

Relationship between e-cigarette use and oral health: An integrative literature review



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ABSTRACT

The objective of the present study was to detect oral problems associated with the use of electronic cigarettes in the literature. This is an Integrative Literature Review, formulated with the aim of investigating the complications and risks to oral health related to the use of electronic cigarettes. It was based on the protocol for systematic reviews PRISMA Flow Diagram. Data were collected from the Latin American and Caribbean Health Sciences Literature Electronic Database (Lilacs), Medline and Pubmed. Decs/Mesh descriptors were used in the form: “Electronic Nicotine Delivery Systems” OR “Vaping” AND “Oral Health”. 196 works were identified in the bases and only 16 articles remained, which are part of this integrative review. It has been observed that over time, the use of electronic devices can result in periodontal diseases, dental caries, oral infections, and oral cancers, affecting both the functionality and appearance of the stomatognathic system. For this reason, it is essential that the dentist guide patients about the care and prevention necessary to minimize the possible damage caused by electronic cigarettes to oral health.

Keywords: Electronic cigarette, Oral health, Vaping, Electronic Nicotine Delivery Systems.

1 INTRODUCTION

The habit of smoking is recognized as an epidemic disease that causes physical, psychological and behavioral dependence similar to what occurs with the use of other drugs such as alcohol, cocaine and heroin (BRASIL, 2020). Increasingly popularized, the Electronic Devices for Smoking - DEFs, also known as *vape*, *electronic cigarettes*, *pod*, among others, emerged as an alternative to stop the use of conventional cigarettes, but ended up evidencing a major health problem.

According to the Pan American Health Organization (PAHO) indicators for the year 2019, the tobacco epidemic is responsible for the deaths of more than 8 million people per year, with more than 7 million of these deaths resulting from direct tobacco use and more than 1.2 million deaths being the result of non-smokers exposed to secondhand smoke. The institution also states that the new tobacco and nicotine delivery devices pose a threat to the control of the epidemic.



The devices with attractive designs and use of tasty essences, which exude flavored smoke, do not cause bad breath or spread gray and seek to attract, above all, young people, stimulating, in many cases, the duality in the consumption of conventional and electronic cigarettes (BARRADAS *et al.*, 2021).

According to the National Cancer Institute (INCA, 2016), the electronic cigarette device includes: a battery, a liquid storage tank, a resistance responsible for heating the liquid, a wick that absorbs the liquid and a nozzle that is used by the user to inhale the aerosol produced. The liquid contained in the storage tank can contain a variety of substances, including nicotine, flavors, and chemical additives. The resistance is usually made of a high-temperature resistive wire, such as kanthal, and is wrapped in organic cotton to absorb the liquid. The battery is responsible for providing the energy needed to heat the resistance and produce the aerosol.

When the user vacuums the device, a sensor detects the airflow and heats the liquid from the cartridge, causing it to evaporate. The steam releases the nicotine to the user, and a portion of the vapor can be released into the ambient air when the user exhales. The steam temperature reaches 40-65°C. According to information from manufacturers, a cartridge can generate from 10 to 250 jets, which could correspond, depending on the brand, to 5-30 cigarettes (KNORST *et al.*, 2014).

Based on current global evidence, the use of nicotine e-cigarettes increases the risk of a range of health harms, such as: poisoning, seizures, addiction, trauma and burns (caused by explosions) and respiratory diseases (including Severe Acute Respiratory Syndrome – SARS – and Electronic Cigarette-Induced Lung Injury – EVALI) (INCA, 2023)

It becomes practically inevitable the comparison between conventional cigarettes and DEF 's, however, there is little widespread knowledge about the harms of the latter both systemically and restricted to the oral cavity. In this way, there is the concern of researching about the devices in order to list if the damages caused are similar, aggravated or diminished.

In Brazil, the marketing, importation and advertising of all types of electronic devices for smoking are prohibited by the National Health Surveillance Agency, ANVISA, since August 2009 (ANVISA, 2016). In this perspective, it is necessary to understand that the problems surrounding the use of these devices, whether in the social or individual sphere, can have numerous influences on the oral health of users.

The growing popularization of the devices and the false sense of non-malignancy of their effects on the body, especially in the oral region, motivated the researchers to carry out this research.

The objective of the present study is to point out the relationship between the use of electronic cigarettes and oral health, through the identification in the existing literature of the main points that health professionals, especially dentists, need to have knowledge to offer scientifically based information and a more complete treatment for their patients.



2 METHODOLOGY

This is a qualitative and descriptive study, based on database research from the perspective of the integrative review, starting from the following guiding question: What are the risks and complications in oral health associated with electronic cigarettes?

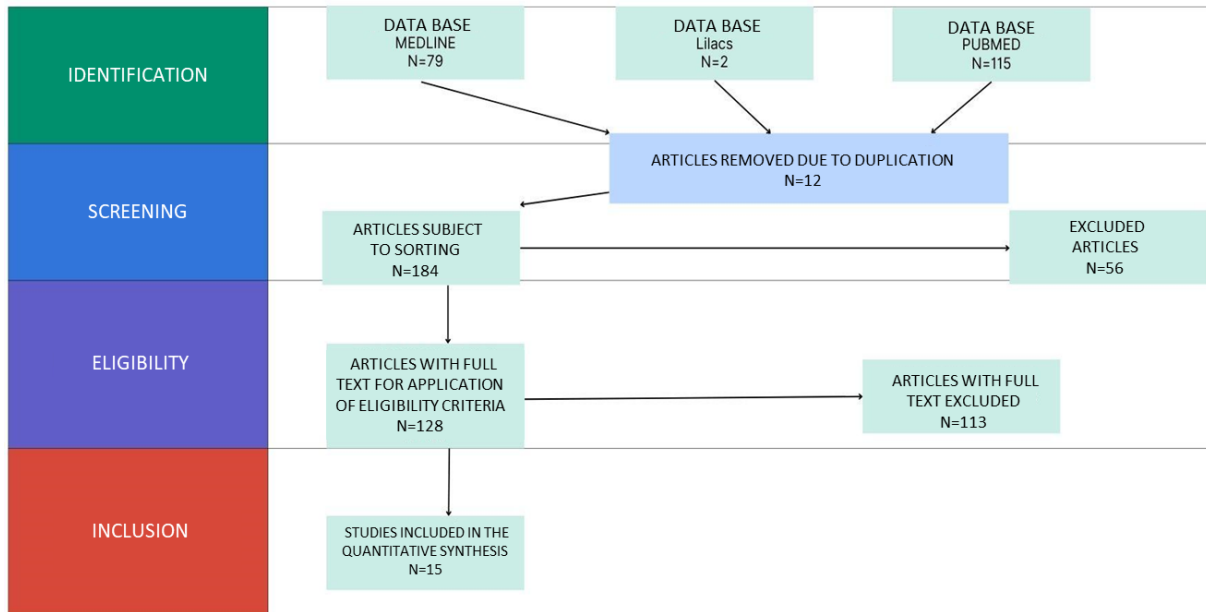
It was necessary to define the data sources to convey reliability for the investigation. The survey was anchored in the protocol for systematic reviews PRISMA Flow Diagram. Data were collected using the Electronic Database of Latin American and Caribbean Health Sciences Literature (LILACS), Medical Literature Analysis and Retrieval System Online (MEDLINE) and PUBMED. The descriptors Decs/Mesh were used in the form: "Electronic Nicotine Delivery Systems" OR "Vaping" AND "Oral Health". The search, reading and selection of scientific articles that interested the theme were carried out.

Thus, the inclusion criteria were: (1) types of productions: original articles, published in full and available electronically; (2) Temporal framework: papers published from January 2018 to December 2022; (3) Languages: Portuguese, English or Spanish. On the other hand, to ensure that only the relevant works were considered, the works denominated as "gray literature" were excluded, as well as those that did not meet the objective of this study, duplicates and those that mixed other pathologies.

A total of 196 works were identified in the databases, where 12 were removed due to duplicity, 56 were excluded because they were not within the established filters and 112 were not in accordance with the intention of this study. Thus, 15 articles remained, upon full reading and which are part of this integrative review, as shown in the diagram below.



Figure 01 - Flowchart of the description of the methodology.



Source: Prepared by the authors.

3 RESULTS AND DISCUSSION

Based on the above, image 1, the studies used in this integrative review are cited in the following table.

Table 01 - List of selected articles according to author, year, type of study, database and category.

Author/year	Type of study	Database	Category
IRUSA <i>et al.</i> (2022)	Cross-sectional study	MEDLINE	Changes in tooth structure
CATALA-VALENTIN <i>et al.</i> (2022)	Laboratory study	MEDLINE	Changes in tooth structure
THOMAS <i>et al.</i> (2022)	Longitudinal study	MEDLINE	Changes in the periodontium
XU <i>et al.</i> (2022)	Longitudinal study	MEDLINE	Changes in the periodontium
VEMULAPALLI <i>et al.</i> (2021)	Cross-sectional study	MEDLINE	Changes in tooth structure
KLAWINSKI <i>et al.</i> (2021)	Case report	MEDLINE	Cellular changes
HONG; MAINOUS (2021)	Cross-sectional study	MEDLINE	Cellular changes
TOMMASI <i>et al.</i> (2019)	Cross-sectional study	MEDLINE	Cellular changes
TOMAR <i>et al.</i> (2019)	Literary review	PUBMED	Changes in tooth structure
ALQAHTANI <i>et al.</i> (2020)	Cross-sectional study	PUBMED	Changes in saliva



EBERSOLE <i>et al.</i> (2020)	Literary review	PUBMED	Cellular changes
PANDARATHODIY IL <i>et al.</i> (2021)	Cross-sectional study	PUBMED	Changes in saliva
CICHOŃSKA <i>et al.</i> (2022)	Cross-sectional study	PUBMED	Changes in saliva
CICHOŃSKA <i>et al.</i> (2019)	Cross-sectional study	PUBMED	Changes in saliva
DE LIMA <i>et al.</i> , (2023)	Cross-sectional study	PUBMED	Cellular changes

Source: Prepared by the authors.

3.1 CELLULAR CHANGES

The *in vitro study* by De Lima *et al.*, (2023) demonstrated in the laboratory how *e-liquid* – also called juice, is a mixture composed of nicotine, flavorings and solvent – can alter oral cells and their implications from a panel of normal oral epithelial cell lines, oral squamous cell carcinoma and mouse oral cancer. The authors point out that this exposure alters the structure and survival of oral epithelial cells, increasing cases of cell death and tumor invasion, and may induce changes consistent with the epithelial-mesenchymal transition, thus increasing the metastatic competence of oral squamous cell carcinoma.

In the same vein, Tommasi *et al.* (2019) aimed to determine the effects of e-cigarette and conventional cigarette use compared to non-smokers from oral epithelial cells to assess cancer-causing potential. They used as a method the collection of these oral cells and the sequential analysis of the collected RNA. In this study, they concluded that e-cigarette users, as well as conventional users, have significant dysregulation of key genes in the oral epithelium converging to cancer-related functions.

Approaching this discussion, the review by Ebersole *et al.* (2020) lists the chemical substances that are emitted and those that can be formed in electronic devices and their effects on the oral cavity. Among them, reactive nitrosamines and carbonyls stand out, with great carcinogenic potentials, in addition to the impurities present in the liquid that, together with the breakage of the wick, can lead to the release of arsenic and silica.

Hong and Mainous (2020) made an association between e-cigarette use and oral human papillomavirus infection from the National Health and Nutrition Examination Survey (NHANES) study between 2013 and 2016 with full oral HPV DNA testing and questions about tobacco use. They resulted in a higher likelihood of HPV-16 infection in dual users, *vape* and conventional cigarettes. From this, they came to the conclusion that there is a significant relevance between electronic and oral HPV-16 infection, responsible for most cases of oropharyngeal cancer.

In this perspective, Klawinski *et al.* (2021) described the case of a previously healthy 19-year-old young adult who presented with an ulcerative lesion of the side of the tongue that did not heal and swelled progressively. The authors provided clinical care and collected the data to describe the case.



The patient, who had an extensive history of e-cigarette use and no other carcinogenic risk factors, developed aggressive and unresponsive HPV-negative squamous cell carcinoma in the oral cavity and underwent total glossectomy, radiotherapy and chemotherapy but developed metastasis.

3.2 CHANGES IN SALIVA

The pilot study by Alqahtani *et al.*, (2020) intended to analyze the modifications present in the saliva of DEF'S users compared to never tobacco users through the evaluation of inflammatory cytokines and metabolite profiles. To this end, they collected salivary samples and applied a questionnaire to both groups. As main results it was evidenced that the users of this product present ongoing inflammation compatible with gingivitis, but the alterations found could be used only to identify risk factors.

The works of Pandarathodiyil *et al.* (2021) and Cichonska *et al.*, (2019; 2022) compared e-cigarette smokers, conventional and non-smokers (control group) for different purposes.

Pandarathodiyil *et al.* (2021) examined the levels of the enzyme lactate dehydrogenase (LDH) among recruits, since it can be used to detect pathologies in the oral mucosa. The research participants were located from an advertisement and after screening their saliva was collected and measured with a calorimetric LDH assay kit to later make the statistical comparisons. In this study, salivary LDH levels in *pod* users were higher compared to the smoking and control group, indicating greater degradation of oral epithelial cells.

On the other hand, Cichonska *et al.* in their 2019 study, aimed to understand the impact of e-cigarettes on the bacterial properties of saliva. In this research, the volunteer participants underwent screening and then saliva was collected for laboratory and statistical analysis. These indicated that IgA levels in vape users were not significantly lower than in the control group and lysozyme levels were also decreased. Lactoferrin levels were increased. Proving that there are changes in the oral environment of vaper smokers.

Approaching this discussion, Cichonska *et al.* In 2022, they intended to study the physicochemical changes of saliva by comparing the 3 groups mentioned. The saliva of the screened participants underwent laboratory tests to check the pH and concentration of proteins, calcium and phosphates. As a result, they noticed that e-cigarette users have altered pH, amount of protein, calcium and phosphates compared to the other two groups.

3.3 CHANGES IN THE PERIODONTIUM

The electronic cigarette is an alternative to traditional tobacco that has gained popularity in recent years among young adults, However, the relationship between EC use and oral health is still little known. Thus, the research conducted by Martell *et al.* (2020) aimed to investigate the knowledge



of EC e-cigarette users about the impact of the use of these devices on oral health. The research was conducted with 220 EC users, who were interviewed in order to evaluate the knowledge and perception about the impact of the use of FB on oral health. The results were analyzed using descriptive and inferential statistics. The results of this research indicate that FB users have little knowledge about the oral problems associated with the use of EC. However, most participants are willing to discuss the effects of vaping on oral health with dental care professionals and would potentially reduce or quit if they believed it was harmful to oral health. These results highlight the importance of user awareness and education about the effects of vaping on oral health.

Clinical studies have also demonstrated an association between e-cigarette use and the presence of signs of inflammation in the periodont. A recent study Thomas SC *et al.*, (2022) compared clinical and demographic measures between e-cigarette users, conventional cigarettes and non-smokers, and found that the progression of periodontal severity was significantly worse for e-cigarette users and conventional cigarettes than for non-smokers.

In addition, e-cigarette use may promote a healthier microbiome compared to conventional cigarette smokers, but not as healthy as that of nonsmokers. According to the study Xu *et al.* (2022) in order to investigate the effect of e-cigarette vapor on the structures of the saliva bacterial community, performed with 101 patients with periodontitis. The results showed that e-cigarette users showed enrichment of bacteria of the genera *Dialister*, *Selenomonas* and *Leptotrichia*, which were correlated with high levels of pro-inflammatory cytokines, including IFN- γ , IL-1 β and TNF- α , thus contributing to oral microbiome dysbiosis and disease progression.

E-cigarettes are often promoted as a healthier alternative to traditional tobacco, but recent studies indicate that it can have detrimental effects on oral health, including the periodont. E-cigarette vapor contains a variety of chemicals, such as glycerin, propylene glycol, nicotine in varying concentrations, and flavoring agents, these toxic compounds can affect periodontal tissue and the oral microbiota Thomas SC, *et al.* (2022).

However, it is relevant to note that there is no consensus in the scientific literature about the effect of electronic cigarettes on the periodont. The peculiarity of the periodontal microbiome of the electronic cigarette reinforces the need for further research on this relatively new microbial community, resulting from the adoption of a recent human habit. It is necessary to investigate how biotic and abiotic components act synergistically in oral health and disease to better understand this relationship.

3.4 CHANGES IN TOOTH STRUCTURE

Tooth decay is a multifactorial disease that involves a complex interaction between the oral microbiota, diet, host, and environmental factors. Recently, the use of e-cigarettes has become popular



as a safer alternative to smoking. However, studies have shown that e-cigarettes can pose risks to oral health, including the association with tooth decay.

A systematic review study conducted by Irusa, *et al.* (2022) evaluated the relationship between e-cigarette use and tooth decay. The authors concluded that e-cigarette use is associated with a higher prevalence of tooth decay. According to research conducted by Xu, *et al.* (2022) the results obtained indicated that flavored essences, compared to unflavored ones, are more harmful to biofilm formation and the growth of oral commensal bacteria. This may be related to the presence of sugars and other additives in e-cigarette liquids, which can be fermented by oral bacteria, leading to the production of acids that erode tooth enamel.

In addition, a study by Thomas SC, *et al.* (2022) showed that e-cigarette vapor can affect the integrity of the dental biofilm and increase the adhesion of oral bacteria to the surface of teeth. This can contribute to the development of tooth decay and other oral diseases. In this sense, the research conducted by Abhilash Vemulappalli, *et al.* (2021) indicates that it is possible to observe a correlation between the use of vaporizers and double smoking with an increase in the prevalence of untreated dental caries.

However, the lack of regulation on the composition of e-cigarette liquids makes it difficult to assess the long-term effects of their use.

4 CONCLUSION

Based on the presented studies of current research and discussions on the effects of e-cigarette use on oral health, a number of symptoms from microscopic to macroscopic levels are observed, affecting not only oral health, but also adjacent systems regarding excessive e-cigarette use. Therefore, it is crucial to highlight that this review offers a comprehensive view of the harms caused by the use of e-cigarettes, which can include from cellular changes, problems in saliva, in the periodont, to the evolution to oral cancer.

The importance of health professionals addressing the subject during interventions in school environments, colleges, medical and dental consultations is highlighted, raising awareness and encouraging the reflection of individuals about the damage to physical and oral health caused by the consumption of electronic cigarettes and other tobacco products and that they are encouraged to seek safer alternatives. In addition, future studies should be conducted to investigate the specific changes associated with e-cigarette use on systemic and oral health, as well as to compare the effects of e-cigarette and conventional cigarette use.

Given all this information, it is important to emphasize the relevance of this study for public health, since it provides important evidence for decision-making about the use of e-cigarettes and the prevention of their harmful effects on oral and systemic health. In this sense, this investigation



contributes to the advancement of scientific knowledge on the subject, as well as to the awareness of the population about the risks associated with the use of electronic cigarettes.



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