

**Use of electronic cigarettes and the cardiovascular impact***Uso de cigarrillos electrónicos y el impacto cardiovascular**Utilização de cigarro eletrônico e o impacto cardiovascular***Juliana Mendes Marques<sup>1\*</sup>**

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This integrative review aimed to analyze the scientific evidence from the last five years on the impact of e-cigarette use on cardiovascular health. An integrative review was conducted using the PubMed/MEDLINE and LILACS databases, including studies published between 2020 and 2025. Studies that evaluated cardiovascular outcomes associated with e-cigarette use were selected. After the screening process, 14 studies comprised the final sample. A consistent association was observed between e-cigarette use and endothelial dysfunction, increased arterial stiffness, elevated heart rate and blood pressure, as well as inflammatory and oxidative markers. It is concluded that current evidence indicates that e-cigarette use is associated with potentially deleterious cardiovascular alterations, and is not a safe method of nicotine consumption for the cardiovascular system.

**Descriptors:** E-cigarettes; Cardiovascular Health; Endothelial Dysfunction; Arterial Stiffness; Nicotine.

**Resumén**

Esta revisión integrativa tuvo como objetivo analizar la evidencia científica de los últimos cinco años sobre el impacto del uso de cigarrillos electrónicos en la salud cardiovascular. Se realizó una revisión integrativa utilizando las bases de datos PubMed/MEDLINE y LILACS, incluyendo estudios publicados entre 2020 y 2025. Se seleccionaron estudios que evaluaron los resultados cardiovasculares asociados con el uso de cigarrillos electrónicos. Tras el proceso de selección, 14 estudios constituyeron la muestra final. Se observó una asociación consistente entre el uso de cigarrillos electrónicos y la disfunción endotelial, el aumento de la rigidez arterial, la elevación de la frecuencia cardíaca y la presión arterial, así como de los marcadores inflamatorios y oxidativos. Se concluye que la evidencia actual indica que el uso de cigarrillos electrónicos se asocia con alteraciones cardiovasculares potencialmente perjudiciales y no es un método seguro de consumo de nicotina para el sistema cardiovascular.

**Descriptoros:** Cigarrillos Electrónicos; Salud Cardiovascular; Disfunción Endotelial; Rigidez Arterial; Nicotina.

**Resumo**

Objetivou-se analisar, por meio de uma revisão integrativa, as evidências científicas dos últimos cinco anos sobre o impacto do uso de cigarros eletrônicos na saúde cardiovascular. Revisão integrativa realizada nas bases PubMed/MEDLINE e LILACS, incluindo estudos publicados entre 2020 e 2025. Foram selecionados estudos que avaliaram desfechos cardiovasculares associados ao uso de cigarros eletrônicos. Após o processo de triagem, 14 estudos compuseram a amostra final. Observou-se associação consistente entre o uso de cigarros eletrônicos e disfunção endotelial, aumento da rigidez arterial, elevação da frequência cardíaca e da pressão arterial, além de marcadores inflamatórios e oxidativos. Conclui-se que as evidências atuais indicam que o uso de cigarros eletrônicos está associado a alterações cardiovasculares potencialmente deletérias, não sendo um método seguro de consumo de nicotina para o sistema cardiovascular.

**Descritores:** Cigarros Eletrônicos; Saúde Cardiovascular; Disfunção Endotelial; Rigidez Arterial; Nicotina.



## Introduction

The introduction of electronic nicotine delivery devices, known as e-cigarettes or "vapes," occurred under the premise of reducing harm associated with conventional smoking. The rapid spread of these devices was driven by the social perception of lower risk, the variety of flavors, and the technological appeal, especially among teenagers and young adults<sup>1</sup>.

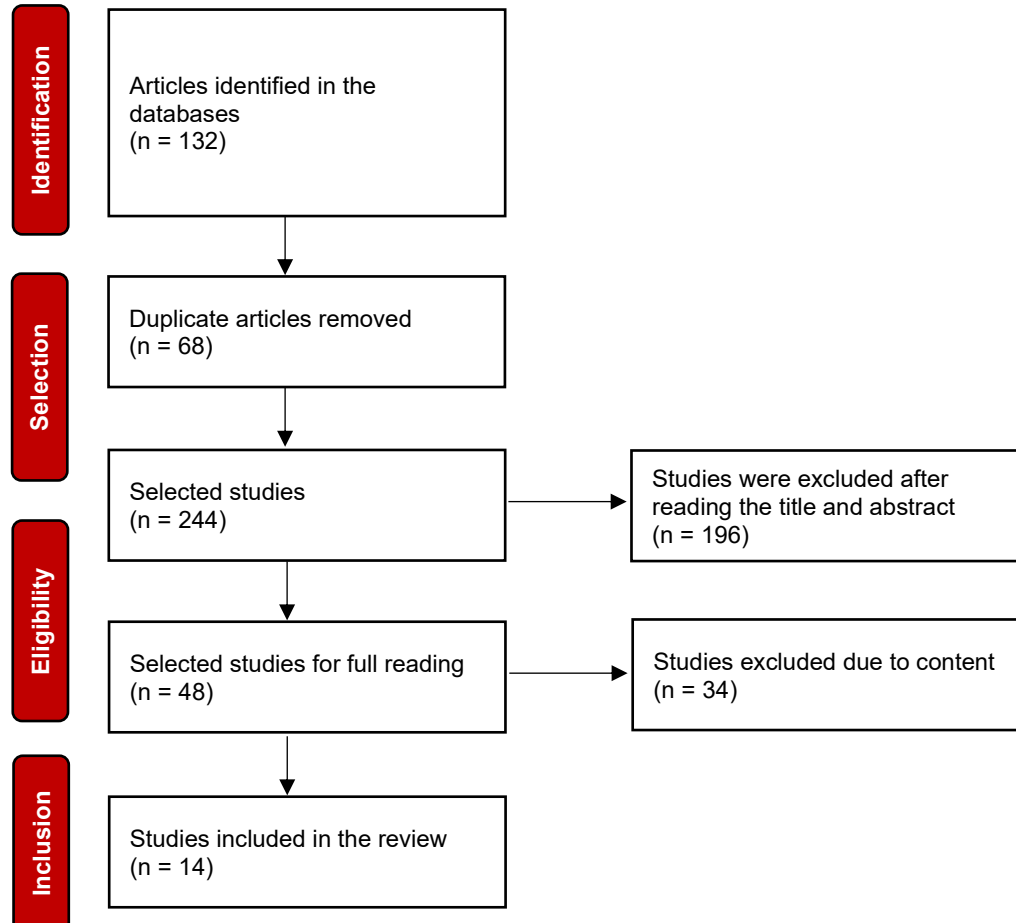
However, the aerosols inhaled during the use of electronic cigarettes contain nicotine, heavy metals, carbonyl compounds, and ultrafine particles capable of inducing oxidative stress, systemic inflammation, and endothelial dysfunction-central pathophysiological mechanisms in the development of cardiovascular diseases. Recent studies have demonstrated acute hemodynamic alterations and impaired vascular function in users of these nicotine devices<sup>2,3</sup>. Even though there is already evidence indicating such harm in the short term, there are still gaps regarding the medium- and long-term effects, especially concerning major clinical events that can be confused with other risk factors, such as acute myocardial infarction, stroke, and arrhythmias. Therefore, a critical synthesis of recent evidence is essential<sup>1,3</sup>.

Thus, the objective of this study was to conduct an integrative literature review of the last five years on the impact of e-cigarette use on cardiovascular health, gathering and critically analyzing the main available findings according to the applied methodology.

## Methodology

This review was conducted using the integrative review method, which allows for the inclusion of different research designs and follows six standardized steps, namely<sup>4</sup>: Step 1 – Identifying the topic and formulating the guiding question. The guiding question was: "What are the impacts of e-cigarette use on cardiovascular health?". Step 2 – Establishing inclusion and exclusion criteria. Inclusion criteria: studies published between 2020 and 2025; original articles, reviews; studies in humans or experimental models with cardiovascular outcomes; databases: PubMed/MEDLINE and LILACS; languages: English and Portuguese. Exclusion criteria: exclusively pulmonary or toxicological studies; experience reports; editorials, opinions, or narrative reviews; duplicates. Step 3 – Searching and selecting studies. The search was conducted using the descriptors and Boolean operator: "electronic cigarettes" OR "vaping" OR "cardiovascular effects" OR "endothelial dysfunction", OR "arterial stiffness", and "electronic cigarettes" AND "vaping" AND "cardiovascular effects" AND "endothelial dysfunction" AND "arterial stiffness". Study selection workflow (PRISMA model described). Records identified: 312. After removing duplicates, 244 studies remained. After reading the title and abstract, 48 studies remained, and after reading the full text, 14 studies, which were included in the review.

Figure 1. Flowchart of the article selection process for integrative review. Angra dos Reis, RJ, Brazil, 2025



Step 4 – Categorization of studies. The studies were analyzed according to authorship/year, type of study, population, type of exposure, cardiovascular outcomes, and main conclusions. Step 5 – Data analysis and interpretation. The analysis was performed descriptively, interpretatively, and comparatively, emphasizing the cardiovascular pathophysiological mechanisms involved. Step 6 – Synthesis of knowledge. The data were organized into a synoptic table and discussed considering the pathophysiological and clinical literature.

**Results**

This section presents a descriptive and analytical synthesis of the main findings of the integrative review, as summarized in Chart 1. The chart, organized chronologically,

compiles 15 relevant studies published between 2020 and 2025, ranging from high-impact journals (Qualis A1) to complementary sources (from Qualis A2 to B1). The synoptic analysis of the columns, which detail author/year, Qualis classification, objective, methodology, main results, and conclusion, allows for a panoramic and comparative view of the current scientific evidence.

As demonstrated in the table and consolidated in the narrative below, the studies converge on a consensus: exposure to vaping, both acute and chronic, is associated with a cascade of adverse cardiovascular effects, ranging from immediate hemodynamic changes to long-term structural and functional damage, configuring a significant risk profile for cardiovascular health.

**Chart 1.** Synthesis of the articles included in the integrative review. Angra dos Reis, RJ, Brazil, 2025

Author/Year	Qualis	Objective	Methodology	Main Results	Conclusion
Kundu et al., 2025 (Heart)	A1	Assess the cardiovascular impacts of vaping.	Meta-analysis (n=38 studies).	Significant increase in blood pressure, heart rate, and arterial stiffness.	Vaping increases overall cardiovascular risk.
Meng et al., 2023 (Eur J Prev Cardiol)	A1	Examine the acute effects of vaping on vascular markers.	Randomized clinical trial.	Reduction of endothelium-dependent vasodilation.	Acute vascular effects like traditional cigarettes.
Mohammadi et al., 2022 (ATVB)	A1	Assess the chronic impact of vaping on endothelial function.	Cross-sectional study.	Decreased FMD levels and increased oxidative stress.	Chronic use impairs endothelial function.
Rose et al., 2023 (Circulation)	A1	Characterize cardiac changes associated with vaping.	Prospective cohort.	Elevated systolic blood pressure and inflammatory markers.	Vaping alters hemodynamic and inflammatory markers.
Critselis et al., 2024 (Angiology)	A2	Determine vascular risk patterns in vape users.	Case-control study.	Increased arterial stiffness and autonomic dysfunction.	Users have a higher cardiovascular risk than non-users.
Hayeck et al., 2021 (JACC Basic Transl Sci)	A1	Analyze the cardiovascular toxicity of aerosols.	Laboratory and in vivo study.	Endothelial injury and increased ROS.	E-cigarette aerosols act as pro-inflammatory agents.
Flores et al., 2020 (Chest)	A1	Assess initial respiratory and cardiovascular effects.	Subacute clinical study.	Increased heart rate and peripheral vascular resistance.	Initial systemic effects are clinically relevant.
Chatterjee et al., 2021 (J Am Heart Assoc)	A1	Relating frequency of use and cardiovascular risk.	Population study (NHANES).	Dose-response correlation with blood pressure and inflammatory markers.	Frequent use increases the long-term risk.
Busch et al., 2024 (Nicotine & Tobacco Research)	A2	Compare vaping vs. traditional cigarettes regarding cardiac risk.	Comparative systematic review.	Both increase oxidative stress and inflammation.	Vaping isn't safe; it's just different.
Pham et al., 2021 (Tobacco Control)	A1	Assess early cardiovascular risk in young people.	Cohort with 1 year follow-up.	Increased resting heart rate and arterial stiffness.	Young users show early signs of change.
Simons et al., 2022 (BMJ Open Heart)	A2	Investigate coronary events associated with vaping.	Integrative review.	Reports of angina, vasospasm, and arrhythmia.	There is growing evidence of ischemic risk
Yingst et al., 2020 (Addictive Behaviors)	B1	Correlate usage patterns and cardiovascular symptoms.	Cross-sectional study (n=845).	Palpitations and tachycardia were reported by 32%.	Subjective cardiovascular symptoms are common.
Goniewicz et al., 2021 (J Am Coll Cardiol)	A1	Determine cardiac biomarkers after acute use.	Experimental clinical study.	Troponin increased slightly in 8% of users.	Aerosols can induce myocardial microinjury.
Wang et al., 2024 (Hypertension)	A1	Relating vape use to the risk of hypertension.	Longitudinal study.	Daily users have a 1.34x higher risk of hypertension.	Strong association between vaping and high blood pressure.

The body of evidence suggests that acute exposure to e-cigarettes promotes an immediate increase in heart rate and blood pressure. Regarding chronic use, it is associated with endothelial dysfunction that triggers inflammation, reduces flow-dependent dilation, and increases arterial stiffness. Furthermore, a consistent increase in systemic inflammatory markers, oxidative stress, and activation of the

sympathetic nervous system is observed. These pathophysiological alterations are associated with a higher risk of developing hypertension, subclinical atherosclerosis, arrhythmias, and heart failure. Although the evidence is still limited, the available data are concerning, pointing to a potentially increased risk of serious cardiovascular events such as myocardial infarction and stroke.



## Discussion

Electronic cigarettes have been shown to promote pathophysiological changes like those observed in conventional smoking, especially regarding endothelial dysfunction, increased sympathetic tone, arterial stiffness, and systemic inflammation, with the difference being the possibility of these events occurring earlier and more abruptly compared to conventional cigarettes. The rationale is that these devices deliver a higher load of nicotine and other inflammatory compounds<sup>6-8</sup>. Nicotine, present in most devices, acts directly on the autonomic nervous system, promoting increased release of catecholamines, elevated blood pressure, tachycardia, and increased myocardial oxygen consumption. In addition, the chemical compounds present in the aerosol promote oxidative stress and endothelial injury, key factors in the development of atherosclerosis<sup>9-12</sup>. From a pathophysiological point of view, the sum of these effects favors microvascular dysfunction, instability of atherosclerotic plaques, cardiac rhythm

disturbances, and adverse cardiac remodeling<sup>3,15,16</sup>. Current gaps in research on the use of electronic cigarettes are mainly related to the lack of long-term prospective studies with "hard" outcomes (mortality, heart attack, stroke), as well as the heterogeneity of the devices and liquids used<sup>2,9-16</sup>.

## Conclusion

Studies have shown that the use of electronic cigarettes is associated with significant cardiovascular changes, including endothelial dysfunction, increased arterial stiffness, sympathetic activation, systemic inflammation, and a potential risk for major cardiovascular events. Given the current evidence, electronic cigarettes cannot be considered safe from a cardiovascular standpoint, making it essential to have public health programs focused on educating and discouraging their use, as well as providing guidance on effective strategies for nicotine addiction cessation.

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