Narrative Review

Smoking E-cigarettes and Seizures: A Review Study

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Introduction: Electronic nicotine delivery systems (ENDS), also known as “e-cigarettes” or “vape,” are battery-powered devices made to help smokers quit. Due to their flavors and being less harmful than conventional cigarettes, they have become popular among adolescents and youth. However, the adverse effects of e-cigarettes should also be considered. This review aimed to investigate the relationship between smoking e-cigarettes and experiencing episodes of seizure.

Materials and Methods: This review is based on research studies found in PubMed, Scholar, Elsevier, and Scopus databases with “electronic nicotine delivery systems”[Mesh] AND “seizures”[Mesh] as keywords. Among the available research, 15 articles were selected as sources for this writing.

Results: Seizures resulting from the high electrical activity of the brain can be considered a consequence of nicotine toxicity. Inhalation of nicotine increases nicotine levels in plasma. Subsequently, nicotine binds to nicotinic acetylcholine receptors (nAChRs) in different body parts. These areas include brain parts associated with seizures and neuronal excitability, where these receptors are highly expressed, and their activation can also lead to seizures.

Conclusion: Although the long-term side effects of e-cigarettes are not fully understood, acute health problems, especially seizures, are now a matter of concern. Seizures might happen possibly due to nicotine toxicity, but the causal relationship between using e-cigarettes and seizures is not yet established and needs more information.

Introduction

Electronic nicotine delivery systems (ENDS), also named “electronic cigarettes,” “e-cigarettes,” or “vapes,” are battery-powered devices that were made first to help smokers quit. However, due to the widespread marketing associated with these products, attractive design, and appealing flavorings, they have become popular worldwide, especially among adolescents and young adults [1]. Statistics show that 2.06 million middle and high school students in the United States smoked e-cigarettes in the last 30 days in 2021, with 2.8% dedicated to middle school students and 11.3% to high school students [2].

E-cigarettes are filled with chemical compounds called “e-liquid” or “e-juice.” E-liquids consist of nicotine and sometimes other substances like tetrahydrocannabinol (THC), hashish, and cocaine, in addition to propylene glycol, glycerin, flavors, and humectants [3-5].

Since nicotine, inhaled from e-cigarettes, acts on nicotinic acetylcholine receptors (nAChR), these devices seem helpful for smoking cessation [1]. However, non-smokers usually use these devices according to the amount of nicotine released and the idea of being less harmful than regular cigarettes [6, 7]. Nevertheless, the concentration of nicotine in e-liquids is about 0% to 5%, which is considered equal to or greater than conventional cigarettes [3, 8].

Although smoking e-cigarettes reduces the exposure to some poisoning agents in conventional cigarettes, e-liquids may contain toxic agents, including toluene, formaldehyde, acetaldehyde, acetone, heavy metals like nickel and cadmium, in addition to volatile organic agents [1, 4].

Smoking e-cigarettes could be accompanied by health adverse effects, classified as short-term and long-term and also as mild and severe. Moreover, while the long-term effects are not yet fully understood, most health effects are mild and short-lived [6]. Respiratory symptoms like cough, wheezing, bronchitis, and EVALI (e-cigarette or vaping use-associated lung injury) are the most common adverse health effects associated with e-cigarettes [3, 5, 7]. However, there are also reports of cardiovascular diseases, gastrointestinal symptoms like nausea and vomiting, burns and injuries due to inappropriate use of the devices, and cognitive and psychiatric disorders happening to e-cigarette smokers, including anxiety, depression, attention-deficit hyperactive disorder, and seizures [3, 4].

One hundred twenty-two cases of psychologic disorders, including 35 cases of seizures, were reported to the Food and Drug Administration (FDA) and the American Association of Poison Centers (AAPCC) from December 2010 to January 2019 [5, 8]. Furthermore, the FDA also received 117 cases of seizures voluntarily reported from April 3, 2019, to June 30, 2019. Thus, it was suspected that more cases of seizures were present and would be submitted in the future [3, 9]. As of March 1, 2021, more than 250 cases of seizures were reported to the FDA, and the majority of cases were young adults [10].

This review aimed to study the association or a causal relationship between smoking e-cigarettes and experiencing episodes of seizure.

Materials and Methods

This study overviews registered research in PubMed, Google Scholar, Elsevier, and Scopus until September 2022. (“Electronic nicotine delivery systems”[Mesh]) AND (“seizures”[Mesh]) were added to the query box. Articles explaining the relationship between smoking e-cigarettes and seizure, adverse effects associated with e-cigarettes, and the effects of e-cigarettes on youth and adolescents were all included. However, research studies on patients with pre-existing comorbidities, studies on the relationship between smoking e-cigarettes and other psychiatric disorders, and articles published before 2000 were excluded. Fifteen articles met the criteria and were selected for review in this study.

Results

Increasing use of e-cigarettes, especially among teenagers and young adults, may result in short- and long-term health disorders. However, the long-term health adverse effects are not yet completely understood [3].

Reported data on smoking e-cigarettes demonstrate that nausea and vomiting, dizziness, and irritation of the eyes were the most common health effects resulting from e-cigarettes. Cardiovascular and gastrointestinal disorders, skin irritation, respiratory suppression, and even death are also other health events associated with vaping [6].

Seizure, caused by high neuronal activity of the brain, could be followed by loss of consciousness, airway obstruction, reduced levels of plasma oxygen, and even coma and death [11]. Seizures may happen as a result of infections, especially of the central nervous system, brain disorders like tumors, bleeding, genetic abnormalities, and sometimes without a specific reason, called “idiopathic seizures” [11].
Nicotine acts on nicotinic acetylcholine receptors (nAChRs) in different body parts, including the respiratory system, cardiovascular system, and brain areas like the hippocampus, amygdala, and thalamus. These areas are associated with neuronal excitability and seizure [1, 11]. There are many possible mechanisms for nicotine to affect the neuronal activity of the brain and reduce the seizure threshold. The most widely accepted one postulates that inhaled nicotine binds to nAChRs in the hippocampus and amygdala, where these receptors are highly expressed, and as a result, glutamate level increases in the brain through the reduction in glutamate uptake [1].

Furthermore, nicotine can act on α7 nAChR in the amygdala, which is significantly associated with seizure generation, and a significant number of this type of nicotinic receptors exist there. Through acting on these receptors, nicotine stimulates glutamate release, which is vital in causing seizures by activating N-methyl-d-aspartate receptors [11].

As previously mentioned, e-cigarettes may contain other substances like THC or cannabis. It is the active ingredient of marijuana with the potential for substance-induced psychotic disorders, which is widely used due to its possible medicinal properties, especially in youth and adolescents. Exposure to THC through vaping may increase the risk of THC toxicity with slurred speech, ataxia, mydriasis, and changes in behavior as clinical symptoms [12, 13]. E-cigarettes with e-liquids containing THC are considered generally with pulmonary disorders and EVALI as the commonest adverse health effects happening to users [4].

Discussion

Besides pharmacotherapy and behavioral counseling, electronic cigarettes assist in quitting smoking [14]. The majority of e-cigarettes have e-liquids containing nicotine, and nicotine toxicity is characterized by nausea, vomiting, sweats, lacrimation, dizziness, and gastrointestinal symptoms, as well as seizures [5, 9]. As nicotine has proconvulsant properties and nicotine-associated seizures were seen in animal models, vaping-associated seizures would respectively be caused as a result of acute nicotine toxicity [5].

Available data on e-cigarette-associated seizures, mainly based on voluntarily reported case reports, indicate that seizures are not specified to a particular brand or a specific algorithm of use. Also, not all cases of seizures result from smoking e-cigarettes [6, 8]. Besides, an analysis of submitted cases demonstrates that seizures are observed in both first-smokers and experienced smokers. As a matter of time, seizures would happen during smoking, after a few puffs, a day after smoking, or even weeks later [4, 8].

Interestingly, inhaled nicotine from e-cigarettes could result in seizures, while regular cigarettes do not [5]. Compared with regular cigarettes, inhaled nicotine from e-cigarettes is absorbed into circulation faster, and in addition to its higher bioavailability, plasma levels of nicotine reach a peak in a shorter time than conventional cigarettes, especially in the brain [11].

Nicotine can interact with brain development, especially in youth and adolescence. Therefore, according to the effects of nicotine on brain function, which can increase the risk of secondary disorders, and the requirement of medical interventions for these patients, the seizures associated with e-cigarettes should be researched, now a matter of concern [9, 10, 15].

On the other hand, because of the widespread use of e-cigarettes by non-smokers, interestingly younger users, health adverse effects related to smoking, and the risk of nicotine addiction, laws, and regulations must be passed to limit e-cigarette sales and reduce the accessibility to these devices for non-smokers [3, 14]. Nevertheless, when a patient uses ENDS for smoking cessation, these devices should not be banned due to the risk of causing seizures [5].

Conclusion

Seizure is a significant side effect of smoking e-cigarettes, and acute nicotine toxicity is considered to be the reason for vaping-associated seizures. Although a causal relationship has not been established, users of these devices should always be aware of signs and symptoms related to seizures.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.
Authors’ contributions

Conceptualization and study design: Fatemeh Rahimi and Ali Massoudifar; Investigation: Roya Rahimi; Manuscript preparation: Fatemeh Rahimi; Review and editing: Hadi Eshaghi Sani, Roya Rahimi and Ali Massoudifar; Final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

References


