E-CIGARETTES, VAPING, AND THE RISK OF LUNG CANCER: A COMPREHENSIVE SYSTEMATIC REVIEW

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Abstract

Background: Vaping and E-cigarette usage are raising concerns since they may also raise the risk of lung cancer, even though tobacco smoking is still the leading cause of lung cancer, which is the most prevalent cause of cancer mortality globally. **Materials and methods:** Fourteen studies that satisfied the inclusion criteria were examined. PRISMA criteria were used to search PubMed/MEDLINE and Google Scholar. The search approach included a blend of keywords lung cancer," "electronic cigarettes," "cancer," and "vaping" The studies in the English language published in and after 2020 were included. Titles and abstracts for discrepancies were checked and discussed. **Results:** The 2019 EVALI pandemic changed people's perceptions of the hazards associated with e-cigarettes, leading some to believe they are just as deadly as regular cigarettes. Research indicates that the usage of e-cigarettes varies by demography, that those with pre-existing lung disorders may be at risk for health problems, and that aerosols contain different amounts of toxic substances. While some research indicates that e-cigarettes cause less damage than traditional cigarettes, other studies emphasize the significance of regulation and knowledge of long-term impacts, particularly for non-smokers. Overall, the results highlight the necessity of regulation, clear risk communication, and more research to support public health strategies. **Conclusion:** E-cigarettes, vaping, and the risk of lung cancer are all examined in the systematic study. Public attitudes change after the 2019 EVALI, exposing complex processes. Research reveals advantages as well as respiratory hazards, particularly from dangerous substances found in aerosols. The results offer a clear, thorough understanding of this intricate interaction.

INTRODUCTION

With its second-highest frequency worldwide and a substantial proportion of cancer-related mortality, lung cancer (LC) is a serious global health concern (Barta et al., 2019; Sung et al., 2021). Globally, 2,206,771 new cases of LC and 1,796,144 fatalities were reported in 2020, according to GLOBOCAN statistics (Ferlay et al., 2021). It is the most frequent cancer in this generation, affecting men disproportionately, and is second only to breast cancer in women (Sharma, 2022). Prostate and colorectal cancers are the next most common cancers in this group. The 5-year survival rate for liver cancer (LC) is still a depressingly low 10% to 20%, despite advances in diagnostic and treatment techniques (Siegel et al., 2021). The dire prognosis is exacerbated by late-stage diagnosis with many systemic metastases, particularly in developing nations. This highlights the urgent need for a more thorough knowledge of the multifarious impacts on the pathophysiology of lung cancer (National Lung Screening Trial Research Team, 2011).

The cause of LC is multifaceted, encompassing both external and internal causes. Various variables, including lifestyle decisions, exposure to environmental toxins, occupational hazards, and genetic and immunological factors, significantly contribute to the development of LC (Shankar et al., 2019). Significantly, active and passive smoking, as well as exposure to environmental toxicants, and other risk factors such as arsenic, asbestos, and air pollution, remain important causes of lung cancer occurrence (Wang & Yang, 2019). Among these well-established risk factors, the introduction of electronic cigarette, or vaping, products (EVPs) has added a new element to the range of probable causes of LC. The use of electronic vapor products (EVP) has experienced a significant increase worldwide, particularly among younger individuals who do not smoke, which has raised concerns over its potential long-term health effects (Cullen, 2018; Tsai et al., 2018). From students in the United States. This has led to electronic cigarettes being the most popular tobacco product among teens in 2020, according to Gentzke et al. (2020) and Hartnett et al. (2020). There has been increased attention on the possible cancer-causing effects of electronic cigarette, or vaping, products (EVPs) due to recent reports of lung injuries connected with their usage (known as EVALI) and the discovery of cancer-causing substances in vaping cartridges (Muthumalage et al., 2020; Petrella et al., 2023). The composition of electronic vapor products (EVPs) includes nicotine, water, flavorings, and humectants such as propylene glycol (PG) and vegetable glycerin (VG).

This raises concerns about potential exposure to harmful substances, including heavy metals, formaldehyde, and benzene (Stefaniak et al., 2021; Muthumalage et al., 2020; Gonzalez-Jimenez et al., 2021). The carcinogenic properties of EVPs are ascribed to certain molecular pathways, such as oxidative stress and genotoxicity (Bracken-Clarke et al., 2021). With the rising occurrence of lung cancer (LC) in individuals who do not smoke, mostly caused by exposure to harmful substances and air pollution (Shankar et al., 2019), it is crucial to comprehend how the use of electronic vapor products (EVP) interacts with these environmental risk factors. Although several researches has investigated the risk factors for lung cancer, there is limited evidence available that

completely explores the collective influence of electronic vapor products (EVPs) and ambient toxicants on the development of malignancy (Lantz et al., 2013). This systematic review seeks to fill this gap in information by comprehensively examining the current body of research on the correlation between electronic vapor product (EVP) usage, environmental toxicants, and the development of lung cancer (LC).

Rationale

Existing systematic reviews shed light on E-cigarettes, vaping, and lung cancer risk. Bracken-Clarke et al. (2021) warn that nicotine compounds, polycyclic aromatic hydrocarbons, and heavy metals in E-cigarettes and E-liquids may cause cancer. However, the study acknowledges the ambiguous nature of research and emphasizes the need for long-term studies, revealing a gap in understanding E-cigarette-related lung cancer risk factors (Bracken-Clarke et al., 2021). Sahu et al. (2023) discuss E-cigarette cancer hazards and the ambiguity of long-term effects. E-cigarettes may pose health hazards, thus the review advises against using them to quit smoking (Sahu et al., 2023). However, it does not fully investigate oncogenic processes and molecular pathways. Shehata et al. (2023) examine the global rise in E-cigarette usage, especially among youth. E-cigarette usage is linked to environmental toxicants and lung cancer risk, however, the evaluation does not analyze molecular pathways or oncogenic processes. The result emphasizes the need for more research on how E-cigarettes and environmental exposures may synergistically cause oncogenicity (Shehata et al., 2023).

Abelia et al. (2023) compare the lung cancer risks of cigarettes with E-cigarettes. The report emphasizes the risks of smoking and vaping, including respiratory and neurological illnesses. Its absence of a systematic strategy in researching molecular and cellular pathways driving lung cancer development in the context of E-cigarette usage indicates a knowledge gap (Abelia et al., 2023). Based on previous evaluations, our complete systematic review critically evaluates and integrates observational and interventional literature to fill gaps. The main objective is to understand how E-cigarettes and Vaping may affect lung cancer development and progression. The review fills these gaps to advance understanding, influence public health policy, and guide future research in this important field. Combining these evaluations and other research will help examine the complicated link between E-cigarettes, Vaping, and lung cancer risk. E-cigarette usage, vaping, and lung cancer research are lacking in studies that address both together. E-cigarettes and vaping are generally studied separately, but their combined effects on lung cancer risk are overlooked. This gap highlights the necessity for a comprehensive review to integrate research and examine the complex relationship between E-cigarettes and Vaping and lung cancer. A complete knowledge of their possible synergistic contributions to lung cancer genesis requires closing this gap.

Research aim

To provide a thorough systematic review that consolidates current research on the correlation between E-cigarettes and Vaping and the likelihood of developing Lung

Cancer. This review seeks to analyze and combine information from pertinent studies, encompassing both observational and interventional research, to comprehensively assess the possible influence of E-cigarette usage and Vaping on the emergence and advancement of Lung Cancer. The primary objective is to enhance the current information base, provide input for public health policy, and direct future research endeavors to get a deeper understanding of the intricate correlation between E-cigarettes, Vaping, and the susceptibility to Lung Cancer.

METHODOLOGY

Database search

We performed comprehensive literature searches on Google Scholar and PubMed databases by the Preferred Reporting Items for Systematic Reviews (PRISMA) criteria. The search approach included a blend of keywords and Medical Subject Headings (MeSH) phrases, such as "lung cancer," "electronic cigarettes," "cancer," "vaping," and "pulmonary." The search encompassed research from the initiation of the databases up to the current time, without any limitations on language.

Inclusion and Exclusion criteria

The inclusion criteria for this systematic review specifically targeted research that investigated the correlation between the use of electronic cigarettes or vaping products (EVP), exposure to environmental toxins, and the likelihood of acquiring lung cancer. Only studies conducted on humans were included. Both observational and experimental study designs were considered. The inclusion criteria were extensive, encompassing people of all ages, genders, and geographic locations. The exclusion criteria included research that did not investigate this particular association, had insufficient data, were reviews or editorials, or were not done on human beings. Before 2020, studies were excluded to guarantee the inclusion of current research. Studies examining the use of e-cigarettes and vaping as a means to quit or reduce smoking, as well as the effects of e-smoking and vaping on conditions other than lung cancer, were excluded from the systematic review.

Study selection

The study selection method consisted of a two-stage screening. At first, two researchers conducted separate reviews of titles and abstracts to find possible papers. During the second phase, the texts of chosen studies were carefully evaluated to determine their eligibility according to the criteria for inclusion and exclusion. Reviewers addressed any inconsistencies by deliberation and agreement while adhering to PRISMA rules by documenting the rationale for excluding certain items.

RESULTS

Searching Google Scholar and PubMed yielded 6,200 results. After the screening, 490 duplicate entries were removed. Also removed were 4400 studies from before 2020. The screening method excluded 1548 of the remaining 2890 records, leaving 1342 for full-text

study. Certain parameters rejected reports. These criteria included not being primary studies (61 reports), being in languages other than English (26 reports), not having specified outcomes (30 reports), focusing on outcomes and risk factors unrelated to pulmonary diseases (713 reports), being unretrievable (28 reports), involving animal studies or models (43 reports), or focusing on e-cigarette smoking cessation (427 reports). The review included 14 studies.
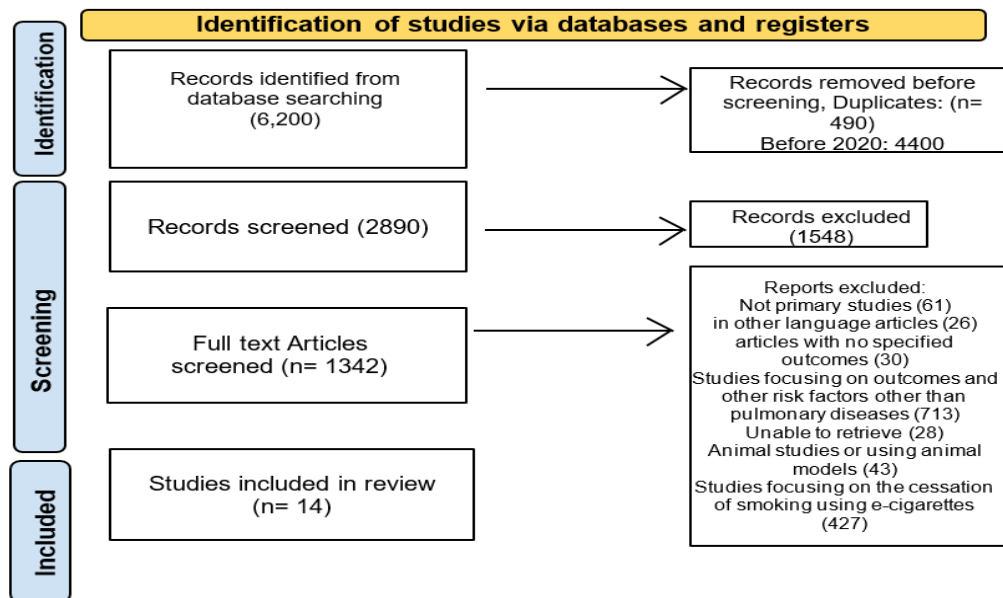
Tattan Birch et al. (2020) conducted a thorough investigation of the complex relationship between E-cigarettes, Vaping, and the risk of Lung Cancer. They discovered a notable change in how current smokers perceive the damage associated with these products after the EVALI epidemic in 2019. Before the incident, 37.0% of individuals had the perception that e-cigarettes were less dangerous, however, this percentage decreased to 30.9% afterward. Significantly, there was a notable rise in the number of people who viewed e-cigarettes as being equally or more dangerous. This perception persisted even after accounting for other factors, indicating a long-lasting influence on people's beliefs. Chidgarla et al. (2022) emphasized that there is a greater occurrence of E-cigarette usage among younger females when examining demographic differences. This underscores the need to comprehend the frequency of cancer in certain demographic cohorts to customize efficacious preventative approaches. O'Farrell et al. (2021) raised concerns over the same toxicity of e-cigarette aerosols and cigarette smoke in the airway cells of persons with COPD. This highlights possible health hazards, especially for those with pre-existing lung diseases. Pulvers et al. (2020) conducted a study to investigate the impact of pod e-cigarettes on exposure to cancer-causing substances. The results showed notable decreases in levels of carcinogens, respiratory symptoms, and cigarette usage after 6 weeks, in comparison to the control group. This indicates the possible use of e-cigarettes as a comprehensive approach to reducing damage, particularly for African American and

Latinx individuals who smoke. Hsien Lin et al. (2022) linked respiratory issues to the presence of detrimental organic compounds and metals in e-cigarette aerosols. The results revealed increased risks of respiratory cancer associated with certain compounds, highlighting the necessity for regulation and adding to the existing body of research on the harmful effects of E-cigarettes. Lu et al. (2021) conducted a comparative investigation of emissions from heated tobacco products (HTPs), e-cigarettes, and traditional cigarettes. Their findings showed that HTPs and e-cigarettes emitted lower levels of volatile organic compounds (VOCs) and carbon monoxide (CO) compared to cigarettes, indicating that they are less dangerous. Nevertheless, the analysis emphasized discrepancies in noncarcinogenic risk levels across the various products.

Barrameda et al. (2020) highlighted the importance of doing prospective research to fully comprehend the detrimental effects of e-cigarettes, especially among non-smokers, on the risk of developing lung illness. This emphasizes the necessity to understand the adverse consequences of e-cigarettes separately from tobacco smoking. Bandi et al. (2020) conducted a study on the comparative harm perceptions of E-cigarettes and cigarettes. They found that these views changed over time and were associated with changes in the usage of tobacco products. The study emphasized the pivotal need for precise communication of the hazards associated with the product. In their study on the health hazards associated with metals in e-cigarette aerosol through passive vaping, Su et al. (2023) determined that the non-cancer risks were typically deemed acceptable. The study indicated that e-cigarette users do not have any risk of respiratory health issues connected to metal exposure. Polosa et al. (2020) conducted a study to examine the health effects of e-cigarette use among individuals with COPD who were previous smokers. The study found that over 5 years, there was a substantial decrease in cigarette smoking, a notable decrease in the frequency of COPD exacerbations, and consistent improvements in lung function. This study emphasized the potential advantages of using e-cigarettes to reduce damage in people with chronic obstructive pulmonary disease (COPD). Suhling et al. (2020) highlighted the immediate necessity for a standardized national database in Germany to investigate the negative consequences and consequential pulmonary alterations linked to e-cigarette usage, based on three instances of acute pulmonary injury. Sangani et al. (2021) investigated EVALI in rural Appalachia and found that severe respiratory failure cases were associated with high levels of volatile organic compounds (VOCs), iron deposition in the lungs, and simultaneous lung injuries. These factors were shown to be linked to poorer outcomes. The case series conducted by Kass et al. (2020) and Kaous et al. (2020) revealed a range of symptoms and levels of severity in respiratory infections linked to e-cigarette usage. The majority of patients showed improvement with the administration of supportive care, corticosteroids, and antibiotics, underscoring the main objective of treatment which is to stop using e-cigarettes. Overall, these data together enhance our comprehension of the intricate correlation between E-cigarettes, Vaping, and the susceptibility to Lung Cancer. They provide useful perspectives to enhance public health policy and direct future research endeavors.

Sr. No	Title, Author Year	Study design	No. of Participants	Specific Intervention or Application	Outcome	Summary of results and conclusion
1	Tattan birch et al., 2020. Association of the US outbreak of vaping-associated lung injury with perceived harm of e-cigarettes compared with cigarettes	Cross-sectional study design	3215	Smoking toolkit, a survey in England	Comparing electronic cigarette hazard perceptions to traditional cigarettes among current smokers before and after the 2019 EVALI epidemic.	After the epidemic (Aug-Dec 2019), 30.9% thought e-cigarettes were less dangerous, down from 37.0% before. Fewer didn't know (10.4% vs 8.1%), however, more saw e-cigarettes as similarly or more dangerous. Significant differences remained following covariate adjustment.
2	Chidgarla et al., 2022. Cancer prevalence in E-cigarette users: A retrospective cross-sectional NHANES study	Retrospective cross-sectional study	154856	NHANES database	Cancer responders' e-cigarette and conventional smoking prevalence and relationship	Younger, female users use e-cigarettes more than traditional smokers.
3	O'Farrell et al., 2021 E-cigarettes induce toxicity comparable to tobacco cigarettes in airway epithelium from patients with COPD	Invitro experimental study	BECs from COPD patients and immortalized 16HBE cells	JUUL® e-cigarette aerosols (Virginia Tobacco and Menthol pods at 5% nicotine intensity) and reference 3R4F cigarette for 30 min at the air-liquid interface (ALI).	IL-8 and IL-6, cell cytotoxicity, DNA damage, and inflammation assessed.	COPD BECs treated with e-cigarette aerosols had similar cytotoxicity, DNA damage, and inflammation to smoking. Similar reactions were seen in 16HBE cells. Fourth-generation e-cigarette aerosols were as harmful as cigarette smoke in COPD patients' airway cells, raising worries about their safety.
4	Pulvers et al., 2020. Effect of pod e-cigarettes vs cigarettes on carcinogen exposure among African American and Latinx smokers: a randomized clinical trial	Randomized clinical trial	186	6 weeks of NSPS e-cigarettes with 5% nicotine pod flavors, information, training, and action planning to quit cigarettes. As usual, the control group smoked cigarettes.	Primary: Week 6 urine NNAL decrease. Secondary: Change in urine cotinine, expired CO, respiratory symptoms, lung function, blood pressure, previous 7-day combustible cigarette usage, and switching rates at weeks 2 and 6.	At week 6, the e-cigarette group had significantly lower NNAL, CO, respiratory symptoms, and prior 7-day cigarette usage than the control group. Maintained cotinine levels. Blood pressure and lung function were unaltered. Switching rates vary among e-cigarette users. E-cigarettes may help African American and Latinx smokers reduce damage.

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5	Hsien Lin et al., 2022 Disposable E-Cigarettes and Associated Health Risks: An Experimental Study	Observational study	Not provided	Analysis of Puff Bar (Grape) and Air Bar (Watermelon Ice), two popular disposable ENDS products.	Identification of hazardous organic compounds and metals in e-cigarette aerosol, calculation of daily and lifetime doses, and cancer and non-cancer risk assessment based on deposited doses	E-cigarette aerosol includes respiratory-damaging organic compounds and metals. Chromium (ENDS products) and nickel (Air Bar - Watermelon Ice) increase respiratory cancer risk. The findings show that ENDS aerosols include harmful chemicals. Possible contribution to ENDS toxicity literature and tobacco regulation.
6	Lu et al., 2021. The emission of VOCs and CO from heated tobacco products, electronic cigarettes, and conventional cigarettes, and their health risk	Comparative analysis	Not provided	Heated tobacco products, e-cigarettes, and traditional cigarettes.	VOCs, CO, nicotine, tar in aerosols, and health hazardsHTPs emitted 81.2%, 95.9%, and 97.5% fewer VOCs, tar, and CO than cigarettes. Compared to HTPs, e-cigarettes generated the most total VOCs (795.4 mg/100 puffs).	HTPs and e-cigarettes emitted less VOCs and CO than cigarettes. No cancer risk: Smoking > HTPs > Acceptable > E-cigarettes. LCR: Cigarettes > HTPs > E-cigarettes > Acceptable.
7	Barrameda et al., 2020. Use of e-cigarettes and self-reported lung disease among US adults	Observational cross-sectional study	45908	Examination of the relation between e-cigarette and lung cancer	Lung disease reporting odds, adjusted for sociodemographic and health behavior variables.	For never-tobacco users, daily e-cigarette users had 4.36 times the adjusted chances of lung disease. Daily e-cigarette users had 1.47 times the adjusted chances of lung disease compared to never users among tobacco users. Non-smokers should avoid e-cigarettes since they increase lung disease risk without tobacco. More future research is needed to understand e-cigarette risk.
8	Bandi et al., 2020. Relative harm perceptions of E-cigarettes versus cigarettes, US adults, 2018–2020	Cross-sectional study design	10,254	Health Information National Trends (HINT) survey	Differential damage perceptions between E-cigarettes vs cigarettes.	E-cigarette harm perceptions quadrupled from 2018 to 2020 (6.8% to 28.3%). Reduced uncertainty (38.2% to 24.7%). Less damaging views fell from 17.6% to 11.4%. As negative impressions were stable (37.4% to 35.6%). Exclusive cigarette smoking rose with E-cigarette views as more dangerous (18.5% to 16.3%). Exclusive E-cigarette usage rose linearly with perceived harm reduction (7.9% to 26.7%). Dual usage rose

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					linearly with E-cigarette harm perception (0.1% to 2.9%). Product-specific harm perceptions increased with tobacco usage. The product risk message must be accurate.
9	Su et al., 2023. Estimation of Health Risks Caused by Metals Contained in E-Cigarette Aerosol through Passive Vaping	Experimental study design	Not provided	Puffing machine and MALDA tests in a room to explore passive vaping of e-cigarette aerosol respiratory deposition.	Estimation of deposited mass and e-cigarette aerosol toxic mental health concerns. Analysis of size-segregated aerosol samples and metal compositions.	With results below 1.0, non-cancer hazards (hazard quotient and index) were acceptable. Usually, less than 1E-6 lifetime increased cancer risk. Metal-related respiratory health consequences were not found in e-cigarettes or passive vaping.
10	Polosa et al., 2020 .COPD smokers who switched to e-cigarettes: health outcomes at 5-year follow-up	Prospective cohort study	39	Patients switching to electronic cigarettes	Spirometric indices, respiratory exacerbations, CAT, 6-min walk distance, conventional cigarette usage	Large drop in EC users' smoking or abstention. COPD exacerbation rate significantly decreased from 2.3 (±0.9) to 1.1 (±1.0) after 5 years (p < 0.001). EC users showed consistent increases in lung function, CAT scores, and 6MWD after 5 years (p < 0.05). EC improves objective and subjective COPD outcomes over time. EC cessation and smoking decrease may reduce COPD patient damage from tobacco smoking.
11	Suhling et al., 2020 Three patients with acute pulmonary damage following the use of e-cigarettes—a case series	Case report	3	e-Cigarette usage	Acute pulmonary illness	CBC and bronchial lavage show eosinophilic inflammation in Patient 1 (48-year-old male). Discharged in 2 days after high-dose systemic corticosteroid therapy. Hemoptysis and widespread alveolar hemorrhage on CT in patient 2 (22-year-old man). Eosinophilic CBC inflammation. Discharged in 12 days after high-dose systemic corticosteroid therapy. The 34-year-old patient has ground-glass lung opacities and CT fibrosing alterations (pulmonary sarcoidosis). Discharged in 2 days after high-dose systemic corticosteroid therapy.

						E-cigarettes are suspected of causing three acute lung diseases in Germany. Interstitial lung disease symptoms vary. A standardized national registry is needed to understand e-cigarette side effects and lung alterations.
12	Sangani et al.,2021 Electronic cigarettes and vaping-associated lung injury (EVALI): A rural Appalachian experience	Case series	17	Patients admitted with EVALI	Bilateral ground-glass opacities, mainly in lower lung areas. The most common pulmonary damage pattern is lipoid pneumonia. The majority of critically sick patients need ventilation or ECMO	Rural Appalachian EVALI had significant respiratory failure. High VOCs, lung iron deposition, and concurrent
13	Kass et al.,2020 Case series: Adolescent victims of the vaping public health crisis with pulmonary complications	Case series	Not provided	respiratory care, corticosteroids, antibiotics	Improvement in most cases of cessation of e-cigarette	The symptoms and severity of respiratory illnesses linked to e-cigarette usage varied, with many of them fulfilling EVALI criteria. Corticosteroids, antibiotics, and supportive care improved the majority of patients. Improvement occurred after the e-cigarette use was stopped. There was discussion of the difficulties of identifying how much of a disorder e-cigarettes cause. The main objective of therapy for respiratory illnesses associated with e-cigarettes, such as EVALI, is to stop using e-cigarettes. It is imperative to prevent the use of e-cigarettes, particularly among young people.
14	Kaous et al.,2020 Clinical, radiology, pathologic patterns and outcomes of vaping-related pulmonary injury in a single institution; A case series	Case series	8	Corticosteroid treatment	Excellent response to corticosteroids, at 8 weeks	Eight EVALI patients responded well to corticosteroids. At the eight-week follow-up, all patients' symptoms were completely resolved. With corticosteroid therapy, the prognosis for EVALI is favourable, which highlights the need of staying away from e-cigarettes and other vaping devices in this situation.

DISCUSSION

The synthesis of evidence from the systematic review provides a comprehensive understanding of the complex relationship between E-cigarettes, Vaping, and the risk of Lung Cancer. Tattan Birch et al. (2020) explored the impact of the EVALI outbreak on perceptions of harm associated with e-cigarettes. The findings revealed a decrease in the percentage of individuals perceiving e-cigarettes as less harmful after the outbreak, emphasizing the influence of public health events on harm perceptions.

Chidgarla et al. (2022) focused on cancer prevalence in E-cigarette users, highlighting a higher prevalence of e-cigarette use in younger, female participants compared to traditional smokers. This suggests a demographic trend that warrants attention in public health interventions. O'Farrell et al. (2021) demonstrated that e-cigarettes induce toxicity comparable to tobacco cigarettes in airway epithelium from patients with COPD. The study raised concerns about the safety of e-cigarette use in individuals with pre-existing lung disease, emphasizing the need for targeted interventions. In contrast, Pulvers et al. (2020) presented a randomized clinical trial suggesting that pod e-cigarettes may serve as a harm reduction strategy for African American and Latinx smokers, showcasing potential benefits in specific populations.

Hsien Lin et al. (2022) identified harmful organic chemicals and metals in e-cigarette aerosols, highlighting respiratory cancer risks associated with certain substances. This study contributes valuable insights into the potential health risks posed by the contents of e-cigarette aerosols. Lu et al. (2021) compared the emission of volatile organic compounds (VOCs) and carbon monoxide (CO) from heated tobacco products (HTPs), e-cigarettes, and conventional cigarettes.

The results suggested that HTPs and e-cigarettes were less harmful than traditional cigarettes in terms of VOCs and CO emissions. Barrameda et al. (2020) focused on the association between e-cigarette use and self-reported lung disease among US adults. The study found higher odds of reporting lung disease among everyday e-cigarette users, emphasizing the independent risk posed by e-cigarettes, particularly for non-smokers. Bandi et al. (2020) explored relative harm perceptions of e-cigarettes versus cigarettes, revealing shifts in perceptions over time. Accurate messaging regarding product risks was highlighted as essential for effective public health communication.

Su et al. (2023) estimated health risks caused by metals in e-cigarette aerosol, suggesting acceptable non-cancer risks but emphasizing the need for continued monitoring. Polosa et al. (2020) presented a longitudinal study on COPD smokers who switched to e-cigarettes, showing marked improvements in COPD outcomes over 5 years, supporting the potential harm reduction benefits of e-cigarette use in this population. Suhling et al. (2020) reported three cases of acute pulmonary damage following e-cigarette use in Germany, highlighting the urgent need for a national registry to understand adverse effects. Sangani et al. (2021) and Kass et al. (2020) provided insights into EVALI cases,

emphasizing the severity of respiratory outcomes and the importance of cessation for improved prognosis.

Kaous et al. (2020) presented a case series demonstrating excellent response to corticosteroids in EVALI cases, reinforcing the importance of prompt medical intervention. Overall, the systematic review contributes a nuanced understanding of the varied outcomes associated with E-cigarettes and Vaping, guiding future research initiatives and informing public health policies to address this evolving landscape.

The findings of our systematic review on E-cigarettes, Vaping, and the Risk of Lung Cancer, when considered alongside the evidence presented in other relevant systematic reviews, provide a comprehensive perspective on the potential oncogenicity of E-cigarettes and vaping products. Bracken-Clarke et al. (2021) emphasized the presence of definite and probable oncogens in E-cigarette devices and vaping fluids, including nicotine derivatives, polycyclic aromatic hydrocarbons, heavy metals, and aldehydes. The review underscores the urgent need for tighter control and regulation of these products, considering the increasing use among the younger cohort and non-smokers. This aligns with our findings that highlighted the potential harm of E-cigarettes, especially in vulnerable populations.

Sahu et al. (2023) also discussed the potential cancer risk associated with e-cigarette use, acknowledging the ongoing debate. They emphasized the need for caution due to the presence of dangerous chemicals and flavorings in the aerosol, suggesting an increased risk of cancer, cardiovascular, and respiratory diseases. Our systematic review supports these concerns, indicating a need for users to carefully examine the potential risks, given the uncertain long-term cancer risk associated with e-cigarette usage. Shehata et al. (2023) focused on the relation between E-cigarette, or vaping, products (EVPs) and environmental toxicants in lung cancer development. They highlighted the dramatic increase in EVP use, particularly among younger individuals and non-smokers. The review emphasized the potential risk factor EVPs pose for lung cancer, aligning with our findings that showcased varied outcomes, including oncogenic concerns and the need for exposure reduction strategies.

Abelia et al. (2023) conducted a narrative review comparing the impact of cigarettes and e-cigs on lung cancer risk. The study critically assessed the biological effects of both, revealing an increased lung cancer risk associated with exposure to cigarette smoke and e-cig aerosol. Our systematic review adds depth to this discussion by presenting a synthesis of evidence, offering a nuanced understanding of the potential risks and benefits of E-cigarettes. Pellegrino (2021) addressed the growing popularity of electronic cigarettes and vaping devices and the concern about their potential oncogenicity. The review highlighted the difficulty in assessing the long-term effects but suggested a likely risk of lung cancer based on substances in the vaporized liquid with oncogenic potential. Our systematic review aligns with these concerns, emphasizing the need for further research to prevent a potential rise in lung cancer incidents.

Finally, Oriakhi et al. (2020) discussed the health risks associated with e-cigarette use, including cardiovascular and respiratory diseases. The review acknowledged the potential for acute lung injury, aligning with our findings that included evidence of toxicity, DNA damage, and inflammation in airway cells from COPD patients exposed to e-cigarette aerosols. In conclusion, the synthesis of evidence from our systematic review, combined with insights from other systematic reviews, underscores the multifaceted concerns surrounding E-cigarettes, Vaping, and the potential risk of lung cancer. The need for further research, tighter regulation, and targeted public health interventions is evident to address the evolving landscape of e-cigarette use and its potential impact on lung health.

CONCLUSION

In conclusion, the systematic review clarifies the complex relationships that exist between vaping, e-cigarettes, and lung cancer risk. Public opinions have been significantly impacted by the 2019 EVALI pandemic aftermath, which has highlighted the long-lasting effects of similar catastrophes. The results highlight the complexity of the problem, as research indicates that using e-cigarettes can have both positive and negative effects on respiratory health, especially when it comes to dangerous substances and metals in aerosols.

CLINICAL IMPLICATIONS

There are important clinical consequences for this review. To inform public health strategies, it is essential to communicate the risks of e-cigarette use in a clear and consistent manner. The necessity for specialized preventative measures is highlighted by the discovery of demographic variations in e-cigarette consumption. Strict regulations are necessary to reduce the risk of respiratory illnesses brought on by dangerous substances and metals. The potential advantages of e-cigarettes in harm reduction for people with COPD may be taken into account in therapeutic settings. To fully comprehend the long-term impacts of e-cigarettes and keep up to date on new products and their health implications, prospective research must be conducted indefinitely.

LIMITATIONS

Although the evaluation offers insightful information, it is not without restrictions. Direct comparisons are hampered by the differences in research populations, methodology, and outcomes. Time-related variables and possible publication bias might impact how broadly applicable the results are. It might be difficult to stay on top of the current advancements due to the constantly changing e-cigarette technology and the launch of new goods. Certain studies can have short follow-up times, which could cause them to miss long-term impacts of e-cigarette use.

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