

Comparison of Respiratory and Neurological Hazards of Regular Cigarettes and Electronic Cigarettes

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Received: 27 Dec 2024; Received in revised form: 28 Jan 2025; Accepted: 05 Feb 2025; Available online: 10 Feb 2025

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Abstract— Smoking is one of the leading causes of preventable diseases and premature death worldwide¹. It is a significant public health concern due to its well-documented adverse effects on various systems of the human body, including the respiratory and neurological systems. The health risks associated with smoking are not limited to traditional tobacco cigarettes but extend to newer products such as electronic cigarettes (e-cigarettes), which have gained widespread popularity in recent years. While e-cigarettes are often marketed as a safer alternative to traditional smoking, research on their long-term effects remains inconclusive, particularly regarding their impact on the respiratory and neurological systems. This study aims to explore and compare the harmful effects of both regular and electronic cigarettes on lung function and neurological health²



Keywords— lung function, neurological health, preventable diseases, Electronic Cigarettes, Regular Cigarettes

I. INTRODUCTION

The public perception of e-cigarettes as a safer alternative to regular cigarettes is a major driving force behind their growing use, especially among younger populations. However, this perception may be misleading, as the safety and health implications of e-cigarettes have not been fully evaluated, and emerging evidence suggests they may pose unique risks to both the lungs and the brain. The necessity of investigating this issue lies in the increasing prevalence of smoking and the need for clear, evidence-based information to

guide public health recommendations [4-6]. This investigation delves into the analysis of respiratory and neurological risks linked with traditional cigarette smoking and e-cigarette use. Given that e-cigarette consumption has increased around the globe, it is necessary to analyze their potential health risks relative to traditional smoking which is well-established to be harmful for the respiratory and nervous systems. This research intends to analyze previous literature on the mechanisms of toxicity, their health impacts, and possible public health issues, so as to develop

¹ X. Abelia, R. Lesmana, H. Goenawan, R. Abdulah, and M. Barliana, "Comparison impact of cigarettes and e-cigs as lung cancer risk inductor: a narrative review," *European Review for Medical & Pharmacological Sciences*, vol. 27, no. 13, 2023.

² S. L. Hamann, N. Kungskulniti, N. Charoenca, V. Kasemsup, S. Ruangkanasetr, and P. Jongkhajornpong, "Electronic cigarette harms: Aggregate evidence shows damage to biological systems," *International Journal of Environmental Research and Public Health*, vol. 20, no. 19, p. 6808, 2023.

a thorough understanding of the differences between the two forms of smoking in terms of their implications on human health.

A) Planar Biological Effects

A-1) Respiratory Hazards of Regular and Electronic Cigarettes: Modernity and Tradition

The respiratory hazards of smoking have been well-established through decades of research. Traditional cigarettes release a wide array of toxic chemicals, including tar, carbon monoxide, and formaldehyde, which contribute to chronic obstructive pulmonary disease (COPD), emphysema, bronchitis, and lung cancer[5]. These conditions are a direct result of the harmful substances inhaled during smoking, which damage the lungs' airways and alveoli, leading to impaired lung function and breathing difficulties[1, 7].

On the other hand, e-cigarettes, which vaporize nicotine-containing liquids (e-liquids), are often considered less harmful due to the absence of tar and many of the carcinogenic chemicals found in tobacco smoke. However, the vapor produced by e-cigarettes contains various potentially harmful substances, such as formaldehyde, acrolein, and diacetyl, which can cause lung irritation and long-term damage. Research has shown that e-cigarette vapor may still have toxic effects on lung tissue, contributing to airway inflammation and impairing lung function, although to a lesser extent compared to traditional cigarettes [2, 4, 8].

A-2) Neurological Hazards of Regular and Electronic Cigarettes

The neurological effects of smoking are equally concerning. Nicotine, a highly addictive substance, is the primary psychoactive component in both regular and electronic cigarettes. Smoking traditional cigarettes can lead to addiction, mood disorders, cognitive

impairment, and a higher risk of developing neurodegenerative diseases such as Alzheimer's and Parkinson's. Nicotine can also cause changes in brain chemistry that alter cognitive function, attention, and memory, especially in young users whose brains are still developing[5, 6, 9].

E-cigarettes, although marketed as a safer alternative, also deliver nicotine to the brain and can result in similar neurological effects. The concentration of nicotine in e-cigarettes can be variable, and some devices allow users to inhale significantly higher amounts of nicotine than they would from traditional cigarettes[5, 9]. This can intensify the addictive potential of e-cigarettes and exacerbate the risk of neurological problems. Furthermore, certain chemicals present in e-cigarette vapor, such as propylene glycol, may have unknown effects on the central nervous system, raising concerns about their potential to cause long-term neurological harm[4].

A) Sociological Impacts³:

The increasing prevalence of vape usage among youth has significant social implications. The accessibility and perception of vaping as a safer alternative to traditional smoking contribute to its growing appeal among younger demographics. This trend fosters social normalization of nicotine use, potentially leading to peer pressure and the glamorization of vaping culture. Moreover, the convenience and discreet nature of vaping devices facilitate habitual use, increasing the risk of addiction⁴. The broader impact includes the potential for altered social interactions, as vaping becomes a social activity within youth communities, reinforcing group behaviors that may undermine public health efforts aimed at curbing nicotine consumption and promoting substance-free lifestyles. Effective education and

³ Goniewicz, M. L., et al. (2018). Comparison of nicotine and toxicant exposure in users of electronic cigarettes and combustible cigarettes. *JAMA Network Open*, 1(8), e185937.

⁴ Callahan-Lyon, P. (2014). Electronic cigarettes: human health effects. *Tobacco Control*, 23(Suppl 2), ii36-ii40.

regulation are essential to mitigate these growing social challenges.⁵

B) The Need for Further Research

Despite the growing use of e-cigarettes, there is a lack of comprehensive studies directly comparing the long-term respiratory and neurological effects of both e-cigarettes and regular cigarettes. Most research on e-cigarettes is still in its infancy, and the full spectrum of their health impacts remains largely unknown. As more individuals, particularly adolescents and young adults, turn to e-cigarettes as an alternative to traditional smoking, it becomes critical to understand the potential risks associated with these devices. This knowledge will help inform public health

policies, smoking cessation programs, and regulations on e-cigarette use[2, 6, 8]. Given the rapidly changing landscape of smoking habits and the increasing popularity of e-cigarettes, it is essential to evaluate the health implications of both regular and electronic cigarettes. This study seeks to fill a gap in the existing literature by providing a detailed comparison of the respiratory and neurological hazards posed by these two forms of smoking. The results of this research can help policymakers, healthcare providers, and the general public make informed decisions about the risks associated with smoking and e-cigarette use[4, 7].

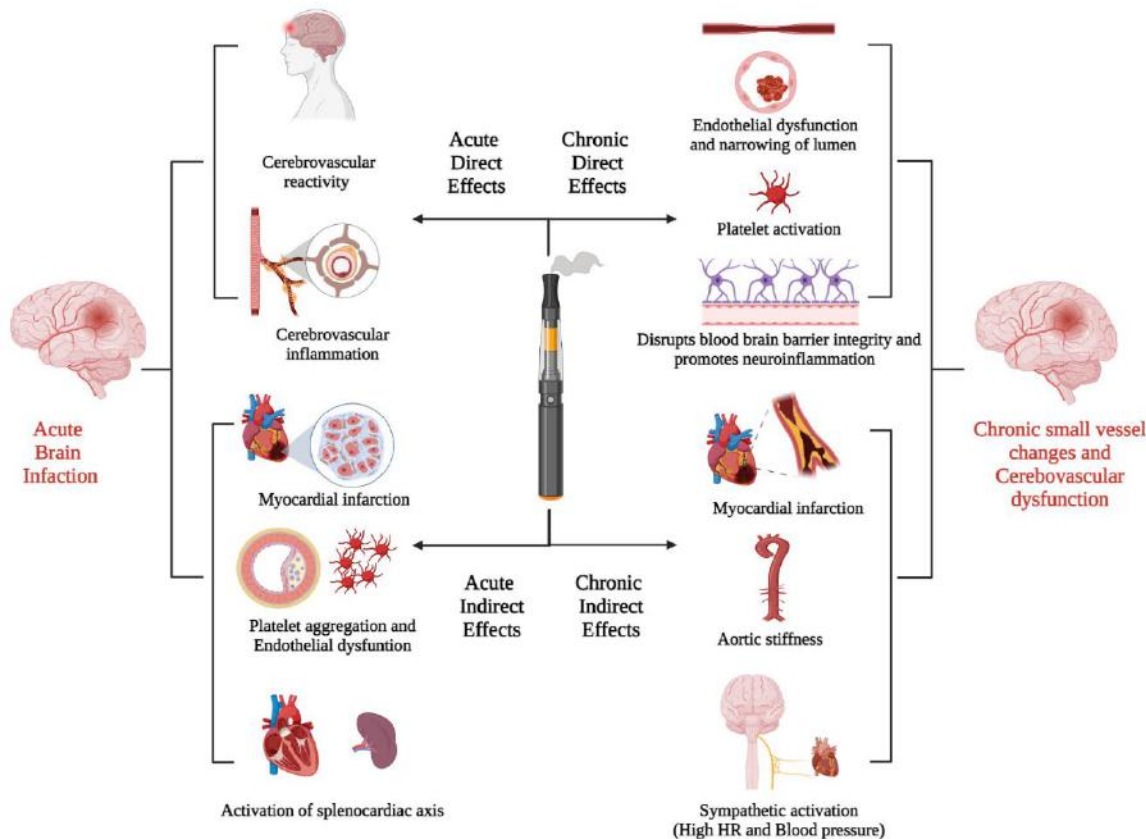


Fig.1. Acute and chronic direct effects of the electronic cigarettes

⁵ Marques, P., Piqueras, L., & Sanz, M.-J. (2021). An updated overview of e-cigarette impact on human health. *Respiratory Research*, 22.

The primary objective of this study is to provide a comparative analysis of the respiratory and neurological hazards associated with regular cigarettes and e-cigarettes. This research will examine the existing literature on the effects of both smoking methods, focusing on their impact on lung function and brain health[10]. By comparing the findings, this study aims to highlight the similarities and differences in the risks posed by these two products and provide a clearer understanding of their respective health consequences. Ultimately, this research aims to contribute to the growing body of evidence regarding the health risks of smoking and e-cigarette use and inform public health strategies aimed at reducing smoking-related diseases[2, 5, 8].

Comparison Table: Respiratory and Neurological Hazards of Regular Cigarettes vs. E-Cigarettes

Health Impact	Regular Cigarettes	E-Cigarettes
Respiratory Hazards	- Causes chronic obstructive pulmonary disease (COPD)	- May cause airway inflammation and respiratory issues
	- Increases risk of emphysema and bronchitis	- Contains potentially harmful chemicals such as formaldehyde, which can irritate the lungs
	- Significant risk for lung cancer due to exposure to tar and carcinogens	- Long-term effects on lung function are still under study, but some evidence of damage exists
Neurological Hazards	- Nicotine addiction leads to cognitive impairment and changes in brain chemistry	- Delivers nicotine, leading to addiction and potential cognitive dysfunction
	- Increased risk of neurodegenerative diseases such as Alzheimer's and Parkinson's	- Variable nicotine concentration may increase neurological risks
	- Impairs attention, memory, and cognitive functions	- Some chemicals in e-cigarettes may have unknown effects on the brain
Addiction Potential	- High due to nicotine and other addictive substances	- Can be equally or more addictive, depending on nicotine concentration
Other Hazards	- Exposure to a wide range of toxic chemicals, including carbon monoxide and formaldehyde	- The potential risks of inhaling vaporized e-liquid ingredients such as propylene glycol and glycerin

Table 1: Urine levels of metabolites of hazardous compounds in e-cigarette-only users versus dual users and non-smokers [6]

HAZARDOUS COMPOUNDS				E-CIGARETTE-ONLY USERS	DUAL USERS	NON-SMOKER CONTROLS
PMA (NG/MG OF CREATININE; BENZENE)				0 (0-2.0)	0.2** (0-2.4)	0 (0-0.1)
HEMA (NG/MG OF CREATININE; ETHYLENE OXIDE)				0.5 (0-7.6)	1.0* (0-8.2)	1.3 (0-4.0)
CNEMA (NG/MG OF CREATININE; ACRYLONITRILE)				1.3 (0-108.4)	59.4** (3.7-142.6)	0** (0-1.6)

3-HPMA (NG/MG OF ACROLEIN)	CREATININE;	254.3 (0-2311.6)	439.7* (153.6-814.4)	192.8* (0-1416.4)
2-HPMA (NG/MG OF PROPYLENE OXIDE)	CREATININE;	28.8 (0-1382.6)	40.2 (10.2-310.9)	15.2** (0-34.5)
AAMA (NG/MG OF ACRYLAMIDE)	CREATININE;	67.3 (0-581.2)	235.6** (41.4-574.7)	34.5** (0-182.0)
HMPMA (NG/MG OF CROTONALDEHYDE)	CREATININE;	148.7 (0-793.4)	185.4 (110.0-437.9)	100.4* (0-522.1)

This table presents the urinary concentrations of metabolites for various hazardous compounds associated with smoking and e-cigarette use. These compounds include metabolites of benzene, ethylene oxide, acrylonitrile, acrolein, propylene oxide, acrylamide, and crotonaldehyde, all of which are harmful chemicals found in both traditional cigarettes and e-cigarettes.

- PMA (Phenylmercapturic acid) is a metabolite of benzene, a known carcinogen. E-cigarette users show significantly lower levels of PMA compared to dual users ($P < 0.01$), suggesting a reduced exposure to benzene in e-cigarette-only users.
- HEMA (2-Hydroxyethylmercapturic acid), a metabolite of ethylene oxide, shows that dual users have higher urinary concentrations than e-cigarette-only users ($P < 0.05$), indicating greater exposure to this compound.
- CNEMA (Cyanoethylmercapturic acid), related to acrylonitrile, is notably higher in dual users than in e-cigarette-only users, with a significant increase ($P < 0.01$). Non-smokers show almost no detectable levels.
- 3-HPMA (Hydroxypropylmercapturic acid), linked to acrolein exposure, also shows higher levels in dual users than in non-smokers and e-cigarette-only users ($P < 0.05$).

- 2-HPMA (2-Hydroxypropylmercapturic acid), a metabolite of propylene oxide, is higher in e-cigarette-only users and dual users compared to non-smokers, though the difference is not as pronounced.
- AAMA (2-Carbamoylmercapturic acid), a metabolite of acrylamide, shows significantly higher levels in dual users compared to e-cigarette-only users, indicating dual users' exposure to higher amounts of this toxic substance ($P < 0.01$).
- HMPMA (Hydroxy-1-methylpropylmercapturic acid), a metabolite of crotonaldehyde, also shows elevated levels in both dual and e-cigarette-only users compared to non-smokers, with dual users again exhibiting higher concentrations than e-cigarette-only users.

Overall, the data illustrates that while e-cigarette-only users have lower levels of most harmful metabolites compared to dual users, they still exhibit some exposure to these hazardous compounds, especially when compared to non-smokers. This highlights the need for further investigation into the long-term health impacts of e-cigarette use.

II. CONCLUSION

Cigarette smoking, whether in the form of traditional cigarettes or electronic cigarettes, poses a significant threat to human health. While traditional cigarettes are widely known to be

associated with respiratory diseases such as COPD, lung cancer, and cardiovascular diseases, electronic cigarettes, despite being marketed as safer alternatives, carry their own specific risks. Although they produce fewer carcinogenic substances, the vapor from e-cigarettes still contains harmful chemicals that can damage the lungs. In terms of neurological effects, both types of cigarettes have negative impacts on brain function. Nicotine in both products leads to addiction and cognitive impairments. Electronic cigarettes, due to their varying nicotine concentrations, can potentially create even greater neurological risks, especially for young users, who are more susceptible to the addictive properties of nicotine.

Overall, despite the differences in the composition of traditional and electronic cigarettes, both products significantly harm human health. Further research is essential to better understand the long-term effects of both types of cigarettes, which will inform public health guidelines and policies aimed at reducing their use. This study highlights that replacing traditional cigarettes with electronic ones does not entirely eliminate health risks. Therefore, the best approach to mitigate health damages from smoking is to avoid both forms of smoking altogether. In conclusion, the findings of this study emphasize the importance of public awareness regarding the risks associated with electronic cigarettes. Instead of relying on commercial promotions, informed decisions must be made to protect public health.

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