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Electronic Cigarette: Current Evidence and Implications for Public Health

(Cigarro Eletrônico: Evidências Atuais e Implicações para a Saúde Pública)

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RESUMO

Os cigarros eletrônicos, uma alternativa popular ao tabaco tradicional, têm sido amplamente discutidos quanto aos seus impactos na saúde pública. Com o aumento do uso de dispositivos eletrônicos de vaporização, há uma necessidade crescente de entender seus efeitos na saúde humana, particularmente em relação às doenças cardiovasculares e respiratórias e ao risco de dependência. Embora considerado por alguns como uma opção menos prejudicial, diversas evidências sugerem riscos à saúde, especialmente em longo prazo. Este estudo tem como objetivo revisar as evidências atuais sobre os efeitos do uso do cigarro eletrônico, com foco em suas implicações para a saúde pública. Também busca avaliar as consequências do uso do cigarro eletrônico para a saúde cardiovascular e respiratória e a prevalência de doenças associadas ao seu uso. Trata-se de uma revisão retrospectiva da literatura científica publicada entre 2015 e 2024, utilizando bases de dados como PubMed, Medline e SciELO. A seleção dos artigos foi baseada na análise de estudos e revisões clínicas e epidemiológicas que investigaram os efeitos do cigarro eletrônico em usuários, com ênfase em dados sobre complicações respiratórias, cardiovasculares e de dependência. A partir deste estudo, foi possível observar que o uso de cigarros eletrônicos está associado a uma série de riscos à saúde, incluindo aumento da pressão arterial, danos ao sistema cardiovascular e alterações na função pulmonar. Além disso, os estudos mostraram que os vapores contêm substâncias tóxicas, como formaldeído e acetaldeído, que podem causar inflamação crônica nos pulmões e contribuir para doenças respiratórias. Além disso, a presença de nicotina em líquidos de vaporização continua sendo uma preocupação significativa devido ao seu potencial de induzir dependência. Em resumo, embora os cigarros eletrônicos sejam promovidos como uma alternativa mais segura aos cigarros tradicionais, evidências científicas mostram que os cigarros eletrônicos ainda representam riscos consideráveis à saúde pública. Assim, a falta de estudos longitudinais sobre seus efeitos a longo prazo exige monitoramento contínuo e ações regulatórias rigorosas são necessárias para mitigar os danos causados por esses produtos, especialmente entre os jovens, e para evitar o aumento do consumo em massa.

ABSTRACT

Electronic cigarettes, a popular alternative to traditional tobacco, have been widely discussed regarding their impacts on public health. With the increase in the use of electronic vaporization devices, there is a growing need to understand their effects on human health, particularly in relation to cardiovascular and respiratory diseases and the risk of dependence. Although considered by some as a less harmful option, several pieces of evidence suggest health risks, especially in the long term. This study aims to review the current evidence on the effects of electronic cigarette use, focusing on its implications for public health. It also seeks to assess the consequences of electronic cigarette use for cardiovascular and respiratory health and the

prevalence of diseases associated with their use. This is a retrospective review of the scientific literature published between 2015 and 2024, using databases such as PubMed, Medline and SciELO. The selection of articles was based on the analysis of clinical and epidemiological studies and reviews that investigated the effects of electronic cigarettes on users, with an emphasis on data on respiratory, cardiovascular and dependence complications. From this study, it was possible to observe that the use of e-cigarettes is associated with a series of health risks, including increased blood pressure, damage to the cardiovascular system and changes in lung function. In addition, the studies showed that the vapors contain toxic substances such as formaldehyde and acetaldehyde, which can cause chronic inflammation in the lungs and contribute to respiratory diseases. In addition, the presence of nicotine in vaping liquids continues to be a significant concern due to its potential to induce dependence. In summary, although e-cigarettes are promoted as a safer alternative to traditional cigarettes, scientific evidence shows that e-cigarettes still pose considerable risks to public health. Thus, the lack of longitudinal studies on their long-term effects requires continued monitoring and rigorous regulatory actions are necessary to mitigate the harm caused by these products, especially among young people, and to prevent the increase in mass consumption.

1. INTRODUÇÃO / INTRODUCTION

The electronic cigarette, also known as "Vape" or Electronic Nicotine Delivery System (ENDS), has become a global phenomenon, particularly among young people and former smokers[1,2]. Initially introduced to the market as an alternative to traditional cigarettes, promoted as a harm reduction tool, its use has grown exponentially over the past decade[3,4]. However, as the popularity of these devices increases, emerging scientific evidence points to potential health risks, raising concerns among healthcare professionals and regulatory authorities[5,6].

The World Health Organization (WHO) has warned about the potential dangers of electronic cigarettes, emphasizing the lack of robust evidence proving their effectiveness as a smoking cessation strategy and highlighting their associated risks, mainly due to the toxic content of the inhaled aerosols[7,8]. Recent studies suggest that while electronic cigarettes may contain fewer harmful chemicals than conventional cigarettes, they are still significant sources of harmful compounds such as formaldehyde, acrolein, and heavy metals[9,10].

In addition to chemical risks, the impact of electronic cigarettes on lung health has been widely debated. EVALI (E-cigarette or Vaping Product Use-Associated Lung Injury), a severe lung disease associated with the use of vapes, was first identified in the United States in 2019 and resulted in thousands of hospitalizations and several deaths[11,12]. Although most cases were attributed to the use of liquids containing tetrahydrocannabinol (THC) adulterated with vitamin E acetate, the outbreak highlighted the vulnerability of users to the toxic effects of inhaled aerosols[13,14].

Moreover, the impact of electronic cigarettes on lung health has been a growing concern among researchers and healthcare professionals. Although initially promoted as a less harmful alternative to conventional tobacco, emerging evidence indicates that the aerosols released by electronic cigarettes contain toxic substances that can compromise lung function and induce respiratory inflammation[15,16]. Laboratory and clinical studies have shown that inhaling the vapors can cause epithelial injuries in the lungs, increasing the risk of diseases such as chronic bronchitis, asthma, and alveolar damage[17,18].

Furthermore, the EVALI epidemic reinforced concerns about the pulmonary risks of using electronic cigarettes. The outbreak, which resulted in more than 2,800 hospitalizations and approximately 68 deaths, was initially associated with the use of products containing tetrahydrocannabinol (THC) adulterated with vitamin E acetate, but also raised questions about the overall safety of vaping devices[19,20]. Exposure to chemicals such as formaldehyde, acrolein, and diacetyl has been linked to inflammatory damage and dysfunction of the pulmonary epithelial barrier, contributing to the development of respiratory pathologies[21,22].

Additionally, research suggests that electronic cigarettes may negatively affect lung immunity. A recent study demonstrated that exposure to vape aerosol reduces the ability of alveolar macrophages to phagocytize pathogens, increasing susceptibility to respiratory infections[2324]. These findings reinforce the need for continuous monitoring of the impacts of electronic cigarettes on lung health and the implementation of public policies to limit their spread, especially among adolescents and young adults[25,26].

Another concerning factor is the increasing adoption of electronic cigarettes by young people. According to data from the Centers for Disease Control and Prevention (CDC), approximately 14.1% of high school students in the United States reported using electronic cigarettes in 2022, with a higher prevalence among adolescents than among adult smokers seeking smoking cessation[27,28]. This trend is partly due to the wide availability of flavored devices, aggressive marketing by industries, and the mistaken perception that electronic cigarettes are harmless[29,30].

Nicotine, the main active substance present in electronic cigarettes, represents an additional challenge for public health. Highly addictive, nicotine can affect the brain development of adolescents and young adults, impairing cognitive functions and increasing the risk of dependency[31,32]. Moreover, prolonged exposure to nicotine is associated with cardiovascular dysfunctions, including increased blood pressure and the risk of atherosclerosis[33].

From a regulatory standpoint, various countries have adopted different approaches regarding the marketing and

use of electronic cigarettes. While countries such as Brazil and India prohibit the sale of these devices, others, such as the United Kingdom, incorporate them into smoking cessation strategies, based on the premise that they represent a lower risk compared to conventional tobacco[34,35]. The absence of global consensus on the issue underscores the need for more longitudinal studies to assess the long-term impacts of electronic cigarette use and its implications for public health[36,37].

Given this scenario, it is essential to deepen scientific investigation into the effects of electronic cigarettes on human health, as well as to strengthen effective public policies to prevent their spread, especially among vulnerable populations[38]. This article seeks to analyze the most recent evidence on the impact of electronic cigarettes and discuss the implications for public health, addressing both the potential benefits and risks associated with their use.

METHODS

This study was developed based on a retrospective literature review using the PubMed, Medline, and SciELO databases. The search terms used were "Electronic Cigarettes," "Impact," "Public Health," and their corresponding terms in English, "Electronic cigarette," "Impact," "Public Health," along with the Boolean operator "AND" for database searches. The exclusion criteria were: articles that did not correlate with the theme of electronic cigarette use, its impacts, and challenges in the context of public health, as well as articles published outside the studied period from 2015 to 2024.

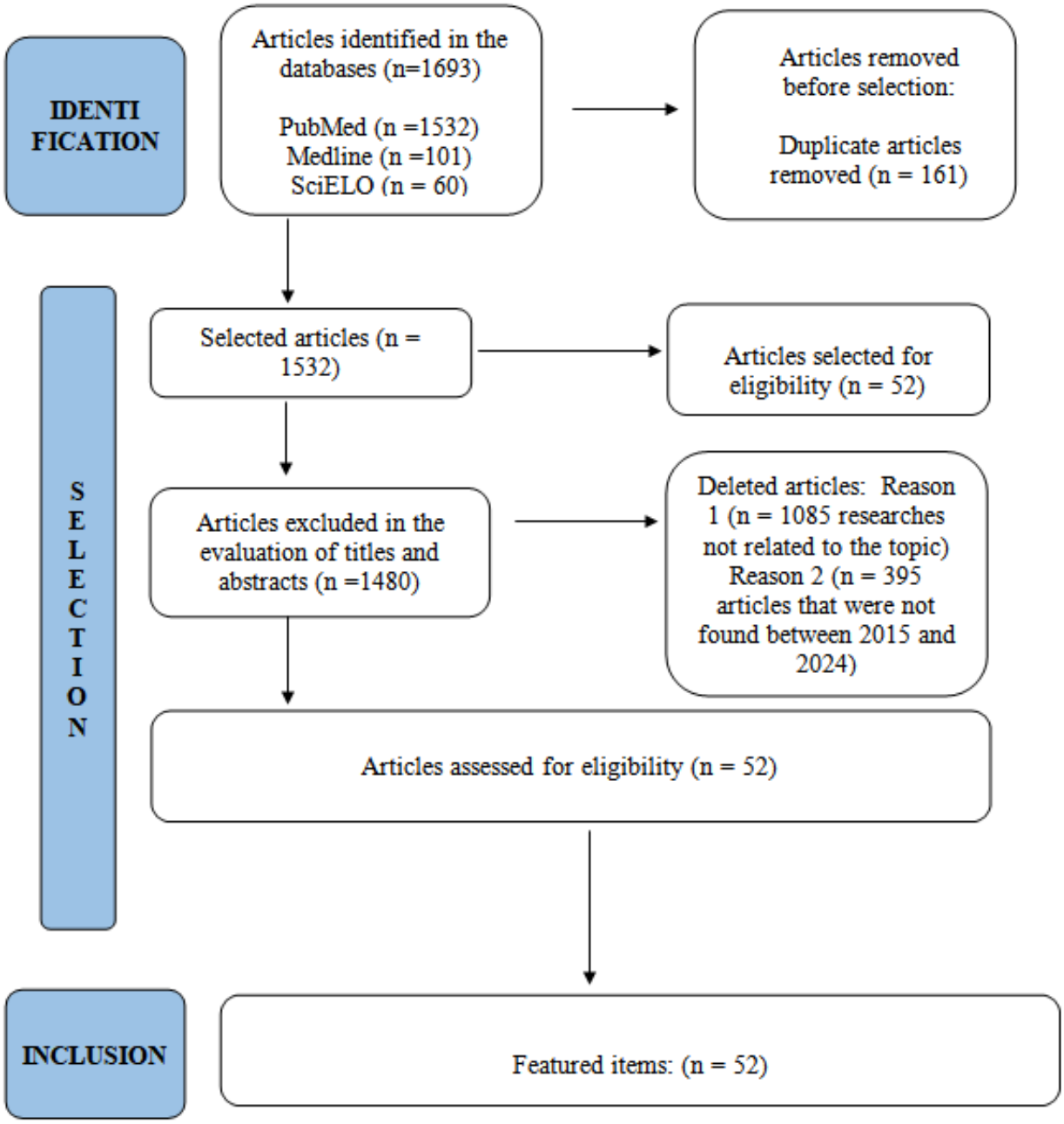

Figure 1. PRISM method of the research presented.

A total of 1,693 articles were found across all databases. After reviewing the titles of the articles, it was observed that some did not meet the inclusion criteria for this study. Consequently, 161 duplicate articles were removed, and 1,532 articles were selected for abstract reading. Of these, 1,480 articles were excluded based on abstract analysis, as they did not align with the objective of elucidating the challenges of electronic cigarette use in the context of public health and its predominant factors, resulting in 52 full-text articles being included in this literature review. The selection criteria were studies that necessarily met the following: studies published in English and Portuguese, systematic reviews, case reports, clinical studies, and articles published between 2015 and 2024.

RESULTS & DISCUSSION

From this study, it was possible to observe that the growing popularity of electronic cigarettes has driven a series of scientific investigations aimed at analyzing their impacts on human health[39]. The results obtained so far indicate that, although electronic nicotine delivery devices may be less harmful than conventional tobacco, their adverse effects cannot be ignored[40]. Several studies reveal that the use of these devices is associated with lung, cardiovascular, and neurological damage, raising concerns about their potential to cause addiction, especially among young people[41],[42].

The assessment of the impacts of electronic cigarettes on respiratory health suggests that the aerosols generated by these devices contain toxic substances capable of triggering inflammatory processes in the respiratory tract[43],[44]. A recent study demonstrated that exposure to electronic cigarette vapor results in increased permeability of the pulmonary epithelial barrier, promoting inflammation and oxidative stress[45]. Furthermore, histological analyses in experimental models pointed to degeneration of the pulmonary alveoli and the presence of inflammatory infiltrates similar to those observed in chronic obstructive pulmonary diseases[46],[47].

The outbreak of vaping-associated lung injury (EVALI) reinforced concerns about the toxicity of electronic cigarettes. Data from the Centers for Disease Control and Prevention (CDC) indicate that most patients diagnosed with EVALI presented symptoms such as dyspnea, persistent cough, and chest pain, with many requiring ventilatory support[48],[49]. Although vitamin E acetate was identified as one of the main agents causing EVALI, research suggests that other components present in vaping liquids may contribute to pulmonary toxicity, including carbonyl compounds, heavy metals, and flavoring agents[50].

In addition to pulmonary effects, the cardiovascular toxicity of electronic cigarettes has been widely investigated. Nicotine, present in most liquids used in these devices, is a known vasoconstrictor that can increase blood pressure, heart rate, and arterial stiffness, raising the risk of adverse cardiovascular events[51]. Studies have shown that regular use of electronic cigarettes is associated with endothelial dysfunction and increased vascular inflammation, factors that contribute to the development of atherosclerosis and other cardiovascular diseases[52].

An epidemiological analysis identified a higher prevalence of myocardial infarctions among regular users of electronic cigarettes compared to individuals who had never used these devices[23],[45]. The findings reinforce the hypothesis that, despite the reduction in exposure to some toxic substances present in conventional tobacco, electronic cigarettes are not free from cardiovascular risks. Furthermore, chemical analyses demonstrated that the aerosols generated by vapes contain heavy metals, such as nickel and cadmium, which can induce oxidative stress and vascular dysfunction, increasing the risk of heart diseases[21],[36].

Another relevant aspect in the discussion about the impacts of electronic cigarettes is their popularity among adolescents and young adults. According to CDC data, the prevalence of electronic cigarette use among high school students in the United States increased significantly over the past decade, reaching 14.1% in 2022[28],[33]. This trend is concerning, as the nicotine present in vaping liquids can interfere with adolescent brain development, affecting cognitive functions and increasing susceptibility to dependency[19],[27].

The aggressive marketing by electronic cigarette industries, combined with the wide availability of flavored products, has been identified as one of the main factors driving increased consumption among young people[39],[41]. Research indicates that flavors such as fruits and sweets make the vaping experience more attractive, reducing risk perception and facilitating the development of dependency[50],[13]. Additionally, studies suggest that early use of electronic cigarettes may act as a gateway to conventional smoking, increasing the likelihood of long-term adoption of traditional cigarettes[25].

Given the accumulated scientific evidence, several countries have adopted different regulatory approaches to address the spread of electronic cigarettes. While nations such as Brazil and India have banned the sale of these devices, countries like the United Kingdom have incorporated them into harm reduction strategies, arguing that they represent a less harmful alternative to conventional tobacco[43],[51]. The lack of global consensus on the regulation of electronic cigarettes reflects the complexity of the issue and the need for more longitudinal studies to assess their long-term effects[46].

Tobacco control policies must be strengthened to prevent electronic cigarettes from undermining the progress made in reducing tobacco consumption. Implementing restrictions on advertising, banning flavors attractive to youth, and regulating the sale of these products are essential measures to mitigate the negative impacts of vaping on public health[8],[15]. Furthermore, educational campaigns should be intensified to raise awareness about the risks of electronic cigarette use and discourage their consumption, especially among adolescents and non-smokers[18].

CONCLUSÃO

In summary, the impacts of electronic cigarettes on public health remain a topic of intense debate and research. Although their popularity has been driven by the promise of being a less harmful alternative to conventional tobacco, the accumulated scientific evidence indicates that these devices are not without risks. Studies show that regular use of electronic cigarettes can compromise lung function, increase vulnerability to cardiovascular diseases, and contribute to the development of nicotine dependence, especially among young people. Furthermore, the chemical composition of the aerosols generated by these devices includes toxic substances and heavy metals that can trigger inflammatory processes and oxidative stress, resulting in long-term damage to the body. Thus, the lack of strict regulation and the growing adoption of vaping among youth represent significant challenges for public health, requiring effective responses from health authorities.

Given this scenario, the implementation of public policies aimed at regulating electronic cigarettes becomes essential to mitigate their adverse effects. Measures such as restricting advertising targeted at young people, banning attractive flavors, and expanding educational campaigns can help reduce the spread of these devices. Additionally, ongoing research is crucial to assess the long-term impacts of electronic cigarette use and guide more effective control strategies. While some approaches advocate for the potential of vaping as a harm reduction tool for conventional cigarette smokers, caution must prevail, especially considering the risk of early initiation and dependency. Therefore, it is essential to strike a balance between the need to assist smokers in quitting tobacco and protecting the population from the potential harms associated with the use of these devices.

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