

The Effects of E-cigarettes on Oral Health



KEY POINTS:

- The possible health risks concerning e-cigarette use involve cancers, other diseases, and injuries due to explosions.
- Mouth and throat irritation is the most common adverse effect of e-cigarettes.
- To date, there is no conclusive evidence to prove causal effects of e-cigarettes on poor oral health conditions. Current systematic reviews have shown that mouth and throat irritation and periodontal damages are the most reported oral health effects.
- Oral health professionals should not recommend e-cigarettes for smoking cessation but inform patients about their potential risks.

What is the current situation?

E-cigarettes are collectively known as “electronic nicotine delivery systems (ENDS)” and are available in different shapes, sizes, and device types. There are various names given to e-cigarettes such as e-cigs, vapes, vape pens, dab pens, tanks, mods, pod-mods, e-hookahs, JUUL, while the use of e-cigarettes is called vaping, juuling, or dabbing^{1,3}. E-cigarettes are classified into four generations^{2,4} according to their designs^{2,4} and the use of nicotine salt instead of the freebase nicotine^{2,3}. In 2003, the electronic cigarette use was introduced by a Chinese pharmacist as a possible nicotine replacement therapy¹, but its effectiveness on tobacco cessation remains controversy. Regardless of its potential risks, the trend of using e-cigarettes is increasing, especially among young adults^{1,3}. E-cigarettes attract young users by their appealing looks and flavors³. In the United States, the number of e-cigarette users who are young adults (18-24 yrs.) increased from 5.1% in 2014 to 7.6% in 2018. Men were twice more likely than women to use e-cigarettes (4.3% vs. 2.3%, in 2018)^{5,6}. Unlike tobacco smokers, the number of e-cigarette smokers has been increasing much more rapidly. In 2018, there were approximately 41 million e-cigarette users globally, and it has been estimated to reach 55 million e-cigarette smokers by 2021⁷.

What are the possible health risks of e-cigarettes?

The incidence of e-cigarette explosion is increasing along with the growing demand for use. The burn severity cases were observed from first- to third-degree or sometimes a combination of a second- and third-degree involving the hands, face, eyes, mouth, and genitals⁸. A systematic review distributed by WHO, focusing on health effects of e-cigarettes, reported that the use of e-cigarettes is significantly associated with respiratory symptoms, mouth and throat irritation, cough, headache, and nausea⁹. The use of e-cigarettes increases health risks especially in ex-smokers and never smokers; however, little is known about health effects of dual use of e-cigarettes and conventional cigarettes⁹. The uses of e-cigarettes, water pipes, and tobaccos are linked to poor health conditions, including infertility, nasopharyngeal cancer, lung cancer, bladder cancer, and gastroesophageal reflux disease¹⁰.

Do e-cigarettes affect oral health?

The use of e-cigarettes affects not only general health but also oral health. According to the latest systematic reviews focusing on e-cigarette effects on oral health, **the most common effects are mouth and throat irritation and periodontal breakdown**¹¹⁻¹³. Mouth and throat irritation is prominent in non-smokers who have initiated e-cigarette smoking. However, among conventional cigarette smokers, changing to e-cigarettes is more likely to mitigate the irritation¹¹. The most common periodontal problems are an increased accumulation of plaque and deeper probing depth¹¹⁻¹³. E-cigarette aerosols can cause cytotoxicity to oral keratinocytes through an oxidative stress response¹¹. Specific metals like nickel, lead, and chromium are more concentrated in e-cigarette aerosols than in conventional cigarettes, which profoundly influence the gingival epithelium, periodontal ligament, and oral mucosa¹⁴. Also, the toxic material, called cadmium, in e-cigarettes might disturb alveolar bone remodeling in periodontal disease, leading to bone resorption¹⁴.

Figure 1. Summary of the Possible Effects of E-cigarettes on Oral Health (Yang I. et al., 2020)

Mouth irritation:

dryness, burning, irritation, bad taste, bad breath, pain/discomfort

Throat irritation:

throat dryness, irritation, soreness, cough, tonsillitis, uvulitis, para-tracheal edema, laryngitis

Periodontal effects:

increased accumulation of plaque, deeper probing depths, an increased bone loss, higher concentrations of localized inflammatory markers, a higher volume of sulcular fluid

Oral lesions:

black tongue, burns, nicotine stomatitis, hairy tongue

Dental effects:

cracked or broken teeth, toothache, tooth discoloration, caries, tooth sensitivity, tooth loss/extraction, increased cariogenic bacteria (flavored e-cigarettes), decreased enamel hardness (flavored e-cigarettes)

Oral microbiome disturbance:

oral candidiasis, oral herpes

Cytotoxic, genotoxic, and oncogenic effects:

increased risk for cancer

Accidental injuries:

risk of explosions

The other effects on oral health include oral lesions, dental effects, oral microbiome disturbance, an increased risk of cancer, and a risk of explosions as described in **Figure 1**. Two out of three recent systematic reviews have reported oral lesions as being oral tissues' possible responses to e-cigarettes. On the other hand, there is no consistent result regarding dental effects, oral microbiome disturbance, cancers, and explosive injuries. **Appendix 1** shows the results of the three recent systematic reviews. Considering all the studies included in the latest reviews¹¹⁻¹³, it appears that the majority of the primary studies aimed to examine the relationship between the use of e-cigarettes and changes in periodontal parameters rather than any other components of oral health. There is a high possibility that effects on other oral structures may not have been studied enough.

Should we use e-cigarettes for smoking cessation?

The use of e-cigarettes to reduce the consumption of conventional cigarettes currently remains a controversy. Many conventional smokers use e-cigarettes as an alternative method of tobacco cessation due to lower health risks^{4,15}. However, the United States Food and Drug Administration has not approved the safety of e-cigarette compositions¹⁶. Studies reported that its components are the source of hazardous trace metals; besides, e-liquid (propylene glycol and glycerin) may have more irritating effects on the mucosa of the airways than conventional cigarettes^{14,17}. Concerning the effectiveness that e-cigarettes have on smoking cessation and their safety, studies did not find that they have a statistically significant advantage over other nicotine replacement aids or placebos^{18,19}. Moreover, the use of e-cigarettes among young adults can increase the risk of further initiation of traditional cigarette smoking for various behavioral and physiological reasons. Researchers found that young adults smoking nicotine-containing electronic cigarettes may become addicted to nicotine and eventually start smoking traditional cigarettes²⁰.

Hence, according to the present evidence, **oral health professionals should not recommend the use of e-cigarettes, but should instead provide patients with information regarding the possible risks**. In addition, oral health practitioners should prioritize providing smoking cessation advice, for both e-cigarettes and combustible cigarettes, in their routine practice as outlined in WHO Monograph on Tobacco Cessation and Oral Health Integration²¹.



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References

1. National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). Adult Smoking Cessation - The Use of E-cigarettes.
https://www.cdc.gov/tobacco/data_statistics/sgr/2020-smoking-cessation/fact-sheets/adultsmoking-cessation-e-cigarettes-use/index.html. Published 2020. Updated January 23, 2020. Accessed 8 May, 2020.
2. U.S. Department Of Health and Human Services (CDC). E- CIGARETTE, OR VAPING, PRODUCTS VISUAL DICTIONARY.
https://www.cdc.gov/tobacco/basic_information/e-cigarettes/pdfs/ecigarette-or-vaping-products-visual-dictionary-508.pdf. Accessed 21 August, 2020.
3. Truth Initiative. E-cigarettes: Facts, stats and regulations.
<https://truthinitiative.org/research-resources/emerging-tobacco-products/e-cigarettes-facts-stats-and-regulations>. Published 2019. Accessed 21 August, 2020.
4. El Dib R, Suzumura EA, Aki EA, et al. Electronic nicotine delivery systems and/or electronic non-nicotine delivery systems for tobacco smoking cessation or reduction: a systematic review and meta-analysis. *BMJ Open*. 2017 ;7(2) :e012680.
5. Schoenborn CA, Gindi RM. Electronic cigarette use among adults : United States, 2014. NCHS data brief, no 217 Hyattsville, MD: National Center for Health Statistics. 2015(no. 217).
6. Villarroel MA, Cha AE, Vahratian A. Electronic cigarette use among U.S. adults, 2018. In. NCHS Data Brief , no 365. Hyattsville, MD: National Center for Health Statistics.; 2020.
7. Jones L. Vaping : how popular are e-cigarettes? BBC News.
<https://www.bbc.com/news/business-44295336>. Published 15 September 2019. Accessed 24 August, 2020.
8. Seitz CM, Kabir Z. Burn injuries caused by e-cigarette explosions: A systematic review of published cases. 2018; 4 (September).
9. Pisinger C. A Systematic Review of Health Effects of Electronic Cigarettes. In. Document prepared for the World Health Organization 2015.
10. Waziry R, Jawad M, Bailout RA, Al Akel M, Aki EA. The effects of waterpipe tobacco smoking on health outcomes: an updated systematic review and meta-analysis. *Int J Epidemiol*. 2017 ;46(1) :32-43.
11. Yang I, Sandeep S, Rodriguez J. The oral health impact of electronic cigarette use: a systematic review. *Critical reviews in toxicology*. 2020;50(2) :97-127.
12. Faisal IA, Aini G. Electronic cigarettes and oral health: A narrative review . *International Journal of Pharmaceutical Research*. 2018;10:84-86.
13. Ralho A, Coelho A, Ribeiro M, et al. Effects of Electronic Cigarettes on Oral Cavity: A Systematic Review. *J Evid Based Dent Pract* . 2019;19(4) :101318.
14. Gaur S, Agnihotri R. Health Effects of Trace Metals in Electronic Cigarette Aerosols-a Systematic Review. *Biol Trace Elem Res*. 2019 ;188(2) :295-315.
15. World Health Organization. Electronic Nicotine Delivery Systems and Electronic Non-Nicotine Delivery Systems (ENDS/ENNDS). Conference of the Parties to the WHO Framework Convention on Tobacco Control; 7-12 November 2016, 2016; Delhi, India .
16. Bardellini E, Amadori F, Conti G, Majorana A. Oral mucosal lesions in electronic cigarettes consumers versus former smokers. *Acta Odontol Scand*. 2018 ;76(3) :226-228 .
17. Franco T, Trapasso S, Puzzo L, Allegra E. Electronic Cigarette : Role in the Primary Prevention of Oral Cavity Cancer. *Clin Med Insights Ear Nose Throat*. 2016 ;9:7-12.
18. Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF, Hajek P. Electronic cigarettes for smoking cessation. *Cochrane Database of Systematic Reviews* . 2016(9).
19. Khoudigian S, Devji T, Lytvyn L, Campbell K, Hopkins R, O'Reilly D. The efficacy and short-term effects of electronic cigarettes as a method for smoking cessation : a systematic review and a meta-analysis. *Int J Public Health* . 2016 ;61(2) :257-267 .
20. Soneji S, Barrington-Trimis JL, Wills TA, et al. Association Between Initial Use of e-Cigarettes and Subsequent Cigarette Smoking Among Adolescents and Young Adults: A Systematic Review and Meta-analysis. *JAMA Pediatr*. 2017 ;171(8):788-797.
21. Geneva: World Health Organization. WHO Monograph on Tobacco Cessation and Oral Health Integration. In: 2017 :31-34.

Appendix 1: Systematic reviews addressing association between e-cigarettes and oral health during 2015-2020.

Author	Irene Yang et al. ¹¹	Ahmad Faisal Ismail et al. ¹²	Ana Ralho et al. ¹³
Year of publication	2020	2018	2019
Number of incl. stories	98	8	8
Inclusion criteria	<ul style="list-style-type: none"> • The bibliography included all designs including case reports • All studies up to December 2019 	<ul style="list-style-type: none"> • English-language • Human studies and reports presenting the effect of electronic cigarette on oral health • Studies published between 2003 to 2016 	<ul style="list-style-type: none"> • Clinical observational and analytical studies with clinical/radiographical parameters • Studies with more than 30 participants per group • Studies published between 2003 to 2018
Exclusion criteria	<ul style="list-style-type: none"> • Review, commentary • Pilot study data within a more extensive study • Second-hand exposure studies to e-cigarette • Studies related to dual use of e-cigarette and combustible e-cigarette 	<ul style="list-style-type: none"> • Laboratory studies, review articles, letters and comments 	<ul style="list-style-type: none"> • Review articles, cells/ animal studies, clinical cases, conference summaries, questionnaires, and studies related to the quality of life
Effects/ Symptoms	<ul style="list-style-type: none"> • Mouth and throat irritation • Periodontal damages • Oral mucosa! lesions • Dental damages • Changes in the oral microbiome • Changes at the cellular level of oral tissue • Potentially dangerous genotoxic and carcinogenic properties of e-cigarette constituents • Risks for traumatic injury related to explosions 	<ul style="list-style-type: none"> • Mouth and throat irritation • Dry mouth • Periodontitis 	<ul style="list-style-type: none"> • Worsen Periodontal and peri-implant clinical and radiographic parameters • Higher pro-inflammatory cytokine levels • More likely to have nicotinic stomatitis, hairy tongue, and angular cheilitis