REVIEW
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Electronic Cigarettes: A Growing Threat of Oral Squamous Cell Carcinoma in Young Adults?

Thayná Assencio Pereira Aguiar[1], Raianny de Souza Santos[1], Sara Rocha Moraes Sousa[1], Anna Clara de Matos Marçal[1], Isnaya Almeida Brandão Lima[2], Ana Cláudia Garcia Rosa[3]

[1]Department of Dentistry, Afya Faculty of Medical Sciences, Tocantins, Brazil
[2]Department of Public Health, Afya Faculty of Medical Sciences, Tocantins, Brazil
[3]Department of Oral Pathology, Federal University of Tocantins, Tocantins, Brazil

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Abstract

Electronic cigarettes are widely used by young adults, yet their impact on oral health, specifically in the context of oral squamous cell carcinoma (OSCC), is poorly understood. This study aimed to evaluate the association between e-cigarette use and OSCC incidence in young adults. An integrative literature review was conducted using the PICO framework. Databases, such as PubMed and Google Scholar, were searched for studies published between 2020 and 2024. Observational studies, controlled trials, systematic reviews, and meta-analyses were included. Quality assessment was performed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool. This review found evidence of DNA damage, cellular changes, and increased cell proliferation associated with e-cigarette use, which may contribute to the development of OSCC. However, these studies have shown mixed results regarding the direct increase in OSCC incidence, indicating the need for further research. In conclusion, while there is some indication of the carcinogenic potential of e-cigarettes, further research is necessary to establish a definitive link. This review supports the need for stricter regulations and increased awareness of the risks associated with e-cigarette use among young adults. Public health policies should reflect these findings to reduce the risks associated with vaping.

Keywords: Oral squamous cell carcinoma, electronic cigarettes, young adults, oral health, risk assessment

INTRODUCTION

Oral cancer poses a major global public health challenge. Among the various types of malignant tumors affecting the oral cavity, oral squamous cell carcinoma (OSCC) is the most prevalent, accounting for approximately 90% of all malignant lesions in the oral cavity.[1]

OSCC is the most common form of oral cancer and is characterized by its high potential for metastasis and significant aggressiveness. It accounts for 90%-95% of all oral cancer diagnoses. Predominantly, this cancer affects men aged 50-65 years. According to the National Cancer Institute of Brazil, there are approximately 15 100 new cases of oral cavity cancer in Brazil between 2023 and 2025, with an incidence of 6.99 per 100 000 inhabitants.[2] A total of 10 900 cases are expected to occur in men and 4200 in women, corresponding to an incidence rate of 10.30 per 100 000 in men and 3.83 per 100 000 in women. Oral cavity cancer is the eighth most common type of cancer in Brazil. Worldwide, its incidence is 4.53 per 100 000 men and 1.96 per 100 000 women in the northern region.[2]

The etiology of OSCC is strongly linked to environmental and behavioral factors.[1,2] Smoking in all forms, whether combined with chronic alcohol consumption, is one of the main risk factors for the development of this form of cancer. In the oropharynx, the presence of the human papillomavirus (HPV), especially type 16, plays a significant role in the pathogenesis

Corresponding author: Anna Cláudia Garcia Rosa, e-mail: anaclaudiagarcia@uft.edu.br

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of the disease. In addition, prolonged exposure to ultraviolet radiation, which is common in individuals exposed to the sun for long periods without adequate protection, is associated with OSCC of the lips. Other factors, such as a diet low in fruits and vegetables, poor oral hygiene, and genetic predisposition, can also increase this risk.[1,2] This variety of influences highlights the complexity and multifactorial nature of the etiology of this lesion.

However, recent research has indicated a significant increase in the incidence of OSSC in young patients, specifically in the 18-45 age group.[3,4] One of the probable reasons for the increase in the incidence of this neoplasm in this age group may be related to the use of electronic cigarettes, popularly known as "vaping," "e-cigs," and "pods."[5] These devices were introduced in the market as a less harmful alternative to traditional cigarettes and as a measure to prevent smoking. Consisting of a battery, heating coil, wick, and an e-liquid cartridge, as well as a mouthpiece for inhalation, electronic cigarettes are designed to vaporize nicotine and flavorings containing chemicals such as propylene glycol and glycerin. The user inhales the resulting vapor, which is aerosol.

Although the sale and use of e-cigarettes have been banned in Brazil since 2009 by the National Health Surveillance Agency, the consumption of these devices in this country quadrupled between 2018 and 2022.[6] Data from the Intelligence in Research and Consulting (IPEC) shows that 2.2 million adults used these products illegally, a substantial increase from 0.3% in 2018. In addition, approximately 6 million adult smokers have tried e-cigarettes, representing 25% of all industrial cigarette smokers, marking a 9% increase since 2019.[6] This increase is attributed to the lack of control over the composition and origin of the devices, and the ineffectiveness of the ban without proper regulation to control the market.[6] Thus, there is a growing focus on the damage to oral health caused by these devices, highlighting the importance of research on the effects of e-cigarettes.

Given these factors, this study aimed to investigate the potential impact of e-cigarette use on the prevalence of OSSC, with a special focus on young adults. The justification lies in the growing concern about the incidence of OSSC in an age group that was previously less affected, as well as the need to understand the impact of e-cigarette use in this context.

MATERIAL AND METHODS

This integrative literature review was conducted to synthesize the main results of studies on the effects of e-cigarette use on OSCC incidence in young adults. The process began with the formulation of a research problem to verify the relationship between e-cigarette use and OSCC prevalence in young adults. The research question, formulated following the PICO strategy, was: "In young adults (P), what is the impact of exposure to electronic cigarettes (I), compared to non-exposure (C), on the incidence of OSCC (O)?" To collect data, PubMed and Google Scholar databases were used, with a search strategy that included the descriptors "Squamous Cell Carcinoma," "Young Adult," "Electronic Nicotine Delivery Systems," and "E-cigarettes and Oral Carcinoma" in English and Portuguese. These descriptors were combined using Boolean operators, and language filters were applied to ensure coverage in both languages. All the articles considered for this review were published between 2020 and 2024. Case reports, observational studies (including cohort, case-control, and cross-sectional studies), randomized controlled clinical trials, systematic reviews, meta-analyses, and qualitative studies exploring perceptions and experiences related to e-cigarette use were included. Short communications and commentaries were also included to provide expert insights and context. Editorials, letters to the editor, duplicate studies, and studies that did not focus on the research topic were excluded. The inclusion criteria were peer-reviewed articles, studies involving young adults, and research on the link between e-cigarette use and squamous cell carcinoma. The exclusion criteria were non-peer-reviewed articles, and studies on other types of cancers. This information is detailed in the flow diagram of this study (Figure 1). In addition to the 24 studies included in the primary analysis, as outlined in the flow diagram and Table 1, additional documents and articles were referenced to provide a complementary context and enhance conceptual discussion. These articles were not part of the formal selection process but were instrumental in broadening the understanding of key concepts. The included studies were assessed for methodological quality using the

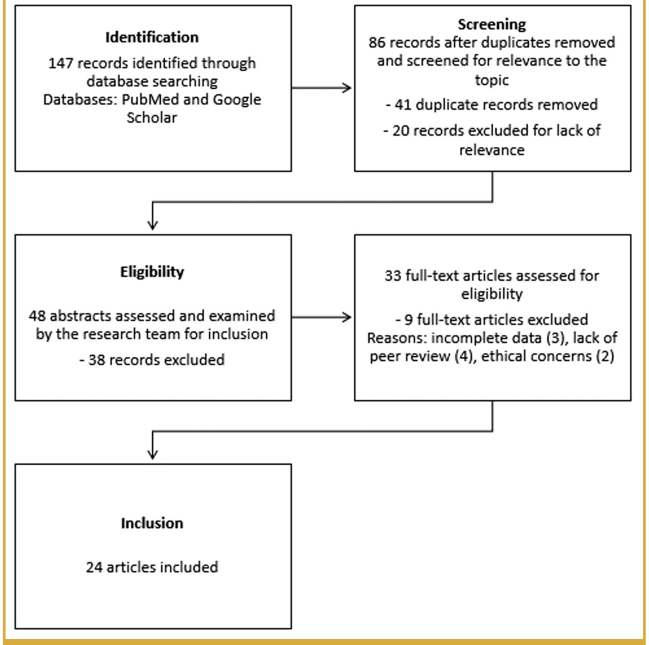

Figure 1. Flow diagram for study selection process.

Table 1. Studies on the Effects of Electronic Cigarettes on Oral Health

Year	Author(s)	Kind of Study	Main Results	Key Takeaways
2020	Rao et al.[7]	Literature review	Health risks associated with electronic cigarettes, including toxic substances	Support banning e-cigarettes due to long-term health risks
2021	Klawinski et al.[8]	Case report	Diagnosis of squamous cell carcinoma on the tongue in a frequent user	More research is needed to confirm the association with oral cancer
2021	Sultan et al.[9]	Literature review	Lack of definitive evidence on oral health implications of electronic nicotine delivery systems, including carcinogenesis	Importance of longitudinal studies to understand the effects on oral health
2021	Zhou et al.[10]	Experimental research	Increased nicotine deposition and carbonyl levels with higher voltage	Health risks caused by electronic cigarettes, influenced by voltage and composition
2021	Manyanga et al.[11]	Experimental research	Increased resistance to chemotherapy in cancer cells exposed to aerosols	E-cigarettes can increase resistance to chemotherapy
2022	Garcia et al.[12]	Literature review	Popularization of use among young people due to aromas, flavors, and marketing	Necessary prevention strategies for young people and awareness by dental surgeons
2022	Lisboa et al.[3]	Cross-sectional study	High incidence of squamous cell carcinoma among smokers and alcohol consumers	Importance of prevention, early diagnosis, and effective treatment
2022	Ying et al.[13]	Cross-sectional study	No significant changes in the lung microbiome of e-cigarette users	E-cigarette toxicity may not significantly affect lung microbiota
2022	Martins et al.[14]	Systematic review	Analysis of the epidemiological profile of electronic cigarette users	Need for targeted interventions for young users
2023	Cameron et al.[15]	Short communication	Deleterious effects of vaping on oral health and possible risks of oral cancer	Controversial perception about the safety of electronic cigarettes and the need for more evidence
2023	Abbott et al.[16]	Literature review	Association of electronic cigarettes with cardiovascular, respiratory, and immunological health problems	Need for more research on safety compared to conventional cigarettes
2023	Guo & Hecht[17]	Systematic review	DNA damage in oral cells and genotoxicity	Association with oral DNA damage and need for more extensive research
2023	Auschwitz et al.[18]	Literature review	Effects of vaping on various cellular functions and tumorigenic potential	Uncertain long-term effects, need for more studies on tumorigenesis
2023	Lima et al.[19]	Preclinical research	E- liquid promotes cell proliferation and morphological changes	Tumorigenic potential of e-liquids, promotion of malignant characteristics
2023	Soares Borges et al.[20]	Integrative review	Etiological factors in the development of oral squamous cell carcinoma	Importance of the role of the dental surgeon in early detection and education about the risks of oral cancer
2023	Amaral et al.[21]	Literature review	Carcinogenic effects of components of electronic nicotine delivery systems and disruption of the oral microbiome	Risks to oral health, need for long-term studies
2023	Lohner et al.[22]	Observational study	Perception of dependence on electronic cigarettes and associated factors	Indication of limited but relevant dependence on electronic cigarettes
2023	Pilati & Pilati[23]	Experimental research	Effects of e-cigarette liquid on cell proliferation and motility	Promotion of invasive and aggressive characteristics in cancer cells
2023	Keller-Hamilton et al.[24]	Clinical trial	Impact of label descriptors on perceived harm from electronic cigarettes	Significant influence of labels on young people's perceptions of risks
2024	Gallagher et al.[25]	Literature review	Presence of carcinogenic compounds in saliva and cellular changes in users	Limited and insufficient evidence to confirm risks of oral cancer
2024	Chhina[26]	Comment	Evidence of DNA damage and genotoxicity in users' oral cells	Need for more research and education on oral health risks
2024	Cameron et al.[27]	Literature review	Popularity and lack of comprehensive evidence on oral health impacts	Need for long-term studies to better understand the risks to oral health
2024	Avelar et al.[28]	Literature review	Variable composition of electronic cigarettes and potential negative effects on oral health	Greater regulation and more studies on long-term impacts were suggested
2024	Cheng[29]	Protocol for a case-control study	Study proposal to investigate the damage caused by electronic cigarettes to the oral mucosa	Study designed to explore associations between vaping and oral injuries in youth

Joanna Briggs Institute (JBI)[30] critical appraisal checklist (Table 2). Each study was evaluated against the relevant criteria, and studies that met at least 70% of the applicable criteria were included. Short communications and commentaries were not subjected to the same rigorous quality appraisal, owing to their narrative nature and lack of empirical

Table 2. JBI Critical Appraisal Checklist for Different Studies Used in this Integrative Review

Reviews (When Applicable) and Systematic Reviews					
Domain	**Question**	**Y**	**N**	**U**	**N/A**
1	Is the review question clearly defined?				
2	Were the inclusion criteria appropriate?				
3	Was the search strategy adequate?				
4	Were the sources and resources used to search for studies adequate?				
5	Were the criteria for appraising studies appropriate?				
6	Was critical appraisal conducted by 2 or more reviewers independently?				
7	Were there methods to minimize errors in data extraction?				
8	Were the methods used to combine studies appropriate?				
9	Was the likelihood of publication bias assessed?				
10	Were recommendations for policy and/or practice supported by the reported data?				
11	Were the specific directives for new research appropriate?				
Case Report Studies					
Domain	**Question**	**Y**	**N**	**U**	**N/A**
1	Were patient's demographic characteristics clearly described?				
2	Was the patient's history clearly described and presented as a timeline?				
3	Was the current clinical condition of the patient on presentation clearly described?				
4	Were diagnostic tests or assessment methods and the results clearly described?				
5	Was the intervention(s) or treatment procedure(s) clearly described?				
6	Was the post-intervention clinical condition clearly described?				
7	Were adverse events (harms) or unanticipated events identified and described?				
8	Does the case report provide takeaway lessons?				
Case Control Studies					
Domain	**Question**	**Y**	**N**	**U**	**N/A**
1	Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?				
2	Were cases and controls matched appropriately?				
3	Were the same criteria used for the identification of cases and controls?				
4	Was exposure measured in a standard, valid, and reliable way?				
5	Was exposure measured in the same way for cases and controls?				
6	Were confounding factors identified?				
7	Were strategies to deal with confounding factors stated?				
8	Were outcomes assessed in a standard, valid, and reliable way for cases and controls?				
9	Was the exposure period of interest long enough to be meaningful?				
10	Was appropriate statistical analysis used?				
Experimental Research					
Domain	**Question**	**Y**	**N**	**U**	**N/A**
1	Was the allocation to treatment groups randomized?				
2	Were participants and those administering the interventions blinded to treatment group allocation?				
3	Were the groups treated identically other than the named interventions?				
4	Were the outcomes measured in the same way for the treatment groups?				
5	Was the follow-up period sufficiently long to detect an effect?				
6	Were the statistical methods used appropriate?				
7	Was the intervention clearly described and standardized?				
8	Were the results reliable and valid?				
9	Were all participants accounted for at the conclusion of the study?				
10	Were adverse events or side effects reported and managed appropriately?				

N, no; N/A, not applicable; U, unclear; Y, yes.

data. Two experienced reviewers conducted the methodological quality assessment. Reviewer 1 was a researcher and clinical oral pathologist with 16 years of experience in the field. Reviewer 2 was a clinician and researcher in public health with 10 years of experience. Discrepancies between reviewers were resolved through discussion and consensus, or by consulting a third reviewer when necessary.

Data from the included studies was analyzed using Microsoft Excel. This analysis primarily focused on identifying qualitative similarities and differences across studies. The approach involved thematic synthesis, in which data was categorized based on common themes related to the impact of e-cigarette use on OSCC incidence. This method provides a comprehensive overview of aggregated findings and facilitates a deeper understanding of the effects of e-cigarette exposure.

RESULTS

Epidemiological Profile of Electronic Cigarette Users

A systematic review conducted by Martins et al.[14] revealed that e-cigarettes are especially popular among young adults, who represent the majority of users. This remarkable increase in popularity suggests an emerging challenge in public health campaigns. In parallel, Lisboa et al.[3] explored the relationship between e-cigarette use and risk behaviors such as alcohol consumption and traditional smoking. The authors highlighted the difficulty in attributing the risk of developing OSSC exclusively to e-cigarette use, indicating the need for more targeted studies to elucidate these complex interactions.

Evidence of Carcinogenic Potential

Raj et al.[9] and Auschwitz et al.[18] identified carcinogens in e-cigarette vapors that can cause significant DNA damage. Experimental studies by Zhou et al.[10] and Lima et al.[19] have documented how nicotine and other aldehydes in vapors can induce cell proliferation and epithelial-mesenchymal transition, which are critical processes in carcinogenesis. Pilati and Pilati[23] expanded on these findings by observing that e-liquids from e-cigarettes also promote morphological changes in cells that can facilitate the emergence of tumor processes. Guo and Hecht[17] added that exposure of cells to e-liquids results in oxidative stress and additional DNA damage, further increasing carcinogenic risks.

Impacts on Microbiomes

Ying et al.[13] studied the effects of e-cigarette use on pulmonary and oral microbiomes. They found that while the lung microbiome of e-cigarette users showed no significant changes compared to that of non-smokers, the oral microbiome exhibited changes that may have long-term implications for oral and systemic health. The possible effects of the components of electronic nicotine delivery systems (ENDS) and disruption of the oral microbiome were corroborated by Amaral et al.[21] These findings suggested that the impact of vaping may be specific to body systems and that more research is needed to fully understand these findings.

Exposure Biomarkers in Users of ENDS

Exposure biomarkers are substances present in tobacco products or their metabolites that can be measured in biological samples, such as serum, urine, and saliva. These biomarkers help to identify and assess health risks arising from the use of tobacco products, including electronic nicotine delivery systems (ENDS). Combustible tobacco products generate smoke inhaled by users, which contains substances such as carbon monoxide (CO), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs). These compounds have been detected in various biological samples. ENDS emit aerosols containing nicotine, metals, VOCs, PAHs, tobacco-specific nitrosamines (TSNAs), and aldehydes.[31] The concentrations of toxic substances in ENDS aerosols are generally lower than those found in cigarette smoke. ENDS users typically have lower VOC biomarker concentrations than users of combustible tobacco products.[31] A study comparing ENDS users and non-users found significantly elevated levels of several biomarkers in the urine of ENDS users ($P < .05$).[31] These results include increased levels of cotinine (a nicotine metabolite associated with tobacco addiction), total nicotine equivalents (TNE; indicating cumulative nicotine exposure), NNAL (4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol, a primary metabolite of the carcinogen NNK), 2CyEMA (*N*-acetyl-S-(2-cyanoethyl)-L-cysteine, a metabolite of the carcinogen acrylonitrile), 1-hydroxypyrene (a metabolite of PAH), and toxic metals, such as lead and cadmium.[13] The same study comparing ENDS users with cigarette smokers found significantly lower levels of several biomarkers in ENDS users ($P < .05$),[13] indicating reduced exposure to these substances among ENDS users. Biomarker concentrations in ENDS users were lower than those in cigarette smokers but higher than those in non-users, highlighting the greater exposure to harmful substances among ENDS users compared to non-users.

Clinical Aspects

A case study by Klawinski et al.[8] reported a young frequent e-cigarette user who was diagnosed with fatal OSSC on the tongue, highlighting the potential risks of malignancy associated with prolonged use of these devices. In addition, Manyanga et al.[11] found evidence that e-cigarette use can increase the resistance of neoplastic cells to chemotherapy, making cancer treatment more difficult for users.

Role of Dentistry

Dentists play an essential role in the prevention and early diagnosis of such neoplasms. During regular appointments, these professionals perform meticulous anamnesis and detailed intraoral examinations, looking for and biopsying suspected lesions. In cases where the diagnosis of OSCC is confirmed, the dentist manages the patient's oral health, particularly during chemotherapy or radiotherapy. In this context, a multidisciplinary team ensures that patients receive better treatment and assistance for complications arising from the disease.[11]

Recommendations for Health Policies
Studies by Auschwitz et al.[18] and Lima et al.[19] have highlighted the importance of developing public health policies based on sound scientific evidence. They suggested that stricter regulations are needed to control the composition of e-cigarettes and to inform users about their risks. Avelar et al.[28] suggested greater transparency in disclosing e-liquid components to ensure that users are fully aware of the potential risks.

Need for Conclusive Evidence
Gallagher et al.[25] and Sultan et al.[9] highlighted the lack of conclusive evidence regarding the effects of e-cigarette use on oral health. Cameron et al.[27] also emphasized the importance of continuing to explore the topic to provide accurate guidance to patients, particularly regarding the risk of developing OSSC.

Additional findings from the present review are summarized in Table 2.

DISCUSSION

OSSC, which accounts for approximately 90% of all malignant lesions in the oral cavity, has a high potential for metastasis and is highly aggressive.[1,2] In Brazil, it is responsible for 90%-95% of the diagnoses of malignant oral lesions,[1,2] with an increase in incidence in young adults, which highlights the need to understand the associated risk factors, including new behaviors, such as the use of e-cigarettes.

An e-cigarette is a battery-operated device that enables nicotine inhalation through vapor and is classified as an Electronic Nicotine Delivery System (ENDS). These devices, including vapes, e-hookahs, e-pipes, and e-cigars, heat a liquid composed of propylene glycol and/or glycerine to create vapor.[32] They offer various flavors and nicotine levels but do not contain tobacco. ENDS are categorized by generations: first-generation "cigalikes" with disposable cartridges, second-generation vape pens with refillable tanks, third-generation mods with adjustable power settings, and fourth-generation pod systems using nicotine salts for smoother delivery.[33]

The emergence of new habits, such as the use of e-cigarettes, requires attention. Recent studies have reported an increase in the incidence of OSCC among younger adults, a previously less affected age group, which is potentially related to vaping. Martins et al.[14] found that most e-cigarette users belong to this demographic group, highlighting the increasing popularity of these devices among young adults. Several studies have highlighted significant knowledge gaps that require additional research to better understand the effects of e-cigarettes on the increased incidence of OSCC in this specific group. This observation underscores the importance of investigating the contribution of these devices to oral carcinogenesis.

Although direct emissions from e-cigarettes have been well studied, secondhand and thirdhand aerosol exposures in indoor environments are less understood. Direct smoke or first-hand smoke is inhaled by users of tobacco products. Secondhand smoke, or passive smoke, is smoke exhaled by a smoker or emitted from the burning end of a cigarette and can be inhaled by people. Thirdhand smoke refers to the residual nicotine and other chemicals left on indoor surfaces by tobacco smoke. Son et al.[34] measured the indoor air quality in vapor shops and found significant increases in particulate matter (PM2.5), formaldehyde, acetaldehyde, and nicotine during operational hours. Surface analysis revealed substantial nicotine and nitrosamine deposits, indicating that thirdhand exposure from e-cigarette use is comparable to or higher than that from cigarette smoking.[34] These findings underscore the need for further research and regulatory measures to address secondhand and thirdhand aerosol exposure, especially to protect vulnerable populations such as children.

The use of e-cigarettes is strongly associated with potential carcinogenic effects in the oral mucosa. Auschwitz et al.[18] identified carcinogenic compounds in the vapors of these devices, highlighting the risks of DNA damage and gene deregulation, which can induce oncogenesis in oral mucosal cells. Zhou et al.[10] and Lima et al.[19] provided experimental evidence that nicotine and aldehydes present in these vapors can cause cellular alterations, such as increased proliferation and epithelial-mesenchymal transition, which are important mechanisms in inducing cellular carcinogenesis. These findings are corroborated by Pilati and Pilati,[23] who observed that in addition to vapors, e-liquids from electronic cigarettes can favor epithelial-mesenchymal transition in cells. Additionally, Lima et al.[19] found that exposure to e-liquid could promote cell proliferation and growth in oral carcinoma cells, indicating its potential to increase the aggressive phenotype of pre-existing malignant cells. Guo and Hecht[17] emphasized the induction of oxidative stress and DNA damage caused by e-cigarette vapors in oral cells, underlining the risks of genotoxicity and carcinogenic effects. In addition, concerns regarding chemotherapy resistance in cancer cells exposed to e-cigarette aerosols were raised by Manyanga et al.,[11] underscoring the negative effects of these devices on OSCC treatment. These findings highlight the complex effects of e-cigarettes on oral mucosal cells and potential risks of carcinogenesis, reinforcing the need for a more comprehensive understanding of the influence of these devices on oral oncogenesis.

It is important to recognize that there are divergent views in the literature. Gallagher et al.[25] and Sultan et al.[9] suggested the need for more robust and long-term investigations to generate definitive evidence on the health implications of e-cigarette use and its relationship with oral carcinogenesis, which has been corroborated by additional studies.[15,16] The prevalence of risk behaviors, such as the use of alcohol and tobacco, among young people makes it difficult to

directly attribute the risk of developing OSCC solely to the use of e-cigarettes.[3] This gap reinforces the need for further research to clarify the potential risk of OSCC development associated with the use of these devices.

The variation in the composition of e-cigarettes, as observed by Avelar et al.,[28] suggests the need for stricter regulations to ensure user safety and raise awareness of the potential effects on oral health. Another critical point is the limited but relevant perception of e-cigarette addiction, as noted by Lohner et al.[22] This highlights the importance of targeted prevention strategies, especially among young adults, who constitute the predominant demographic group of e-cigarette users.[8] The role of dental surgeons in the early detection and prevention of OSSC is fundamental, emphasizing the importance of continuous training, which includes recognizing the risks associated with the use of these devices. During regular consultations, these professionals are on the frontline to identify alterations in the oral mucosa that may suggest the onset of OSSC, stressing the need to be updated on all risk factors, including emerging ones.

When comparing ENDS and conventional smoking, combustible tobacco products' CO, VOCs, and PAHs in smoke inhaled by users can be detected in diverse biological samples such as serum, urine, and saliva. In contrast, ENDS emit aerosols containing nicotine, metals, VOCs, PAHs, tobacco-specific nitrosamines (TSNAs), and aldehydes.[30] ENDS users typically have lower VOC biomarker concentrations than those of tobacco products and fuels. Thus, a biological sample that is positive for nicotine metabolites and negative for combustion biomarkers suggests the use of ENDS or other noncombustible nicotine products.[30] Although biomarkers used in ENDS studies include nicotine metabolites, TSNAs, PAHs, VOCs, and metals, there are still no specific biomarkers for ENDS due to the presence of these compounds in other tobacco products and environmental sources.[30] Additionally, levels can vary significantly depending on the device settings, solvent type, and user behavior. Biomarker concentrations in ENDS users were lower than those in cigarette smokers but higher than in non-users.[30] Further research is needed to validate exposure biomarkers in biological samples and to establish thresholds within different biological matrices for the biochemical validation of ENDS usage status.[30]

Auschwitz et al.[18] and Lima et al.[19] highlight the importance of informed and evidence-based public health policies to address the potential risks of e-cigarettes, including their possible role in inducing carcinogenic processes. The ban on e-cigarettes in Brazil since 2009 and the significant increase in their illegal use highlight flaws in the current regulations and control of these devices. This scenario highlights the need for more robust public health policies that not only effectively regulate these devices but also promote awareness campaigns about the risks associated with their use.

Given the increasing incidence of OSSC among young people and the complex interactions between traditional and emerging risk factors, further research should explore these relationships. Furthermore, the scientific community and the government must work together to develop effective prevention strategies and public health policies that address both traditional and emerging ones.[20] The research proposed by Cheng in 2024[29] to assess the association between vaping and oral injuries in young people reflects the continuing concern about the potential risks of e-cigarette use and the urgency to provide concrete evidence to guide public health policies.

Research on the role of e-cigarettes in OSCC incidence in young adults has revealed a complex and multifaceted panorama. Despite growing evidence demonstrating the carcinogenic effects associated with the use of these devices, the literature still contains significant gaps that complicate definitive conclusions. These studies strongly suggest that compounds present in vapors and e-liquids induce oncogenesis in the cells of the oral mucosa; however, the interaction of these factors with other risk behaviors, such as alcohol and tobacco use, still requires more detailed evaluation. In addition, the variation in the composition of e-cigarettes indicates the urgency for stricter regulations to protect users, especially young people, who comprise the predominant demographic group. The development of informed and evidence-based public health policies is essential to minimize the risks identified and to educate the population. Therefore, it is imperative that the scientific community continue to investigate these issues in depth. Only through long-term research will there be an understanding of the impact of e-cigarette use on oral health and the development of effective prevention and treatment strategies. Collaboration among researchers, policymakers, and health professionals is essential to address this challenge and protect public health in the future.

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