the production of biofilm and microbial adhesion to enamel by two and four times, respectively.[13] Nicotine, a key component of many e-cigarettes, may have a pathogenic role in tooth loss due to its capacity to modify genetic signaling, activate inflammatory pathways, and impair tooth mineralization.[15,16]

Traditional cigarette use is a significant contributor to the development of peri-implantitis and periodontitis.[17] After the emergence of e-cigarettes or vaping was found to be the most prevalent risk indicator for peri-implantitis.[17,18] A more compromised response to peri-implantitis treatment, both clinically and biologically, was found among electronic cigarette.

The e-cigarette has been revealed to have carcinogenic elements, and studies have indicated that when its vapor is inhaled, it alters DNA and disrupts genes in oral cells. The most dangerous type of DNA damage is DNA double-strand breaks, which, if unrepaired, can cause chromosomal rearrangements and possibly result in carcinogenesis. The research indicating that switching

from conventional combustible cigarettes to e-cigarettes lessens overall toxicity is the main source of disagreement in the evidence for e-cigarette-mediated oral carcinogenesis. Some studies suggest that the chemicals are emitted by e-cigarette vapor can cause pathophysiological changes that lead to ulceration or oral cancer.[19] Even though e-cigarettes have a lower toxin content than conventional cigarettes, oral cancer risk may still exist at lower toxin levels. However, the evidence is not sufficient to prove the causal association.

The other reported oral health complications related to vaping or using e-cigarettes are oral mucosal lesions, and dry mouth, which can lead to chronic halitosis, mouth sores, decreased enamel hardness, tooth discoloration, tooth sensitivity, and even tooth decay.[20] E-cigarettes or vaping may have a negative influence on gingival and periodontal health. The detailed pathogenesis and evidence are explained in the following sessions.

Impact of e-cigarettes on periodontitis development

It is well understood that smoking aggravates periodontal disease by allowing pathogenic oral gram-negative bacteria to invade the mouth, resulting in increased dental calculus formation and gingivitis, a leading cause of periodontal disease; this clearly shows how smoking exacerbates periodontal disease.[21] Salivary antioxidant properties are critical when considering anti-cancer properties as well as arising periodontal health conditions. Among e-cigarette users, a decrease in the antioxidant capacity of saliva in comparison to non-smokers to the same extent as smoking traditional cigarettes has been reported.[22] On the oral surface, e-cigarette aerosols cause DNA damage and reduce cellular antioxidant defenses in absence of nicotine.[23] Periodontitis patients have a lower level/decreased efficiency of antioxidant mechanisms, which might be associated with depletion of antioxidants due to chronic inflammation.[24] Even if e-cigarettes were less harmful, they could still lead to development of periodontal diseases through inflammatory effect, cell injury and impaired reparability.[25]

An earlier pilot study that investigated substituting vaping for cigarette smoking for two weeks found a significant increase in bleed on probing and an increases in gingival cervicular fluid volume, even when plaque levels were similar between participant visits.[8] E-cigarette users had greater plaque levels, bone loss, deeper probing depths, a high volume of sulcular fluid, and higher concentrations of inflammatory markers, according to research by Al-Aali et al.[26] An e-cigarette user's periodontal health drastically declined over the course of a cohort trial with a 6-month follow-up.[27] Later reports indicate that smoking-associated periodontal disease is not only true for conventional cigarette or nicotine smokers but also for e-cigarettes. According to Atuegwu et al people who use electronic nicotine products on a daily or weekly basis for a year or more have an increased risk of developing gum disease. The participants also had an increased risk of reporting bone loss around teeth, which is indicative of advanced periodontal disease, according to their study.[28] Roubhia et al reported the adverse effects of e-cigarette vapor on gingival epithelial cells.[29] E-cigarette users are more likely to develop gingival disease (three times) compared to non-users or non-smokers.[30] The use of e-cigarettes or vapes with high nicotine doses increased the risk of periodontal disease.[31] A great addictive factor of e-cigarettes is flavoring, and filling liquids come in great variety. *In vitro* investigations revealed that flavoring from e-cigarettes could cause considerable damage to cell proliferation. According to Willershausen et al menthol e-liquid preparation had significant negative impact on periodontal ligament fibroblasts.[32] Korean study suggests that people who vape or smoke cigarettes demonstrate a higher probability of periodontal disease when compared to both non-users and ex-users.[33] Nicotine contained in many e-cigarette aerosols inhibits proliferation of gingival fibroblasts and human periodontal ligament cells.[34] This is because e-cigarette aerosol produces reactive oxygen species, aldehydes, and carbonyls, which cause DNA adducts and extracellular matrix protein carbonylation. Direct exposure to e-liquids has also been shown to produce harmful effects in periodontal ligament cells and gingival fibroblasts in culture.[32,35]

Emerging evidence shows that e-cigarettes may be hazardous to oral health. Ategwu et al discovered that study participants who used electronic nicotine products on a daily or weekly basis for a year or more had a higher risk of getting gum disease even if they had no prior history of the condition.[28] In a recent well-designed, fully adjusted model that revealed a substantial link between periodontal disease and e-cigarette users, all individuals who considered having periodontal disease and reported bone loss had a greater percentage of e-cigarette users.[36] Periodontal disease risk may be increased if electronic nicotine products are combined with marijuana, and illegal narcotics.[28]

In an in-vitro study, it was shown that vaping with flavorings increases oxidative stress, DNA damage, and levels of proinflammatory cytokines (PGE2 and COX-2) in human periodontal ligament fibroblasts and gingival epithelium.[19] In addition to that, they found that exposure to e-cigarette vapor or aerosol increases the levels of cycloxygenase-2 and prostaglandin-E2, which up-regulate the expression of RAGE in gingival tissue.[19]

E-cigarettes, on the other hand, appear to be less detrimental to oral health than conventional cigarettes, according to some of the existing research. Some research findings noted that periodontal disease symptoms are comparatively lower when compared to conventional cigarette smokers. Javed et al have shown that e-cigarette and vaping individuals may have a periodontal status comparable to non-smokers, and e-cigarette use may not be as hazardous to periodontal health as cigarette smoking. E-cigarette users' levels of pro-inflammatory markers and clinical periodontal status were comparable

to those of nonusers and were much lower than those of tobacco smokers.[37] Supporting evidence is also reported in Mokeem et al these studies assess clinical attachment loss, which would be the measurements of choice to detect periodontitis as suggested by the latest classification. As a result, their findings provided more reliable data on effect of vaping on periodontal disease status.[38] Even though the benefits or value of e-cigarettes as a substitute for tobacco cigarettes are still unknown. In light of certain scientific investigations, there was a progressive improvement in the periodontal indexes in tobacco smokers who switched to e-cigarettes.[39] Further, another investigation by BinShabaib et al did not find a significant difference between e-cigarette users and non-smokers in terms of periodontal inflammation and gingival cellular fluid proinflammatory cytokine levels.[40]

Some confounding variables must be taken into account when analyzing epidemiological research assessing the impacts of e-cigarette usage on oral health. Older people (>60 years old) with a long history of tobacco smoking and vaping are more vulnerable to its health effects. Age-related correlations in earlier studies have confirmed the finding that periodontal disease is more likely to affect men and women as they get older. The majority of the studies covered in this evaluation, however, included young participants. This is because the majority of e-cigarette users are young and do not have a long history of vaping use. It would be more applicable to have a longitudinal approach to investigate how vaping influences the periodontal status of the users over the years. To fully comprehend how vaping affects periodontitis, more studies with a fully adjusted model as well as from different regions are required.

CONCLUSION

This study concluded that there is not sufficient evidence to fully characterize the impacts of vaping on oral health as well as the development of periodontitis. However, within the limitations of our review and selected included studies, available results point to increased destruction of periodontium, leading to development of disease.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Bamani MS, Alkurdi KA, Muqri BT, Tayeb OS, Al-Dehneen HA, Bin Afif KS et al. Effect of e-cigarettes on oral health and the development of periodontitis. Int J Community Med Public Health 2023;10:357-61.