Continued e-cigarette use and oral health: A critical review of the literature

Michelly Cauás de Queiroz Gatis
Dr. student in Oral and Maxillofacial Surgery at the Faculty of Dentistry of the University of Pernambuco - UPE, Recife-PE, Brazil
E-mail: michelly.cauas@upe.br

Adriana da Costa Ribeiro
Dr, Assistant Professor at Centro Universitário UNIFBV | Wyden, Recife-PE Brazil
E-mail: ribeiroac@gmail.com

Milton Halyson Benevides de Freitas
Dr. student in medicine at UFPE, Master in medicine at Imip, Recife-PE. Brazil
E-mail: miltonhalyson@gmail.com

Analice Kethura de Melo Alves
Graduated in Dentistry from Centro Universitário UNIFBV, Recife-PE, Brazil
E-mail: akethura@gmail.com

Maria Dayanne Ramos dos Santos
Graduated in Dentistry from Centro Universitário UNIFBV, Recife-PE, Brazil
E-mail: daysnts@hotmail.com

Jerlúcia Cavalcanti das Neves Melo
Dr, in Dentistry - Public Health, University of Pernambuco - UPE, Recife-PE, Brazil
E-mail: jerlucia@hotmail.com

Marcio Handerson Benevides de Freitas
Graduating in Medicine at FMO - Faculty of Medicine of Olinda, Olinda-PE, Brazil
E-mail: marcio.handerson@outlook.com

Carlos Augusto Pereira do Lago
Dr. Associate Professor at the University of Pernambuco - UPE, Recife-PE, Brazil
E-mail: carlos.lago@upe.br

ABSTRACT
The use of devices such as electronic cigarettes has become an object of common use and can cause harm to the health of the individual and the community. Objective: To identify the impact of continuous use of electronic cigarettes on oral health through a critical review of the literature. Methodology: The following guiding question was asked: "Does the continuous use of electronic cigarettes cause damage to the oral cavity?". The survey was conducted until May 2023 without language restriction in the MEDLINE/PubMed, Web of Science, Embase, and manual search databases with the PRISMA 2020 guidelines. Results: The continuous use of nicotine-rich e-cigarettes caused a higher rate of plaque, gingival bleeding and depth of the pouch on probing, only when compared to non-smokers. Conclusion: In the present literature, there was no agreement among the authors about a greater harm to oral health resulting from the use of electronic cigarettes. However, due to the notifications of possible impairments to the individual's health, studies are being carried out with long-term evaluations.

Keywords: Electronic Nicotine Delivery Systems, Electronic Cigarette Vapor, Mouth.

1 INTRODUCTION

The electronic cigarette (EC), better known as "pod", "e-cigs", "e-cigarettes" or "vape", has become an object of use all over the world. This battery-powered device can generate vapor from essences of organic origin, flavorings and nicotine. They come in various models, formats and colours (VARGAS et al., 2019).

However, the legalization of the use of EC has presented obstacles in some countries, such as Brazil, which since 2009, advertising, commercialization and importation have been prohibited by Resolution No. 46/2009 of the National Health Surveillance Agency (ANVISA, 2009). In the United States, EC use exceeded conventional cigarettes in 2014 and the number of active users reached about 10 million adult Americans and 3 million adolescents in 2019 (CHAND et al., 2019).

Unlike the paper version, which burns by combustion, EC works since vaporization with pleasant aromas, diverse flavors that arouse curiosity (IASMIM et al., 2021). The vapor released by the device contains nicotine salts ($C_{10H14N2}$), arousing sensations such as dizziness and blurred vision. Its active ingredient is NicSalt, a nicotine salt, formed in tobacco leaves in a natural way, being a stable presentation, easy to handle and synthesize, stored inside a condenser inserted in the device and activated during inhalation (KNORST et al., 2014).

The initial idea was that these devices would be less harmful to health when compared to conventional tobacco, a fact not supported by the World Health Organization (WHO). In the scientific literature, there are reports of systemic alterations such as cardiovascular alterations, inflammatory processes, gastrointestinal problems (CDCP et al, 2019), and pulmonary alterations such as Electronic Cigarette-Induced Lung Injury, where the acronym in English is EVALI (E-cigarette or Vaping product use-Associated Lung Injury), pointed out by the United States Centers for Disease Control and Prevention (CDC) (MISKOFF; CHAUDHRI, 2020; WHO 2022).

In oral health, there is the possible compromise of the microbiota by the chemicals in electronic cigarettes, causing, for example, halitosis, hairy tongue, burns, burning, xerostomia and pain; as well as increased dental biofilm, damage to the periodontium, elevated concentrations of inflammatory markers, and damage to tooth structure (BRIGGS et al., 2021; ATUEGWU et al., 2019; YANG et al., 2020; TORRES, 2021; RALHO et al., 2019). In view of the above, this critical review of the literature seeks to answer what the continuous use of electronic cigarettes brings to oral health, when compared to other types of smoking.

2 MATERIALS AND METHODS

This article is a critical review of the literature carried out in a qualitative and descriptive way, which aimed to evaluate possible oral alterations related to the continuous use of electronic cigarettes. The guiding question was "Does the continuous use of electronic cigarettes cause damage to the oral cavity?". The search

strategy established using the PICO system: P (patient), smokers; I (intervention), patients using electronic cigarettes; C (comparison), use of other types of cigarettes and non-smokers; The (results), the use of electronic cigarettes causes damage to the oral cavity.

The search was carried out in the *PubMed, Web of Science, Embase database and* manual search in journals, until May 2023 without language restriction, through the Boolean operators AND and OR with the MeSH *Terms/Emtree Terms*: *(Electronic Nicotine Delivery Systems) OR (vaping) OR (E-cigarette vapor) AND (mouth)* and appropriate to each database.

The eligibility criteria included report, case series, review studies, cohort, randomized and non-randomized clinical trials in humans. The articles should evaluate the involvement of the oral cavity by relating the use of electronic cigarettes in comparison with other types of smoking or non-smokers. Laboratory studies, editorials, letters to the editor, or that it was not possible to have access in full were excluded.

The articles retrieved from the databases were submitted to the *EndNote* program to exclude duplicates and assist in the article selection process, which was carried out by two researchers (AKMA and MDRS) individually, independently and blindly. After each stage, disagreements regarding the inclusion or exclusion of a given article were resolved by consensus, and there was no need to request the opinion of a third reviewer for the decision. In the first stage, the titles and abstracts were read for the elimination of articles that did not meet the eligibility criteria. The *Kappa* test was performed as an additional analysis for each database to determine the level of agreement among reviewers.

The selected studies were then submitted to a full reading and extraction of the following data: year of publication, type of study, parameters evaluated, demographic data, time of use of the electronic device, and notification of the presence or absence of involvement in the oral cavity. To assess the level of evidence of the selected articles, the *Oxford* Recommendations (OCEBM, 2011; HOWICK et al.,2011 (a); HOWICK et al., 2011 (b).

3 RESULTS

The search was initially carried out in three databases, resulting in 172 articles in *PubMed*, 72 *in Web of Science*, 368 in *Embase* and 5 in manual search. After the elimination of the duplicates, a total of 179 remained, of which 61 were selected according to the titles and abstracts, following the eligibility criteria. After reading the full articles, 13 were included for the evaluation of oral cavity involvement, with a good level of agreement by the *Kappa* test, among the reviewers, for each database (Figure 1).

Most of the studies had Saudi Arabia as their country of origin (69.23%), with ages ranging from 11 to 52 years, with no difference between genders. The time of EC use among consumers ranged from 2 to 12 years. The main involvements evaluated in the oral cavity were plaque index, bleeding and pouch depth on

probing; there was no agreement among the included authors on the harm to oral health resulting from the use of electronic cigarettes (Table 1).

Figure 1: Flowchart of the selection process of the included articles.

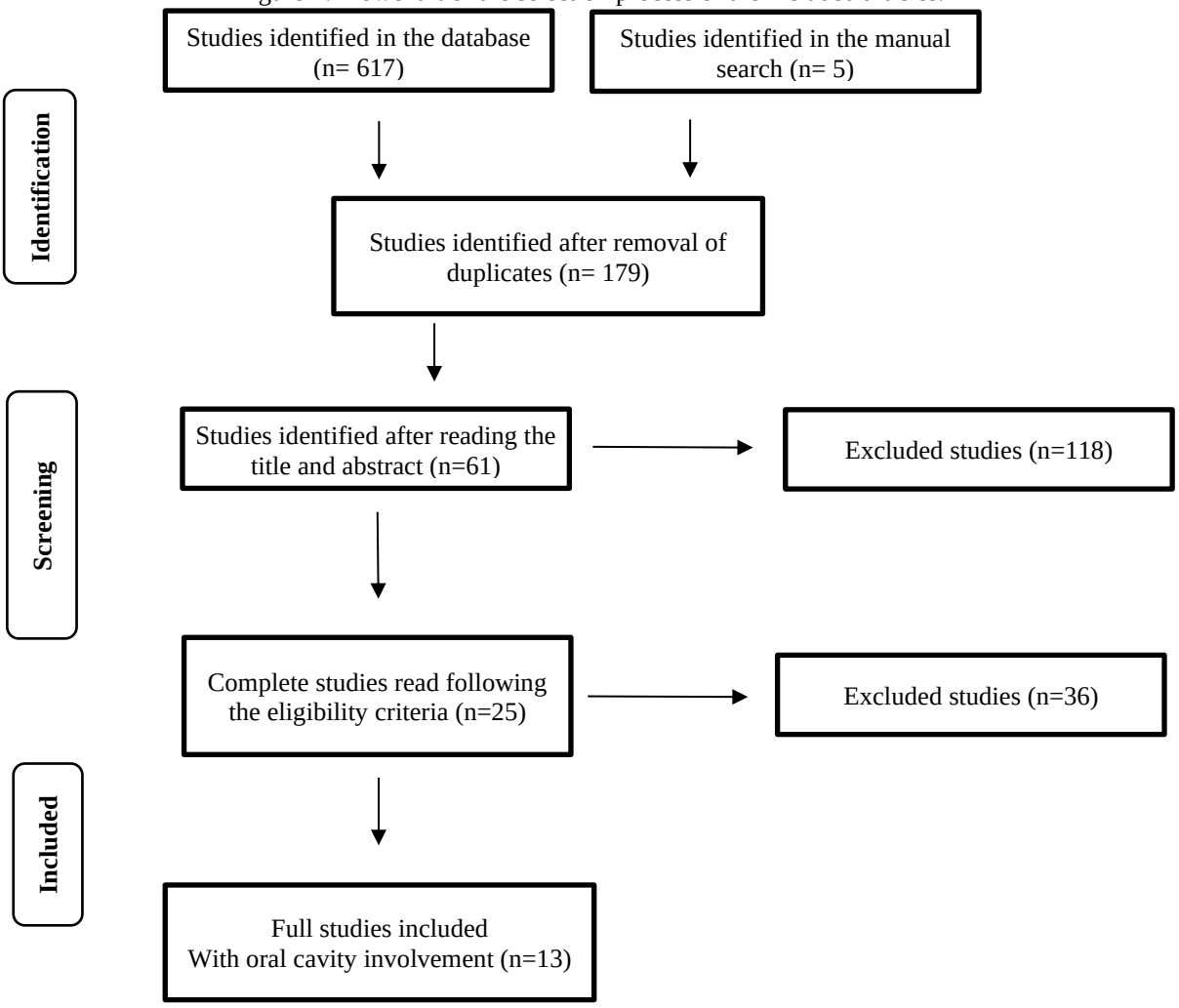

Table 01: Description of the data extracted from the articles.

Author/Year	Country of Origin	Type of Study	Population	Electronic Cigarette Model	E-cigarette usage time	Comparison Groups	Involvement in the oral cavity				Results	Level of evidence
							Plaque index	Bleeding on probing	Probing depth (≥4mm)	Clinical Attachment Loss		
Javed et al. 201717	United States of America	Cohort Study	N=94 Group 1: CC; H=33 Age=41.3±2.8 years Group 2: EC; H=31 Idade= 37.6±2.1 years Group 3: NF; H=30 Age=40.7±1.6 years	NU	2.2±0.2 years	CE x DC x NC	CC; N= 52.1±6.6*† CE; N= 23.3±3. NF; N= 21.4±2.8	CC; N= 5.8±0.8* CE; N= 4.6±2.9* NF; N=	CC; N= 29.3±1.7*† CE; N= 5.1±1.2 NF; N= 5.6±0.8	CC; N= 2.1±0.2 CE; N= 1.1±0.2 NF; N= 0.8±0.1	There was no difference for plate index and probing depth ≥4 mm for the use of CE and CC.	2B

								27.5± 3.2				
ArRejaie et al. 201818	Saudi Arabia	Pilot Study	N=95 Group 1: CC; H=32 Age: 40.4 ± 3.5 years Group 2: CC; H=31 Age: 35.8 ± 6.2 years Group 3: NF; H=32 Age: 42.6 ± 2.7 years	NU	4.4 ± 1.8 years	CE x DC x NC	Plaque Index CC; N= 56.4 ± 12.3 CE; N= 43.5 ± 8.1 NF; N= 29.7 ± 5.2	Bleeding gums on probing CC; N= 18.4 ± 4.8 CE; N= 14.7 ± 5.3 NF; N= 39.8 ± 18.1	Depth of pouch probing ≥4 mm CC; N= 23.8 ± 2.7a EC; N= 15.9 ± 1.4a NF; N= 4.5 ± 0.7	Marginal bone loss CC NM= 2.1 ± 1.1 ND= 2.4 ± 1.6 EC NM=1.2 ± 0.7 ND=1.6 ± 1.0 NF NM=0.8 ± 0.2 ND= 1.1 ± 0.5 TOTAL CC; N= 2.3 ± 1.2 CE; N= 1.4 ± 0.9 NF; N= 0.9 ± 0.3	Peri-implant health impairment was more affected with the time of use in CC than in individuals who vaporized CE and NF	1B
Al-Aaali et al. 201819	Saudi Arabia	Pilot Study	N=92 Group 1: EC; H=47 Idade= 35.8 ± 6.2 years Group 2: NF; H=45 Idade = 42.6 ± 2.7 years	NU	4.4±1.8 years	CE x NF	Plaque Index CE; N= 52.6 ± 11.9 NF; N= 47.6 ± 9.6	Bleeding gums on probing EC; N= 24.7 ± 5.3a NF; N= 39.8 ± 18.1	Depth of pouch probing CE; N= 5.9 ± 1.4b NF; N= 4.5 6 0.7		Peri-implant clinical and radiological parameters have been compromised in individuals who use e-cigarettes.	1B
ALHarthi et al. 201920	Saudi Arabia	Prospective Clinical Study	N=89 Group 1: CC; H=30 Idade=36.4 ± 2.8 years Group 2: EC; H=28 Idade=32.5 ± 4.8 years Group 3: NF; H=31 Idade=32.6 ± 3.5 years	IS	3.1 ± 0.4 years	CE x DC x NC	Plaque Index T=0 CC; N=49.4 ± 7.3 CE; N=43.5 ± 5.6 NF; N=46.3 ± 5.2 T=3 months CC; N=34.5 ± 4.6 CE; N=21.4 ± 2.8 NF; N=18.2 ± 1.6 T=6 months CC; N=38.6 ± 3.8	Bleeding gums on probing T=0 CC; N=17.2±3.3 CE; N= 11.6± 4.5l NF; N= 38.2 ± 6.5 T=3 months CC; N= 11.4 ± 2.4l CE; N= 9.8 ± 0.3	Depth of pouch probing T=0 CC; N= 5.2 ± 0.4 CE; N= 4.6 ± 0.2 NF; N= 4.2 ± 0.3 T= 3 months CC; N= 4.4 ± 0.4 CE; N= 3.1 ± 0.2	Loss of gingival attachment T=0 CC; N=0 THAT; N=0 NF; N=0 T=3 months CC; N=0 THAT; N=0 NF; N=0 T=6 months CC; N=0	N of pouch locations≥ 4 mm T=0 CC; N= 14.2 ± 1.5 CE; N= 10.6 ± 1.2 NF; N= 12.6 ± 2.2 T=3 months CC; N= 7.1 ± 0.6 THAT; N=0 NF; N=0 T=6 months CC; N= 7.4 ± 0.5 THAT; N=0 NF; N=0	After the Ultrasonic Whole Mouth Scaling (RUBI) treatment, there was an increase in gingival inflammation in CC smokers compared to those who vaporize CE and NF.	1B

							CE; N=19.4 ± 1.7 NF; N=20.3 ± 21.2	NF; N= 8.5 ± 0.4 T=6 months CC; N= 13.5 ± 0.6l CE; N= 10.2 ± 1.5 NF; N= 10.4 ± 0.6	NF; N= 2.7 ± 0.1 T=6 months CC; N= 4.6 ± 0.1 CE; N= 3.2 ± 0.4 NF; N= 2.4 ± 0.2	THAT; N=0 NF; N=0			
Al Deeb et al. 202021a	Saudi Arabia	Clinical Trial	N=75 Group 1: CC; H=25 Idade=44.7 ± 7.2 years Group 2: EC; H=21 M=4 Idade=35.6 ± 4.8 years Group 3: NF; H=25 Idade=41.3 ± 6.5 years	IS	6.8 ± 2.5 years	CE x DC x NC	Plaque Index T=0 CC;N=48.8 ± 11.4 CE; N= 39.5 ± 9.2 NF; N= 46.4 ± 12.3 T=3 months CC;N= 21.4 ± 6.8 CE; N= 19.6 ± 8.5 NF; N= 25.4 ± 7.8 T=6 months CC;N= 16.1 ± 2.2 CE; N= 14.5 ± 2.8 NF; N= 18.2 ± 4.3d	Bleeding gums on probing T=0 CC;N=31.7 ± 6.2 Ce; N=25.6± 5.8 NF; N=47,1± 16,3 T=3 months CC;N=25.6 ± 3.5 Ce; N=16.4± 5.2 NF; N=19,8± 4,3 T=6 months CC;N=20.4 ± 4.8 Ce; N=14.9± 6.7 NF; N=18,5± 5,3	Depth of pouch probing T=0 CC;N=5.8± 1.7 Ce; N=5.3± 1.5 NF; N=5,4± 0,9 T=3 months CC;N=4.4± 1.4 Ce; N=4.2± 1.6 NF; N=4,0± 1,4 T=6 months CC;N=3.7± 1.7 Ce; N=3.3± 1.8 NF; N=3,0± 1,7		There was no change in the depth of the pouch probing, possibly justified by the action of nicotine in CC and FB by vasoconstriction of gingival microvascularization	1B
Al Deeb et al. 202022b	Saudi Arabia	Randomized Clinical Trial	N=71 Group 1: CC; H=25 Idade=29.5 ± 5.8 years Group 2: EC; H=21 Idade=27.8 ± 3.1 years	IS	3.8 ± 1.5 years	CE x DC x NC	Plaque Index T=0 CC;N=45.3 ± 12.6 CE; N= 37.6 ± 8.0	Bleeding gums on probing T=0 CC;N= 13.8 ± 2.4	Depth of pouch probing T=0 CC;N= 4.1 ± 0.8 CE; N= 3.8 ± 0.6 NF; N= 3.5 ± 0.4 T=12 weeks CC;N= 3.7 ± 0.3 CE; N= 3.2 ± 0.5 NF; N= 2.7 ± 0.3		There was an increase in bleeding on probing in the baseline in CE users	1B

			Group 3: NF; H=25 Idade= 30.2 ± 4.4 years				NF; N= 32.4 ± 14.7 T=12 weeks CC;N= 13.2 ± 3.4 CE; N= 17.4 ± 6.8 NF; N= 15.8 ± 7.0	CE; N= 18.6 ± 3.7 NF; N= 37.4 ± 6.5 T=12 weeks CC;N = 21.6 ± 10.3 CE; N= 24.7 ± 12.2 NF; N= 12.8 ± 9.3				
Aldakheel et al. 202023	Saudi Arabia	Clinical Trial	N=60 Group 1: CC; H=15 Idade= 40.5 ± 2.1 years Group 2: EC; H=15 Idade= 38.6 ± 3.3 years Group 3: NF with periodontitis; H=15 Idade=39.4 ± 1.6 years Group 4: NF without periodontitis; H=15 Idade= 39.5 ± 0.8 years	NU	3.3 ± 0.2 years	CE x DC x NC	Plaque Index CC;N= 2.6 ± 0.6 CE; N= 2.2 ± 0.3 NF with periodontitis; N= 2.3 ± 0.4 NF sem periodontitis; N= 0.4 ± 0.06	Índice relay CC;N= 1.4 ± 0.2 CE; N= 1.2 ± 0.3 NF with periodontitis; N= 1.7 ± 0.3 NF sem periodontitis; N= 0.3 ± 0.02	Loss of gingival attachment CC;N= 3.5 ± 0.2 mm CE; N= 3.1 ± 0.06 mm NF with periodontitis; N= 3.2 ± 0.04 mm NF sem periodontitis; N= 0.3 ± 0.02 mm	Depth of pouch probing CC;N= 4.5 ± 0.4 mm CE; N= 4.1 ± 0.07 mm NF with periodontitis; N= 4.5 ± 0.2 mm NF sem periodontitis; N= 1.1 ± 0.3 mm	Plaque Index, Gingival Index, Bone Attachment Loss, Pouch Depth were significantly higher among CC smokers, EC users, and nonsmokers with periodontitis compared to nonsmokers without periodontitis. There was no statistically significant difference in plaque index, gingival index, loss of bone attachment, pocket depth between CC, FB and NF with periodontitis	1B
Al-Hamoudi et al. 202024	Saudi Arabia	Clinical Trial	N=71 Group 1: EC; N=36 H= 32; M= 4 Age= H; N=50.3±4.6 years M; N=46.4±2.8 years Group 2: NF; N=35 H=30; M= 5 Age=	NU	3.3±0.5 years	CE x NF	Plaque Index T= 0 CE; N= 2.62±0.43 NF; N= 2.25±0.16 T= 3 months CE; N= 1.91±0.18	Índice relay T= 0 CE; N= 0.36± 0.08 NF; N= 2.25± 0.8 T= 3 months CE; N=	Loss of gingival attachment T= 0 CE; N= 5.2±0.87 NF; N= 5±0.06	Depth of pouch probing T= 0 CE; N= 3.4±0.2 NF; N= 3.1±0.2b	Bone loss marginal T= 0 THAT; NM; 4.8±0.3 ND= 4.6±0.2 NF; NM= 4.6±0.1 ND= 4.7±0.2 T= 3 months THAT; NM= 4.7±0.08	No discrepancy in indexes between CE and NF users	1B

			H; N= 49.5±2.2 years M; N= 45.1±1.3 years				NF; N= 0.62±0.14	0.34± 0.06 NF; N= 0.86± 0.1	T= 3 months CE; N= 3.7±0.2 NF; N= 1.8±0.07	T= 3 months CE; N= 3.7±0.2 NF; N= 1.8±0.07	ND= 4.5±0.05 NF; NM=4.5±0.05 ND= 4.5±0.02		
Ibraheem et al. 202025	Saudi Arabia	Case-control study	N=120 Group 1: CC; H=30 Idade = 46.5 + 5.3 years Grupo 2: NG; H=30 Idade = 45.5 + 4.4 years Group 3: EC; H=30 Idade = 45.6 + 3.6 years Group 4: NF; H=30 Idade = 43.8 + 1.7 years	IS	6.4 + 0.2 years	CE x CC x NG x NF	Plaque Index CC; N= 43.5 ± 5.6% NG; N= 46.7 ± 4.1% CE; N= 40.1 ± 2.2% NF; N= 15.2 ± 2.1%	Bleeding gums on probing CC; N= 15.4 ± 2.5% NG; N= 13.8 ± 1.9% CE; N= 14.5 ± 0.8% NF; N= 21.5 ± 3.3%	Depth of pouch probing CC;N = 4.6 ± 0.4 mm NG; N= 4.8 ± 0.6 mm CE; N= 4.2 ± 0.2 mm NF; N=1.8 ± 0.08 mm	Loss of gingival attachment CC; N= 2.8 ± 0.3 mm NG; N= 2.7 ± 0.4 mm CE; N= 2.5 ± 0.2 mm NF; N= 0.4 ±0.05 mm	Bone loss marginal CC NM=4.06 ± 0.4 mm ND=4 ± 0.3 mm THAT NM= 4.4 ± 0.4 mm ND= 4.4 ± 0.5 mm NG NM=4.2 ± 0.5 mm ND=4.1 ± 0.3 mm NF NM=1.5 ± 0.1 mm ND=1.4 ± 0.08 mm	Plaque index, probing depth, gingival attachment loss, and marginal bone loss on the mesial and distal surfaces were substantially higher between NG and CE	3B
Alade et al. 202126	Nigeria	Cross-sectional study	N=2870 H=1449 M=1421 Group 1: CE+CC; N=401 Group 2: CC; N=386 Group 3: EC; N=167 Group 4: NF; N=1916 Age (in years): 11-14; N=337 15-17; N=327 18-23; N=2206	IS	IS	CE x DC x NC	Gingivitis N=627 CE+CC; N=148 CC; N=170 THAT; N=43 NF; N=26	Alteration of taste N=326 CE+CC; N=89 CC; N=64 THAT; N=21 NF; N=152	Ulcers in the oral cavity N=170 CE+CC; N=38 CC; N=40 THAT; N=14 NF; N=78	Xerostomia N=376 CE+CC; N=77 CC; N=102 THAT; N=24 NF; N=173	At first glance, users of CE and CC pointed to gingival inflammation, oral ulcers, and xerostomia (dry mouth). In contrast to FB, CC patients reported changes in taste.	2C
Alazmi et al. 202127	Saudi Arabia	Cohort Study	N=127 THAT; N=63 H=46 M=17 Age=34.2±1.3 years NF; N=64 H=46 M=18 Age=35.1±0.5 years	IS	9.3±0.5 years	CE x NC	Plaque Index T=8 years CE; N=1.05 ±0.08 NF; N=1.2± 0.05	Bleeding gums on probing T=8 years CE; N=0.8 ±0.06	Depth of pouch probing T=8 years CE; N=1.8±0.1 NF; N=1.6±0.03		There were no statistical differences between CE and NF for peri-implant plaque index, gingival index, probing depth, and mesial and	2B

								NF; N=0.7 ±0.04				distal alveolar bone loss.	
Alhajj et al. 202228	Yemen	Cross-sectional study	N=5676 NF; N= 4564 H= 1594 M= 2970 Age = ≤20 years = 1502 / >20 years = 3062 CC; N= 596 H=344 M=252 Age=≤20 years= 178/>20 years =418 EC; N= 255 H=176 M=79 Age = ≤20 years = 72 / >20 years = 183 CCxCE; N= 261 H= 144 M= 117 Age=≤20 years= 86/>20 years=175	NU	NU	CE x DC x NC	Pain in the mouth or throat N= 1600 NF; N = 1314 CC; N= 162 EC; N=54 EC+CC; N= 70	Xerostomia or dryness in the throat N= 1367 NF; N= 1042 CC; N = 172 THAT; N = 54 CE+CC; N = 70	Inflammation in the mouth or throat N= 517 NF; N = 425 CC; N=52 EC; N=25 EC+CC; N=15	Hairy tongue N= 182 NF; N = 129 CC; N =23 EC; N=14 CE+CC; N = 16	Gingivitis N= 1077 NF; N = 883 CC; N = 111 EC; N= 42 CE+CC; N = 41	After prolonged exposure to the pathogenic effects of CC, those who switched to CE noticed milder oral effects	2C
Ali et al. 202229	Kuwait	Case-control study	N=75 Group1: CC; N=19 H=15 M=4 Age=52.6±6.1 years Group 2: EC; N=18 H=12 M=6 Age=49.5±2.3 years Group 3: NF with periodontitis; N=19 H=13 M=6 Age=50.7±2.2 years Group 4: NF without periodontitis; N=19 H=14 M=5 Idade= 48.1±1.3 years	NU	12.5±0.8 years	CE x DC x NC	Plaque Index CC;N= 3.1±0.2 CE; N= 2.5±0.2 * NF with periodontitis; N= 2.3±0.2 NF sem periodontitis; N= 0.3±0.05	Índice relay CC;N = 0.9±0.04† CE; N= 1.05±0.03† NF with periodontitis; N= 3.3±0.05 NF sem periodontitis; N= 0.5±0.004†	Loss of gingival attachment CC;N = 8.4±0.5 mm CE; N= 7.1±0.4 mm NF com periodontite; N= 7.8±0.3 mm* NF sem periodontis; N= 0.2±0.003	Depth of pouch probing CC;N = 6.5±0.2 mm CE; N= 5.7±0.2 mm NF com periodontite; N= 6.1±0.4 mm NF sem periodontis; N= 1.2±0.06 mm	Marginal bone loss CC; NM= 6.2±0.7 mm ND= 6.3±0.6 mm EC; NM= 5.8±0.2 mm ND= 5.5±0.2 mm NF with periodontitis NM= 5.7±0.2 mm ND= 5.8±0.3 mm NF sem periodontite NM=0.4±0.004mm ND=0.3±0.004 mm	Scores of PI, PIC, PS, mesial and distal POM and the number of missing teeth were significantly higher among patients in the CC, CE, NF groups with periodontitis compared to NF without periodontitis	3A

SUBTITLES: Electronic Cigarette (EC); Conventional Cigarette (CC); Dual Use of Electronic Cigarettes and Conventional Cigarettes (EC+CC); Hookah (NG); Plaque Index (PI); Clinical Attachment Loss (ICP); Probing depth (PS); Marginal Bone Loss (POM).

4 DISCUSSION

A total of 13 articles were included, which evaluated the use of electronic cigarettes and reported the type of oral cavity involvement. The studies were evaluated for the level of evidence by the *Oxford Recommendations* (OCEBM, 2011; HOWICK et al., 2011 (a); HOWICK et al., 2011 (b)), where 53.85% were classified as 1B. In this review, there was no prevalence of gender, although the age group was above 24 years (JAVED et al., 2017; ARREJAIE et al., 2019; A-AALI et al., 2018; ALHARTHI et al., 2019; AL DEEB et al., 2020 (a); AL DEEB et al., 2020 (b); ALDAKHEEL et al.,2020; AL-HAMOUDI et al., 2020; IBRAHEEM et al., 2020; ALADE et al., 2022; ALI D et al., 2022). For Martins et al., (2022), when analyzing the epidemiological data of users, they found a higher percentage in Croatia and a lower one in Brazil with 0.43%; with an age range of 18 to 24 years, and a prevalence that is not very large for males, results in which the population inclusion criteria that were part of the studies should be taken into account.

For the scientific evidence on the damage caused, in the long term, it is still inconclusive. In *vitro studies* have shown increased oxidative stress, apoptosis and altered function of the cilia of the respiratory mucosa. These losses are similar to those caused by conventional cigarettes, but in a less aggressive way (INCA, 2022).

Some additives used in *e-liquid* are also harmful to the respiratory tract, especially vitamin Acetate and diacetyl (DA; 2-3-butanedione). A sticky, oily-textured chemical used as a thickener for vaping products containing tetrahydrocannabinol (THC) that can affect the ability of the surfactant and maintain surface tension in the lung alveoli. In addition, there are isomers of vitamin E that may have regulatory effects on protein kinase C α (PKCα) in respiratory endothelial cells by regulating leukocyte recruitment, a critical stage in inducing airway hyperresponsiveness and lung inflammation (DIAS et al., 2010).

The use of regular cigarettes or electronic cigarettes can cause changes in the oral cavity, increased biofilm, bleeding on probing, depth of the gingival pocket on probing, loss of clinical attachment, and marginal bone loss (MALHEIROS et al., 2019; CASAIS et al., 2018). In the present study, the biofilm index among the groups of regular cigarettes, e-cigarettes and non-smokers showed a higher prevalence in smokers of conventional nicotine-based cigarettes (ARREJAIE et al., 2019; AL-AALI et al., 2018; ALHARTHI et al., 2019; AL DEEB et al., 2020 (a); AL DEEB et al., 2020 (b); ALDAKHEEL et al., 2020; AL-HAMOUDI et al., 2020; MARTINS et al., 2022). Among non-smokers, conventional cigarettes, electronic cigarettes, and hookahs were higher for hookahs (ALADE et al., 2022), a fact possibly justified by the higher amount of nicotine (COELHO et al., 2008). Among e-cigarettes and non-smokers, the prevalence was 50% for smokers (AL DEEB et al 2020(a)) and 50% for non-smokers (ALHAJJ et al., 2022).

In addition, the gingival bleeding index on probing is the clinical parameter used to assess gingival inflammation and periodontal pocket exudates (CHAFFEE et al., 2021). Thus, within the findings, greater gingival bleeding was observed in non-smoking patients, this differential is due to the vasoconstriction

caused by nicotine in conventional cigarettes and electronic cigarettes (PESCE et al., 2022), which decreases gingival microcirculation. After prolonged contact with cigarette smoke, the growth of human gingival fibroblasts is affected. Smoking induces neoformation and accumulation of advanced glycation products in periodontal tissues (ALHARTHI et al., 2019).

There is, therefore, a risk in the groups that use electronic cigarettes and/or regular cigarettes because they have direct contact with the smoke/vapor released. However, it was observed that the depth of the gingival pocket, probing, and periimplant marginal bone loss were marked in conventional cigarette users (ARREJAIE et al., 2019; AL-AALI et al., 2018; ALHARTHI et al., 2019; AL DEEB et al., 2020(a); AL DEEB etal., 2020(b); ALDAKHEEL et al., 2020; AL-HAMOUDI et al., 2020; MARTINS et al., 2022). On the other hand, the CE group had a higher periimplant bone loss compared to nonsmokers (IBRAHEEM et al., 2020). In addition, among the groups of conventional cigarettes, FB, hookah, and non-smokers, the highest prevalence is seen in hookah smokers (ALADE et al., 2022).

In terms of symptoms and other involvements in the oral cavity, the following were reported: xerostomia, gingivitis, hairy tongue, ulcers, alteration in taste, pain and inflammation in the oral cavity and throat. The main pathogenic mechanism of oral alterations is the accumulation of nicotine in the body and high levels of pro-inflammatory cytokines (ALHARTHI et al., 2019; ALZMI et al., 2021; SOARES, G.S.; MELO, R.C.O.; ESPÍNDOLA, L.C.P. 2022).

It should be remembered that the oral cavity and intestine are made up of a diverse microbiota responsible for defending against pathogenic and opportunistic microorganisms (CABRAL et al., 2022; KUMAR et al., 2019). The imbalance of the microbial flora makes it more susceptible to bacterial infections. Thus, nicotine and flavoring substances in e-liquid cause alterations and imbalances in this microbiota, also favoring the development of several diseases such as inflammatory bowel disease, obesity, heart disease, vascular diseases, cancer and rheumatoid arthritis (KC, D.; SUMNER, R.; LIPPMANN, S. 2020; DEBNATH et al., 2019).

5 CONCLUSION

In the present literature, there was no agreement among the authors about a greater harm to oral health resulting from the use of electronic cigarettes. However, due to the notifications of possible impairments to the individual's health, studies are being carried out with long-term evaluations.

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