CARDIOVASCULAR REPERCUSSIONS RESULTING FROM THE USE OF ELECTRONIC CIGARETTES BY YOUNG ADULTS

REPERCUSSÕES CARDIOVASCULARES DECORRENTES DO USO DE CIGARRO ELETRÔNICO POR JOVENS ADULTOS

REPERCUSIONES CARDIOVASCULARES RESULTANTES DEL USO DE CIGARRILLOS ELECTRÓNICOS POR ADULTOS JÓVENES

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Wagner de Brito Veras[1], Ana Carolina Marim Favarato[2], Anne Carolliny Kaffler Barboza[3], Isabela Marastoni Durão Romualdo[4], Laiza Menelli Dalpiero Costa[5], Marco Siqueira Bolzani[6]

ABSTRACT

This integrative review aimed to investigate the relationship between the use of electronic cigarettes and the occurrence of cardiovascular outcomes in young adults. Initially, the analysis intended to include individuals aged 18 to 28; however, due to the scarcity of specific studies, it was necessary to expand the age range to 18 to 54 years.
The literature search was conducted using the PubMed, LILACS, and ScienceDirect databases, employing controlled descriptors and specific Boolean operators. After identifying 57 articles and removing duplicates, 11 studies were selected for full reading and analysis. The extracted data were organized in a comparative table including author, title,

[1] Bachelor of Science in Biological Sciences
Bachelor of Science in Physical Therapy
Specialization in Cardiorespiratory Physiotherapy
Master of Science in Physiological Sciences
Dr in Health Sciences
Professor at the University Center of Espírito Santo
Email: wagnerveras@uol.com.br
Lattes: http://lattes.cnpq.br/1676312093014678
Orcid: https://orcid.org/0009-0004-2380-675X
[2] Medical Student, Centro Universitário do Espírito Santo
E-mail: carolfavarato03@gmail.com
Lattes: http://lattes.cnpq.br/7096630624370270
Orcid: https://orcid.org/0009-0007-1242-3093
[3] Medical Student, Centro Universitário do Espírito Santo
Email: annekaffler@hotmail.com
Lattes: http://lattes.cnpq.br/4902233997650652
Orcid: https://orcid.org/0009-0003-6677-4121
[4] Medical Student, Centro Universitário do Espírito Santo
E-mail: isabelamduraor@gmail.com
Lattes: http://lattes.cnpq.br/9220353844460185
Orcid: https://orcid.org/0009-0002-6551-9324
[5] Medical Student, Centro Universitário do Espírito Santo
E-mail: laizamenelli@hotmail.com
Lattes: http://lattes.cnpq.br/0288293545591218
Orcid: https://orcid.org/0009-0002-9813-3786
[6] Medical Student, Centro Universitário do Espírito Santo
E-mail: marco.sb5@hotmail.com
Lattes: https://lattes.cnpq.br/4766064692727437
Orcid: https://orcid.org/0009-0009-9856-7550

study type, exposure, analyzed outcome, and main findings. The methodological quality of observational studies was assessed using the Newcastle-Ottawa Scale (NOS).
The analysis revealed that the use of electronic cigarettes is associated with significant adverse effects on cardiovascular health, including endothelial dysfunction, increased oxidative stress, arterial stiffness, autonomic nervous system alterations, and a higher predisposition to thrombogenicity. These findings highlight the need for further longitudinal studies to clarify long-term effects and the underlying pathophysiological mechanisms.

Keywords: Electronic cigarettes. Young adults. Cardiovascular outcomes. Endothelial dysfunction. Thrombogenicity.

RESUMO

A presente revisão integrativa teve como objetivo investigar a relação entre o uso de cigarros eletrônicos e a ocorrência de desfechos cardiovasculares em jovens adultos. Inicialmente, a análise visava incluir indivíduos de 18 a 28 anos, porém, diante da escassez de estudos específicos, foi necessário ampliar esta faixa etária para 18 a 54 anos.
A busca por estudos foi realizada nas bases PubMed, LILACS e ScienceDirect, utilizando descritores controlados e operadores específicos. Após a identificação de 57 artigos e a exclusão de duplicatas, 14 estudos foram selecionados para leitura e análise. Os dados extraídos foram organizados em uma tabela comparativa contendo autor, título, tipo de estudo, exposição, desfecho analisado e principais resultados. A qualidade metodológica dos estudos observacionais foi avaliada pela ferramenta Newcastle-Ottawa Scale (NOS).
A análise revelou que o uso de cigarros eletrônicos está associado a efeitos adversos significativos na saúde cardiovascular, incluindo disfunção endotelial, aumento do estresse oxidativo, rigidez arterial, alteração do sistema nervoso autônomo e maior predisposição à trombogenicidade. Esses achados reforçam a necessidade de mais estudos longitudinais para esclarecer os efeitos a longo prazo e os mecanismos fisiopatológicos envolvidos.

Palavras-chave: Cigarro eletrônico. Jovens adultos. Desfechos cardiovasculares. Disfunção endotelial. Trombogenicidade.

RESUMEN

Esta revisión integrativa tuvo como objetivo investigar la relación entre el uso de cigarrillos electrónicos y la incidencia de eventos cardiovasculares en adultos jóvenes. Inicialmente, el análisis se centró en personas de 18 a 28 años, pero dada la escasez de estudios específicos, fue necesario ampliar este rango de edad a 18 a 54 años.
La búsqueda de estudios se realizó en las bases de datos PubMed, LILACS y ScienceDirect, utilizando descriptores controlados y operadores específicos. Tras identificar 57 artículos y excluir los duplicados, se seleccionaron 14 estudios para su lectura y análisis. Los datos extraídos se organizaron en una tabla comparativa que contiene autor, título, tipo de estudio, exposición, desenlace analizado y resultados principales. La calidad metodológica de los estudios observacionales se evaluó mediante la Escala de Newcastle-Ottawa (NOS).
El análisis reveló que el uso de cigarrillos electrónicos se asocia con efectos adversos significativos sobre la salud cardiovascular, incluyendo disfunción endotelial, aumento del estrés oxidativo, rigidez arterial, alteración del sistema nervioso autónomo y mayor predisposición a la trombogenicidad. Estos hallazgos refuerzan la necesidad de realizar más estudios longitudinales para esclarecer los efectos a largo plazo y los mecanismos fisiopatológicos implicados.

Palabras clave: Cigarrillo electrónico. Adultos jóvenes. Resultados cardiovasculares. Disfunción endotelial. Trombogenicidad.

INTRODUCTION

The use of electronic cigarettes has become increasingly popular, especially among the younger population, who see these devices as a less harmful alternative to health compared to traditional cigarettes. However, recent scientific evidence and epidemiological data show that e-cigarette use is associated with significant impacts on cardiovascular health, with considerable potential to increase the risk of heart disease and other complications [1][2].

The National Cancer Institute (INCA) points out that there is moderate evidence that, among smokers, the use of electronic cigarettes causes acute effects on the cardiovascular system after their consumption, drawing attention to the immediate risk to cardiovascular functioning. In addition, studies indicate that e-cigarettes generate a sympathetic response similar to that of traditional cigarettes, raising blood pressure and heart rate, with exposure to the vapor of these devices, especially those containing nicotine, being related to increased thrombogenicity [1][3].

It was also observed that the use of electronic smoking devices has an effect similar to that of conventional cigarettes in increasing the risk of myocardial infarction, and the combined use of these two products may also increase this risk [4]. In addition, regular consumption of these devices is related to inflammation, endothelial dysfunction, vascular lesions, and the development of atherosclerosis [5].

This integrative review aims to synthesize the available scientific evidence on the cardiovascular repercussions resulting from the use of e-cigarettes, focusing on the mechanisms involved and the clinical implications. Understanding these effects is essential to support public policies, guide prevention strategies, and raise awareness among the population about the risks associated with the consumption of these products.

METHODOLOGY

This integrative review aimed to evaluate the relationship between the use of e-cigarettes and the occurrence of cardiovascular outcomes in young adults. Initially, the idea was to include only people aged between 18 and 28 years. However, due to the limitation of studies containing only this age group, studies with larger samples, covering individuals aged 18 to 54 years, were also included, as long as they presented data stratified by age group or analyses that allowed inferences about the group of interest.

For the initial selection of studies, a search was performed in three databases: PubMed, LILACS and ScienceDirect, using controlled descriptors and keywords combined

with Boolean operators (AND and OR) to ensure a more comprehensive survey. The search strategies used were as follows:

PubMed: ("electronic cigarette" OR "e-cigarette" OR "vape" OR "Electronic Nicotine Delivery System") AND ("cardiovascular diseases" OR "acute myocardial infarction" OR "stroke" OR "cerebrovascular accident" OR "systemic arterial hypertension" OR "hypertension" OR "coronary microvascular disease" OR "thrombosis" OR "arrhythmia") AND ("young adult")

LILACS: ("electronic cigarette") OR ("e-cig") OR ("e-cigarette") OR ("vape") OR ("Electronic Nicotine Delivery System") AND ("cardiovascular diseases") OR ("acute myocardial infarction") OR ("stroke") OR ("cerebrovascular accident") OR ("hypertension") OR ("coronary microvascular disease") OR ("thrombosis") OR ("arrhythmia") AND ("young adult")

ScienceDirect (Open Access): Three separate searches were performed to ensure the inclusion of all cardiovascular outcomes of interest, since this database limits the search to a maximum of 8 Boolean operators:

1) ("electronic cigarette" OR "e-cigarette" OR "vape") AND ("cardiovascular diseases") AND ("young adult")
2) ("electronic cigarette" OR "e-cigarette" OR "vape") AND ("acute myocardial infarction" OR "stroke" OR "cerebrovascular accident" OR "systemic arterial hypertension") AND ("young adult")
3) ("electronic cigarette" OR "e-cigarette" OR "vape" OR "Electronic Nicotine Delivery System") AND ("coronary microvascular disease" OR "thrombosis" OR "arrhythmia") AND ("young adult")

Studies that met the following criteria were included:

1) **Inclusion Criteria:** 1.1) Studies published in peer-reviewed journals; 1.2) Observational studies (cohort, case-control, cross-sectional) and clinical trials; 1.3) Studies that analyzed the relationship between the use of electronic cigarettes and cardiovascular outcomes; 1.4) Studies with a population composed mostly of young adults (18-28 years) or that included this age group within a broader group (18-54 years), (provided that the data were stratified); 1.5) Publications in English, Portuguese or Spanish; 1.6) Studies published in the last 10 years.
2) **Exclusion Criteria:** 2.1) Narrative revisions, letters to the editor and comments; 2.2) Studies that did not address the relationship between electronic cigarettes and cardiovascular diseases; 2.3) Studies that exclusively analyzed populations over 30

years of age without stratification by age; 2.4) Studies with weak methodology or insufficient data.

The selection of articles was carried out in five stages:

1. Identification of Studies: The initial search resulted in 62 articles, which were imported into the "Mendeley Reference Manager" software for organization and screening;
2. Duplicate Deletion: 7 duplicate articles have been removed;
3. Initial Screening: Analysis of the titles and abstracts of the remaining 55 articles led to the exclusion of 41 studies that did not meet the inclusion criteria and/or met exclusion criteria;
4. Access to Full Texts: There were 14 articles, 3 of which were restricted. For these, access was requested via the library of the University Center of Espírito Santo (UNESC);
5. Full Reading and Critical Analysis: All remaining 14 articles were read in full for further synthesis and discussion of the findings.

Data analysis:

From the 14 selected articles, comparative tables were constructed containing information on the author, title, type of study, presentation, outcome analyzed, and main results found by each study.

The main results were summarized to the main points identified by the authors, associated with scientific relevance to the objective of this review.

For the methodological analysis of the studies, the Newcastle-Ottawa Scale (NOS) tool was used to assess the methodological quality of observational studies and clinical trials, and the AMSTAR 2 tool was used to assess the methodological quality of the systematic review.

RESULTS

Table 1 - Characteristics of the studies included in the review

Author(s) and Year	Title	Study Type	Population	Outcome Evaluated	Main results
DEMIR, V. et al. (2020)	Acute effects of electronic cigarette smoking on ventricular	Observational	E-cigarette users (n=36) and Healthy control (n=40)	Ventricular repolarization	The group of e-cigarette users showed a significant increase in baseline heart rate, RR interval, Tp-e interval, and corrected Tp-e interval compared to

	repolarization in adults				controls. The Tp-e/QT and Tp-e/QTc ratios were also higher in the e-cigarette group. There were no differences in other ECG parameters between the groups. These ECG changes indicate a potential increase in the risk of ventricular arrhythmias.
ELO-EGHOS, E. et al. (2025)	Sex-specific associations of cigarettes and e-cigarettes use with self-reported premature atherosclerotic cardiovascular disease among adults aged 18-54 in the United States	Observational	480,317 adults aged 18-54 years (data from the Behavioral Risk Factor Surveillance System (BRFSS)	Self-reported early atherosclerotic cardiovascular disease	In the group of isolated e-cigarette users, there was no significant association with the onset of early atherosclerotic cardiovascular disease. On the other hand, both in the group that used e-cigarettes and conventional cigarettes combined with conventional cigarettes, there was a greater chance of developing early atherosclerotic cardiovascular disease.
FETTERMAN, J. L. et al. (2020)	Alterations in vascular function associated with the use of combustible and electronic cigarettes	Observational	Non-smokers (n=94), combustible cigarette users (n=285), e-cigarette users (n=36) or dual users (n=52)	Vascular function	The use of e-cigarettes alone or in combination with combustible cigarettes has been shown to be closely associated with changes in endothelial function and arterial stiffness. In addition, a much higher rate of ALX was identified in combustible cigarette users compared to non-smokers, indicating a much higher arterial stiffness. When compared to exclusive users of electronic cigarettes and users of both, the rates were very similar, confirming that the use of electronic cigarettes does not confer a more favorable profile. Through another analysis, it was found that endothelial cells collected from e-cigarette and fuel users produced less nitric oxide in response to stimulation with A23187 when compared to non-smokers, showing a dysfunction of nitric oxide signaling.

HALSTEAD, K. M. et al. (2023)	Sex Differences in Oxidative Stress-Mediated Reductions in Microvascular Endothelial Function in Young Adult e-Cigarette Users	Observational	Young and healthy e-cigarette users (n=20, 10 men and 10 women), healthy controls (n=20, 10 men and 10 women).	Microvascular endothelial function	The group of chronic e-cigarette users showed a reduction in endothelial function and nitric oxide-dependent dilation, especially in women. In addition, it was identified that this reduction triggers oxidative stress through TBARS markers, increasing superoxide production in peripheral blood mononuclear cells, which in turn increased the risks of cardiovascular diseases.
KELESIDIS, T. et al. (2020)	Elevated cellular oxidative stress in circulating immune cells in otherwise healthy young people who use electronic cigarettes in a cross-sectional single-center study: Implications for future cardiovascular risk	Observational	Healthy young people, as follows: non-smokers (n=12), e-cigarette smokers (n=12) and traditional cigarette smokers (n=9)	Cellular oxidative stress	E-cigarette users had arterial stiffness and endothelial dysfunction similar to those observed in conventional cigarette smokers. Specifically, the endothelial cells of e-cigarette users produced less nitric oxide and more reactive oxygen species.
LYYTINEN, G. et al. (2023)	Electronic Cigarette Vaping with Nicotine Causes Increased Thrombogenicity and Impaired Microvascular Function in Healthy Volunteers	Randomized controlled trial	Selected 22 healthy volunteers, aged between 18 and 45 years	Thrombogenicity and microvascular function	Exposure to nicotine-rich e-cigarette (EC) aerosol significantly increased the formation of fibrin-rich platelet thrombi when compared with non-nicotine FBs within 15 minutes, with normalization after 60 minutes. There was also less endothelium-independent vasodilation, which was reduced after vaporization of CE with nicotine. The results indicated that, after the immediate use of electronic cigarettes, there was a significant increase in thrombogenicity and a deterioration in microvascular function. These outcomes were not significantly associated with the use of non-nicotine ECs, indicating nicotine as

					the main mediator of these effects.
MOHEIMANI, R. S. et al. (2017a)	Increased Cardiac Sympathetic Activity and Oxidative Stress in Habitual Electronic Cigarette Users: Implications for Cardiovascular Risk	Observational (cross-sectional case-control)	E-cigarette users (n=23) and control group (n=19)	Cardiac sympathetic activity and oxidative stress	E-cigarette users showed reduced heart rate variability (HRV), characterized by an increase in sympathetic activity and reduced parasympathetic activity. In addition, greater LDL oxidation was observed in e-cigarette users when compared to non-users. These adverse effects persisted even after the elimination of nicotine from plasma, suggesting a chronic adaptation of the cardiovascular system to the use of e-cigarettes.
MOHEIMANI, R. S. et al. (2017b)	Sympathomimetic Effects of Acute E-Cigarette Use: Role of Nicotine and Non-Nicotine Constituents	Open-label, randomized, crossover study. Each participant underwent 3 exposure sessions, separated by a 4-week washout: (1) nicotine e-cigarette; (2) nicotine-free e-cigarette and (3) simulated control consisting of smoking in a device without e-liquid.	33 healthy volunteers with no history of current use of e-cigarettes or conventional cigarettes	Sympathetic autonomic nervous system activity in the heart.	Only nicotine cigarettes increase sympathetic activity in the cardiovascular system significantly. It was also noted that, in contrast to previous studies, no acute effect on oxidative stress load was observed with either nicotine or non-nicotine. These results indicate that the increase in sympathetic activity is related to inhaled nicotine and not to the other components of e-cigarettes.

PAREKH, T.; PEMMASANI, S.; DESAI, R. (2020)	Risk of Stroke With E-Cigarette and Combustible Cigarette Use in Young Adults	Observational	161,529 participants, aged 18 to 44 years.	Risk of stroke	The use of e-cigarettes (electronic cigarettes) showed a two-fold higher odds of having a stroke when compared to non-smokers. Meanwhile, individuals who use it simultaneously have this rate increased by almost three times. Another important factor is that the greater the intensity of use, the higher these index values will be, which can bring a worse prognosis of the disease. Finally, the study indicates that the exchange of conventional cigarettes for electronic smoking devices does not confer benefit in terms of stroke risk, as both have similar harms.
PODZOLKOV, V. I. et al. (2020)	Relation between Tobacco Smoking/Electronic Smoking and Albuminuria/Vascular Stiffness in Young People without Cardiovascular Diseases	Observational	270 young people with no known CVD. Vape smokers (n=22), regular cigarette smokers (n=51) and nonsmokers (n=197).	Albuminuria and vascular stiffness	The study indicates that smokers of traditional cigarettes and vapers have a much higher rate of albuminuria (AU) when compared to non-smokers. In addition, the results show that the changes of e-cigarette users were considerably greater than those who use traditional cigarettes, showing that the two have large discrepancies. Another significant correlation used was between albuminuria indices and smoking time: the longer the duration of use, the higher the cardiovascular and renal risk index, with differences in impact when the patient's gender is taken into account. Another finding of great importance was that arterial stiffness (measured by the arterial amplification index - Alp) was much higher in smokers than in nonsmokers.

STOKES, A. C. et al. (2021)	Association of Cigarette and Electronic Cigarette Use Patterns With Levels of Inflammatory and Oxidative Stress Biomarkers Among US Adults	Observational (longitudinal cohort)	7,130 participants: exclusive CE users (n= 135), exclusive CC users (n=2110), combined CE and CC users (n=707), and nonsmokers (n= 4,178).	Levels of inflammatory biomarkers and oxidative stress	Exclusive users of electronic cigarettes did not show a significant increase in inflammatory and oxidative stress biomarkers compared to the non-smoking group. Conventional and combined cigarette users had significantly higher values of these biomarkers compared to all other groups, with no marked difference between exclusive users of CC (conventional cigarette) and combined CC and EC (electronic cigarettes). EC-only users had significantly fewer inflammatory biomarkers, except CRP, compared to CC-only users.
Vindhyal et al. (2020)	Cardiovascular Outcomes Associated With Adult Electronic Cigarette Use	Cross-sectional study	Adults (NHIS data 2014, 2016, 2017, and 2018)	IAM, STROKE, DAC	Dual users (CE and CC) had the highest odds of myocardial infarction (OR = 5.44), followed by users of WC alone (OR = 4.52) and current e-cigarette users (OR = 4.09). Dual users of FBs and conventional cigarettes had an increased risk of stroke (OR = 2.32). The combined use of CE and CC increased the risk of AMI, stroke, and CAD.
Alzahrani et al. (2023)	Association between e-cigarette use	Cross-sectional study	Adults (2014 and	Acute myocardial infarction	Daily e-cigarette users had a significantly increased risk of AMI compared to the

	and myocardial infarction		2016 NIHS data)		population with similar characteristics who did not use e-cigarettes (OR 1.56). Daily users of CC were more likely to have AMI compared to the control population (OR = 2.72). There was no statistically significant association between past use of FB and AMI. On the other hand, previous use of CC increased the chance of having a coronary event after cessation of use. In addition, the presence of comorbidities, such as dyslipidemia and diabetes, increase the chance of this outcome occurring.
Siddiqi et al. (2023)	Association of electronic cigarette exposure with cardiovascular health: A systematic review and meta-analysis	Systematic review and meta-analysis	Young adults	Heart rate, systolic/diastolic BP, PWV, FMD, biomarkers (P-selectin, CD40L)	The use of electronic cigarettes is associated with several physiological changes associated with increased cardiovascular risk, including: increased heart rate, blood pressure, arterial stiffness, and inflammatory biomarkers, in addition to reduced dilation mediated by blood flow.

Source: Authorship

EVALUATION OF THE METHODOLOGICAL QUALITY OF THE STUDIES:

The methodological quality of observational studies and clinical trials was assessed using the Newcastle-Ottawa Scale (NOS), shown in Table 2. The scale awards up to 9 stars in three domains: Selection (4 points), Comparability (2 points) and Outcome/Exposure (3 points). Below is the template with the criteria used for scoring. Table 3 presents the scores of the 13 studies analyzed.

For systematic reviews, the tool used to assess methodological quality was AMSTAR-2, whose scoring parameters are shown in Table 4.

Table 2 – Newcastle-Ottawa Scale (NOS): evaluation criteria

Domain	Criterion	Maximum Score
Selection	Representativeness of the sample	1 star
	Control Group Selection	1 star
	Exposure determination	1 star
	Confirmation that the outcome of interest was not present at baseline	1 star
Comparability	Control for key variables	1 star
	Control for other relevant variables	1 star
Outcome/Exhibition	Objective and valid outcome assessment	1 star
	Adequate follow-up time (or measurement of expected effects)	1 star
	Completeness of follow-up data (or appropriate statistical analysis)	1 star

Source: Authorship

Table 3 - Evaluation of the Methodological Quality of the Studies According to the Newcastle-Ottawa Scale

Author(s) and Year	National Team (0-4)	Comparability (0-2)	Outcome/Exposure (0-3)	Total Score (0-9)	Comments
Demir et al. (2020)	4	1	3	8	There was an adequate choice of participants, in addition to well-defined and reliably measured outcomes, despite the lack of randomization and matching between the groups, which impacts the comparison between them.
Elo-Eghosa et al. (2025)	4	2	1	7	The study had a large number of participants, with a good definition of the inclusion and exclusion criteria and used robust statistical analyses. However, the outcomes were counted based on self-reported data, creating a measurement bias.
Fetterman et al. (2020)	3	1	2	6	The study had a good distribution and representativeness of participants, presented a clear definition of the outcomes, and used accurate measurement methods, but the cross-sectional design and the absence of randomization affect the evaluation and association of causality between the variables.
Halstead et al. (2023)	3	1	3	7	The study had good inclusion and exclusion criteria, and had an

					adequate sample distribution. There was an appropriate choice of outcomes and reliable measurement methods. However, as the study was not randomized, the causal relationship between the variables and the outcomes is not solid.
Kelesidis et al. (2020)	3	1	3	7	The study had a homogeneous distribution of participants and included only healthy volunteers, with no previous exposure to confounding factors, which is important to eliminate confounding bias. He used valid and accurate measurement methods. However, the absence of randomization and relatively small sample size limit the robustness of the results.
Lyytinen et al. (2023)	4	2	3	9	The selection of participants was well defined, and the use of randomization, double-blinding, and subsequent cross-over, strengthened the validity of the comparison between the groups. The measurement method was reliable and the outcomes were clear. The study has a good methodological quality.
Moheimani et al. (2017a)	4	1	3	8	The study had adequate selection, distribution and representativeness. He used valid measurement methods in a controlled environment. However, it did not perform toxicological screening for other drugs, in addition to relying on the patients' self-report to assess that they do not use conventional cigarettes or other substances, which compromises the internal validity of the study. However, the results are consistent with studies that measured similar outcomes. In addition, it opened the door for subsequent studies to analyze which compounds in e-cigarettes are involved in the outcomes.
Moheimani et al. (2017b)	4	2	3	9	The selection, comparison and measurement were well carried out. Although the study did not find a significant increase in oxidative stress, it did provide evidence that the sympathomimetic effect of e-cigarettes is primarily associated with nicotine.

Parekh et al. (2020)	4	2	3	9	The study had a highly representative sample, strengthening the external validity. For comparison and measurement, logistic regression models were used, adjusted for demographic variables and comorbidities, increasing the reliability of the results. Although the study found that the exclusive use of e-cigarettes did not increase the chances of stroke in young adults, it highlights that the combined use of e-cigarettes and conventional cigarettes significantly increased the risk of stroke (stroke).
Podzolkov et al. (2020)	4	2	3	9	The study used a well-defined sample of young adults. Data analysis was robust, using multiple assessment methods, which faithfully reflect the cardiovascular health of individuals.
Stokes et al. (2021)	4	2	3	9	The study had a strongly representative sample, with stratification of individual variables and measured valid and relevant outcomes to infer cardiovascular health.
Alzahrani et al., 2018	3	2	2	7	This is a representative cross-sectional study, but it has limitations because it has self-reported data. In addition, there is no specificity of the duration and amount of e-cigarette use.
Vindhyal et al. (2020)	3	2	2	7	Like Alzharani's study, this study relied on the robust NHIS database. However, it presented the same limitations, such as self-reported data and lack of specificity regarding the intensity and duration of e-cigarette consumption. In addition, the population was not controlled for other variables, such as previous CVD (Cardiovascular Disease), use of medications, and treatment used.

Source: Authorship

Table 4: Methodological evaluation of the systematic review using the AMSTAR-2 tool

	Siddiqi et al. (2023)
1. Clear objective and explanation of the problem	Yes
2. Study search method	Yes
3. Selection of studies	Yes
4. Quality of the study	Yes
5. Well-defined inclusion and exclusion criteria	Yes

6. Data Extraction Process	Yes
7. Method of statistical analysis	Yes
8. Confirmation of the reproducibility of the results	Yes
9. Heterogeneity of studies	Yes
10. Publication bias	Not discussed
11. Clear conclusions	Yes
12. Assessment of adverse effects	Yes
13. Discussion and practical implications	Yes
14. Recommendations for future research	Yes
15. Study limitations	Yes
16. Clinical relevance	Yes

Source: Authorship

DISCUSSION

The findings gathered in this review show a consensus in the scientific literature about the impacts of the use of electronic cigarettes on the cardiovascular health of young adults. More recent studies have shown that the use of these devices is associated with significant hemodynamic changes, increased oxidative stress, endothelial dysfunction, arterial stiffness, and impaired microvascular function, which is a worrying scenario considering the growing popularization of the use of so-called "vapes" among the younger population (MOHEIMANI et al., 2017a; KELESIDIS et al., 2020; HALSTEAD et al., 2023).

Comparing the results of the studies analyzed, there is convergence regarding the role of nicotine on the cardiovascular system. Moheimani et al. (2017b) and Kelesidis et al. (2020) point out that the sympathetic activation induced by inhaled nicotine contributes to the increase in heart rate and blood pressure, factors that, when persistent, increase the risk of cardiovascular events. In a complementary way, Lyytinen et al. (2023) demonstrate that exposure to aerosol containing nicotine potentiates thrombogenicity, with the formation of platelet aggregates and impairment of endothelial vasodilation, corroborating the pathophysiological mechanisms suggested by Fetterman et al. (2020).

However, the literature also suggests that cardiovascular effects are not restricted to the presence of nicotine. Substances such as propylene glycol, glycerin, and flavorings present in the liquids used in e-cigarettes have shown potential to induce oxidative stress and vascular changes, even in the absence of nicotine (STOKES et al., 2021; PODZOLKOV et al., 2020). Such a finding demystifies the mistaken perception that nicotine-free devices would be risk-free.

Another highlight is the existence of possible differences between the sexes in the physiological response to the use of electronic cigarettes. Data presented by Halstead et al. (2023) and Elo-Eghosa et al. (2025), indicate that young women may have a greater

susceptibility to endothelial dysfunction mediated by oxidative stress, in addition to a higher risk of early development of cardiovascular diseases. This finding highlights the need for more individualized approaches in future studies and prevention policies.

Regarding electrophysiological changes, Demir et al. (2020) and Panikkath et al. (2011) draw attention to the prolongation of the Tp/Te interval in users of electronic devices, which represents a marker of vulnerability to ventricular arrhythmias and sudden cardiac death. Although it was not possible to establish a direct causal relationship, these findings point to possible lethal outcome mechanisms that deserve further investigation.

The critical analysis of the methodological quality of the studies reveals important variations. According to the Newcastle-Ottawa Scale, articles such as those by Lyytinen et al. (2023) and Halstead et al. (2023) presented robust methodological criteria, with good sample definition, adequate control of variables, and consistent statistical analysis. On the other hand, studies such as the one by Fetterman et al. (2020) had limitations related to the cross-sectional design and the absence of longitudinal data, making it difficult to infer causality. These methodological limitations should be considered when interpreting aggregate results.

In terms of practical applicability, the findings of this review have direct implications for public health. The use of electronic cigarettes, often promoted as a less harmful alternative to conventional smoking, has been consolidated among young people, which poses a new challenge for health professionals. Evidence of cardiovascular risk reinforces the need for educational campaigns, in addition to the formulation of stricter regulatory policies regarding the advertising, sale and consumption of these electronic devices.

Despite the relevance of the data presented, this review has limitations. Among them, the scarcity of clinical trials with long-term follow-up, the predominance of cross-sectional observational studies, and the geographical limitation of samples, often restricted to specific populations in the United States and Europe.

Based on the gaps identified, it is recommended that future research prioritize longitudinal and multicenter designs, capable of assessing the progression of cardiovascular damage over time. In addition, it is essential to explore the interaction between individual factors, such as age, gender, genetic predisposition, and comorbidities, in order to elucidate the mechanisms by which the components of e-cigarettes affect the cardiovascular system in different subgroups.

In this way, this integrative review contributes to strengthening the scientific basis on the risks associated with the use of electronic cigarettes, highlighting the urgency of actions

that promote the reduction of consumption among young adults and reinforce surveillance of the products marketed.

CONCLUSION

The present integrative review found a significant association between e-cigarette use and several adverse cardiovascular health outcomes in young adults. The studies analyzed indicate that both acute and chronic exposure to the products of these devices are related to important changes in endothelial function, increased oxidative stress, arterial stiffness, sympathetic hyperactivity, and increased thrombogenic risk. Such pathophysiological changes contribute to the development and progression of cardiovascular diseases, with similar risks for e-cigarette users compared to those for conventional cigarette smokers.

Evidence of cardiac electrophysiological alterations that can increase the risk of arrhythmias and sudden death was also identified. Despite advances in the understanding of risks, methodological limitations of some studies, such as small sample sizes or inadequate control of confounding factors, highlight the need for more robust investigations.

In view of the findings, the importance of broadening the discussion on the impacts of the use of electronic cigarettes in the context of public health, especially among young adults, is evident. The results of this review point to the need for a more effective preventive approach, combined with health education, which demystifies the idea that electronic devices are a safe alternative to conventional cigarettes.

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