

Health Effects of Cigarette Smoking and E-cigarette Vaping on Respiratory Function among Adolescents: Systematic Literature Review

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Received: July 01, 2026; Manuscript No: JPCH-26-8119; Editor Assigned: July 03, 2026; PreQc No: JPCH-26-8119 (PQ); Reviewed: July 24, 2026; Revised: July 24, 2026; Manuscript No: JPCH-26-8119 (R); Published: August 11, 2026

Citation: Christina R, Silva D, Ekanayake A, Madurapperuma W (2026). Health Effects of Cigarette Smoking and E-cigarette Vaping on Respiratory Function among Adolescents: Systematic Literature Review. J. Pediatr. Med. Child Health. Vol.2 Iss.2, August (2026), pp:62-70

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ABSTRACT

Background

Cigarette smoking and e-cigarette vaping among adolescents is a big problem in worldwide. Cigarette smoking causes respiratory disorders such as COPD, Lung Cancer, Asthma Exacerbation as well as e-cigarette vaping also causes Lung Injury, Bronchiolitis Obliterans, Airway Resistance, Decreased Immune Function etc. E-cigarettes are less harmful compared to combustible cigarettes; but both are harmful for the respiratory function. Therefore this systematic literature review aims to evaluate and compare the health effects of cigarette smoking and e-cigarette vaing on respiratory function among adolescents.

Methods

This systematic literature review was performed using databases such as Google Scholar, MEDLINE, PubMed, ResearchGate, and Web of Science. Articles published between 2013 and 2026 on health effects, cigarette smoking, e-cigarette vaping, respiratory function, and adolescents was searched using specific key terms.

Results

The results obtained from the reviewed articles showed that smoking cigarettes can lead to low lung function, airway inflammation, persistent cough and wheezing. Similarly the use of e-cigarettes has been found to cause respiratory issues such as airway inflammation, cough and mild decrease in lung function. However the evidence also shows that vaping isn't free of health risksand it can cause early respiratory complications among adolescents.

Conclusion

In general this review indicates that although e-cigarettes have fewer respiratory consequences compared to conventional cigarettes, both types of nicotine intake are linked with poor respiratory outcomes in adolescents. It is important for preventive measures to be taken to ensure that adolescents engage in neither activity.

Keywords: Health Effects; Cigarette Smoking; E-cigarette Vaping; Respiratory Function; Adolescents

INTRODUCTION

E-cigarette (vaporizer) use among adolescents has raised significant public health concerns, particularly regarding its comparative safety relative to conventional cigarette smoking. While e-cigarettes are often marketed as safer alternatives, emerging evidence indicates that both vaping and traditional smoking pose substantial health risks to adolescents [1-4]. while

vaping is generally considered less harmful than combustible tobacco, neither vaping nor smoking is free from danger [1,5]. Electronic cigarettes are devices with a heating element which produces aerosol for inhalation. They have been propagated as a healthier alternative to tobacco smoking and a potential device for smoking cessation, despite non documentation of their long term adverse health effects [6-14].

E-cigarette use by a person who has never smoked may cause harm to the respiratory system compared with never using e-cigarettes, particularly if initiation of e-cigarettes occurs at a young age [15-20]. Exposure of the dual user to both combustible tobacco products and e-cigarette aerosols may cause unique health risks to the respiratory system [15,21]. Smoking of combustible tobacco products is the number one cause of Chronic Obstructive Pulmonary Disease (COPD) worldwide. Although the proportion of smokers has decreased over the past 25 years, approximately 1.1 billion people continue to smoke as of 2015 [15,22-25].

The worldwide average of current vaping among youths at roughly 9%, with national figures ranging from under 2% in some countries to over 30% in others. In Europe, e-cigarette use among adolescents aged 13-15 years varies significantly, from less than 1% in some countries to over 20% in others, with several nations reporting that youth vaping now surpasses cigarette smoking in popularity. By contrast, many Asian countries have recorded lower youth vaping rates: surveys in Japan and South Korea found only about 3.5 and 10%, respectively, of adolescents had ever tried e-cigarettes, and a study in China observed just ~1% current use among middle school students. Overall, despite regional differences, the emergence of e-cigarettes has become a global phenomenon among youth, with rapid uptake observed across North America, Europe, and other parts of the world [26]. One large survey of never smokers reported that current e-cigarette users had about 39% higher odds of self reported asthma than non users, with a dose response relationship (daily vapers showed the greatest risk increase). More acute clinical reports have further underscored vaping's potential for harm: in 2019, an outbreak of e-cigarette or vaping associated acute lung injury in the US resulted in over 2800 hospitalizations and 68 confirmed deaths, predominantly in adolescents and young adults. Taken together, current findings, from symptoms and airway reactivity to rare catastrophic injuries, implicate e-cigarette use as detrimental to adolescent pulmonary function and respiratory well being [26-31]. Exposure of the lungs to various components of the e-cigarette aerosol could potentially damage the respiratory system or worsen pre-existing lung disease through a variety of mechanisms. For example, nicotine containing e-cigarette aerosols have the potential to adversely impact several host defense mechanisms in the lungs. In a murine model, $\alpha 7$ nicotine acetylcholine receptors ($\alpha 7$ nAChRs) were shown to regulate Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) activity in the airways. Exposure to nicotine downregulated $\alpha 7$ nAChR activity, which in turn impaired CFTR function, causing impaired mucociliary clearance (MCC). In humans, CFTR dysfunction has been shown to be associated with the development of COPD and asthma hyperresponsiveness. Exposure to nicotine in tobacco smoke and e-cigarette aerosols also has been reported to impair cough [15,32]. And also exposure to heavy metals originating from e-cigarette coils and components has been associated with adverse respiratory outcomes in adolescents. Inhaled metals such as nickel and chromium (commonly leached from heating coils) can deposit in lung tissue and have been associated with chronic airway inflammation and fibrosis [26,33]. Many current studies on

adolescent e-cigarette use, pulmonary function, and physical activity data is dominated by cross sectional designs and relies heavily on self reported data for both e-cigarette exposure and health outcomes [26]. Without prospective longitudinal research, questions remain about whether early e-cigarette use leads to lasting decrements in spirometry indices or exercise performance later in life. The literature's emphasis on short study horizons means we do not yet know if any subclinical pulmonary changes in youth might progress to clinically significant deficits over time. Longitudinal studies with extended follow up are critically needed to clarify these long term trajectories [26].

MATERIALS AND METHODS

A systematic review was conducted to evaluate the health effects of cigarette smoking and e-cigarette vaping on respiratory function among adolescents. The methodology used in this discussion is a qualitative description. It involves summarizing and synthesizing information from various sources, presenting insights from different studies, and offering an overview of the research landscape. A comprehensive search was conducted using the following databases: Google Scholar, MEDLINE, PubMed, ResearchGate, and Web of Science. The search terms included "Health Effects", "Cigarette Smoking", "E-cigarette Vaping", "Respiratory Function", and "Adolescents". The search was limited to studies published in English between 2013 and 2026 to ensure the inclusion of recent and relevant research. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) framework was utilized to guide the review process (Figure 1). Studies were included if they focused on the respiratory health effects of cigarette smoking and e-cigarette vaping among adolescents, including physical and respiratory outcomes such as lung function impairment, respiratory symptoms, or respiratory diseases. Studies comparing the harmful effects of combustible cigarettes and e-cigarettes were also included. Articles unrelated to respiratory health outcomes, non English articles, those not involving adolescents as the target population, or studies focused exclusively on adults were excluded.

Study Selection Criteria

Studies were included in the review if they met the following criteria:

1. focused on the health effects of cigarette smoking and e-cigarette vaping on respiratory function.
2. included adolescents as the primary population.
3. examined either or both combustible cigarettes and e-cigarettes to allow comparison of their harmful effects.
4. utilized quantitative, qualitative, or mixed research methods.
5. reported outcomes related to respiratory health, such as lung function, respiratory symptoms, or respiratory diseases. Studies were excluded if they did not specifically address cigarette smoking or e-cigarette vaping, did not include adolescents as the target

Population, were not available in full text form, were published in a language other than English, or lacked relevant respiratory outcomes. The research process yielded a total of 77 articles meeting the eligibility criteria.

Literature Management

Zotero, a reference management tool, was used to store and organize the collected articles. This tool allowed for efficient handling and retrieval of literature, ensuring a systematic and organized research process.

Data Extraction and Analysis

Extracted data were transferred to Microsoft Excel Sheets, where graphs and tables were created to visually present trends, patterns, and key findings. Keywords and themes were identified using VOSviewer software, which helped highlight recurring concepts related to the health effects of cigarette smoking and e-cigarette vaping on respiratory function among adolescents, including lung function impairment, respiratory symptoms, respiratory diseases, and the comparative harmful effects of combustible cigarettes and e-cigarettes.

Synthesis of Results

The results were synthesized and categorized to identify common themes, emerging patterns, and gaps in the literature. This analysis formed the foundation for understanding the health effects of cigarette smoking and e-cigarette vaping on respiratory function among adolescents and informed conclusions and recommendations regarding the comparative harmful effects of combustible cigarettes and e-cigarettes, as well as future research and public health interventions in this area.

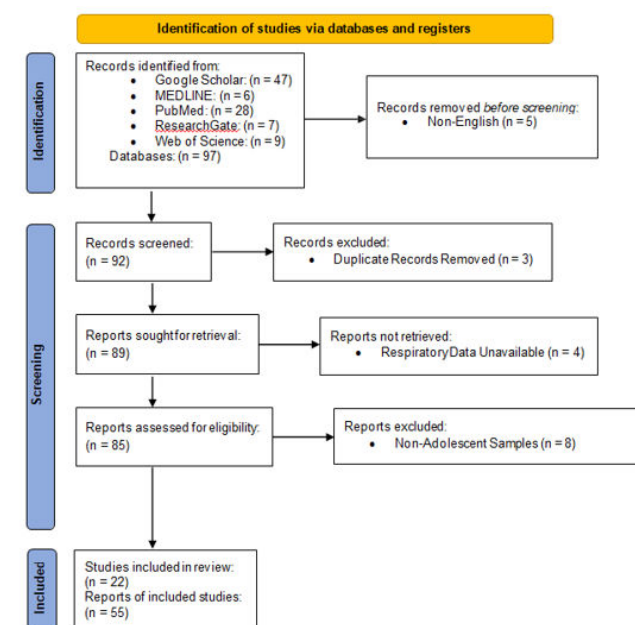


Figure 1: Identification of studies via databases and registers

RESULTS

The electronic cigarette is a cigarette alternative which utilizes a heater element that produces an aerosol. Even though e-cigarettes have been marketed as a healthier choice compared to smoking, there has been no scientific evidence confirming the absence of any adverse health implications caused by using these products. The research carried out indicates the presence of a total of 22 toxins apart from nicotine in the liquid contained in the cartridges and emitted by e-cigarettes. Most of these toxins have been found to be in lesser quantities as compared to those present in combustible cigarette smoke. However, there is great variability in terms of the composition of the cartridges and nicotine content in the refill solutions [6]. The prevalence of e-cigarettes is highly variable by region. The global youth prevalence of e-cigarette use is estimated to be around 9%, with country-level prevalence ranging from less than 2% to over 30%. For example, the prevalence of e-cigarette use among adolescents aged 13-15 years in Europe shows substantial variability, with some countries having prevalence less than 1%, while others have more than 20%. In addition, e-cigarette use is greater than traditional cigarette use in some cases. Moreover, data related to health show that there are certain dangers linked to the use of e-cigarettes. According to one study, in the group of never-smokers, the probability of having asthma-like symptoms was almost 39% higher for e-cigarette users than for non-users. Interestingly, a dose-response relationship was found, with daily users demonstrating the greatest risk. Another example of the adverse consequences of vaping relates to the 2019 EVALI outbreak in the United States, which led to 2,800 hospitalizations and 68 deaths, mainly in adolescents and young people. Overall, it can be said that there are numerous negative health effects caused by vaping [26,34]. Additional evidence on adolescent respiratory outcomes is provided by this study. According to this study, 12.3% of adolescents had wheezing/whistling, 17.4% had dry cough, and 1.9% had newly diagnosed asthma. Cigarette/cigar smokers were found to be at higher risk of wheezing and respiratory disorders than those using other tobacco products. On the other hand, adolescents using alternative tobacco products were at higher risk of having new asthma diagnosis [35-37]. (Table-1)

Category	Findings	Key Statistics /Evidence	Interpretation
Device characteristics	E-cigarettes generate aerosol via heating component	Contains nicotine + other chemicals	Not a harmless water vapor device
Chemical exposure	Toxic substances found in ECIG fluid and emissions	22 non-nicotine toxins identified	Most levels lower than combustible cigarette smoke

Product variability	Wide variation in ECIG fluids and nicotine strength	Different cartridge compositions reported	Makes exposure unpredictable
Nicotine delivery	Second-generation ECIGs mimic cigarette nicotine kinetics	Comparable nicotine delivery speed to cigarettes	High addiction potential remains
Global youth vaping prevalence	Wide variation across countries	~9% global average (range <2% to >30%)	Strong regional differences in vaping epidemic
Europe adolescent vaping (13–15 yrs)	Highly variable prevalence	<1% to >20%; some countries vaping > smoking	In some regions Vaping surpasses smoking
Asia adolescent vaping	Generally lower use rates	Japan ~3.5% ever use; South Korea ~10%; China ~1% regular use	Lower but increasing trend
Respiratory risk (non-smokers)	E-cigarette use linked to asthma risk	~39% increased odds of asthmatic symptoms	Dose-response relationship observed
Severe outbreak (EVALI)	Acute lung injury epidemic	2,800 hospitalizations + 68 deaths	Mostly adolescents & young adults affected
Respiratory symptoms in adolescents	Follow-up study findings	12.3% wheezing, 17.4% dry cough, 1.9% new asthma	Significant respiratory
Tobacco type comparison	Cigarette users had higher symptoms	Smoking/cigar users more wheezing than others	Traditional smoking still highly harmful
Alternative tobacco products	Associated with asthma development	Increased likelihood of new asthma cases	All tobacco forms increase respiratory risk

Table 1: E-Cigarette and Cigarette Use, Exposure, and Respiratory Health Effects in Adolescents

In general, the trend of increased use of tobacco and nicotine by adolescents, especially the increased prevalence of e-cigarettes and dual use with combustible tobacco, is now becoming a serious health issue. As tobacco use often starts in adolescence, prevention programs aimed at this demographic are very important for decreasing morbidity and mortality associated with tobacco use [35].

DISCUSSION

The results of the literature review suggest that there is a

definite negative impact of tobacco consumption on lung functioning, with the use of combustible cigarettes showing strong association with the occurrence of symptoms such as wheezing and coughing. Population studies also show a definite linear correlation between smoking and lung functioning, including a lower FEV1 level, especially in people who suffer from wheezing and respiratory predisposition [38–40]. Adolescent tobacco exposure continues to be a serious health issue because most people become addicted to smoking during their teenage years or when they are young adults, resulting in respiratory illness (Table 2) [13,41].

Year/Period	Combustible Cigarette Use (Adolescents)	E-Cigarette / Vaping Use (Adolescents)	Key Interpretation
2013–2015	~10–20% ever smoking (varies by country)	~5–10% ever vaping (early stage use)	Smoking still dominant among youth
2016–2017	~8–15% current smoking	~7–15% ever vaping	Rapid rise in vaping begins
2018	~5–10% current smoking (declining)	~10–20% vaping (increasing)	Vaping starts surpassing smoking in some countries
2019	~4–8% current smoking	~20–27% vaping (US high school peak ~27%)	Peak adolescent vaping epidemic in some regions
2020	~3–7% smoking	~14–20% vaping (decline due to COVID restrictions)	Temporary drop in
2021–2022	~3–6% smoking	~14–18% vaping (steady high levels)	Vaping becomes most common nicotine product
2023–2024	~2–5% smoking	~10–15% vaping (varies by country)	Smoking continues to decline, vaping stabilizes
2025–2026 (est.)	~2–5% smoking	~10–16% vaping (estimated)	Long-term health impact still under study

However, the impact of e-cigarettes on respiratory health is still ambiguous. Although some research found no relationship between e-cigarette usage and respiratory symptoms, other studies showed a positive correlation between e-cigarette use and respiratory issues like bronchitis, wheezing, and shortness of breath (Figure 2: The graphic highlights how smoking traditional cigarettes versus vaping impacts the respiratory tract, contrasting their unique levels of lung trauma, airway irritation, and chronic medical outcomes.). Studies have shown that e-cigarettes can increase the risk of exacerbating asthma symptoms and being diagnosed with new-onset asthma among adolescents [35,42,43].

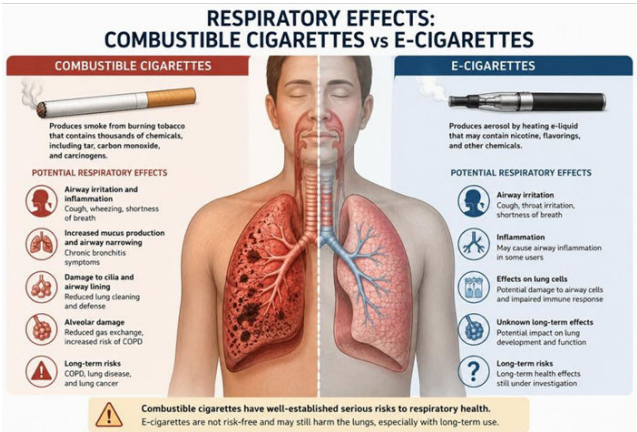


Figure 2: The graphic highlights how smoking traditional cigarettes versus vaping impacts the respiratory tract, contrasting their unique levels of lung trauma, airway irritation, and chronic medical outcomes.

Moreover, there is substantial evidence of the relationship

between e-cigarette use and asthma exacerbation, as well as increased risk of smoking and substance abuse [44,45]. Nevertheless, discrepancies in various studies regarding design, definition of exposure, and outcomes measurement limit the ability for direct comparison and increase uncertainty about evidence [46]. Notably, dual usage of both combustible cigarettes and e-cigarettes has been found to present more health risks compared to using one or the other. In dual smokers, there is increased nicotine consumption along with an elevated risk of respiratory symptoms, implying that there is an element of synergy involved [35,47]. This is especially significant among adolescents since tobacco and nicotine use tend to go hand-in-hand and could result in addiction or respiratory problems. While e-cigarettes are often considered less dangerous because of their lower concentration of toxic compounds than combustible cigarettes, recent studies have shown that this may not be true. In fact, the World Health Organization has concluded that there is currently not enough evidence to claim that e-cigarettes are either safe or effective compared to approved nicotine replacement therapy [48]. Moreover, experiments have shown that even though e-cigarette vapor is much less toxic compared to cigarette smoke, it causes decreased cell viability and triggers inflammatory responses, with flavorings playing a key role in the toxicity instead of nicotine [48]. Further mechanistic and experimental data provide additional insights into possible mechanisms of harm related to e-cigarettes use. Experimental data suggests that e-cigarette aerosols include toxic chemicals such as particulates, heavy metals, carbonyls, and other compounds produced due to heating or by the device itself [49–53]. (Table 3: How Smoking and Vaping Compare: Toxic Chemical Makeup and Respiratory Impacts).

Chemical /Substance	Combustible Cigarettes	E-Cigarettes (Vapes)	Possible Respiratory Effects
Nicotine	Present	Present (usually)	Addiction, airway irritation, impaired lung development in adolescents
Tar	High amounts	Usually absent	Damages lungs, linked to chronic bronchitis and lung cancer
Carbon Monoxide	Present from tobacco burning	Usually absent or very low	Reduces oxygen delivery to tissues
Formaldehyde	Present	Can form during heating of e-liquid	Airway irritation, possible
Acrolein	Present	Present in some aerosols	Lung inflammation, airway damage
Benzene	Present	May be present in small amounts	Cancer risk, respiratory irritation
Heavy Metals (lead, nickel, chromium)	Present	Can leach from heating coils	Toxic to lungs and other organs
Volatile Organic Compounds (VOCs)	Present	Present	Irritation of eyes, nose, throat, and lungs
Particulate Matter	High levels in smoke	Present in aerosol	Can penetrate deep into lungs
Flavoring Chemicals (e.g., diacetyl)	Rare	Common in flavored vapes	Linked to bronchiolitis (“popcorn lung”)

Propylene Glycol	Absent	Common ingredient	Throat irritation, dry cough
Vegetable Glycerin	Absent	Common ingredient	Can produce irritating byproducts when heated
Nitrosamines	High levels	Lower levels but may be present	Cancer-causing compounds
Ammonia	Present	Sometimes detected	Irritates respiratory tract
Polycyclic Aromatic Hydrocarbons (PAHs)	Present	Usually absent or very low	Lung damage and cancer risk

Table 3: How Smoking and Vaping Compare: Toxic Chemical Makeup and Respiratory Impacts

They can cause oxidative stress, inflammation, imbalance of redox status, and lead to lung damage. Moreover, experimental animal and cellular studies have found that long-term exposure to e-cigarette vapor affects airway epithelial barrier function, increases vulnerability to infections, and causes systemic inflammation [49,54]. Furthermore, the heating of e-liquids can result in the generation of toxic substances like formaldehyde and acrolein, which can cause injury to airway cells and endothelial cells [54]. There is also clinical evidence

that demonstrates the possibility of acute as well as chronic respiratory effects. Cases of eosinophilic pneumonia, lipoid pneumonia, acute lung injury, and e-cigarette or vaping-associated lung injury (EVALI) outbreak in the US illustrate the severity of the acute effects caused by vaping [54–58]. The EVALI outbreak caused several deaths and hospitalizations and was also a major factor influencing public perception about the dangers of e-cigarettes, leading to a decline in its use and sale [59]. (Table 4: Deaths Caused by Traditional Cigarettes vs. E-Cigarettes (2013–2026)).

Year/Period	Combustible(Smokin g) Cigarettes	E-Cigarettes / Vaping	Key Notes
2013–2015	~7–8 million deaths/year globally	Very few reported deaths	Smoking already a major global epidemic
2016–2018	~7–8 million deaths/year globally	Very low confirmed deaths	Vaping use increases, but mortality not established
2019	~8 million deaths globally	EVALI outbreak begins	Major lung injury outbreak linked to vaping
2020	~8 million deaths globally	~68 confirmed deaths (EVALI peak)	Mostly USA cases reported by Centers for Disease Control and Prevention
2021–2022	~8 million deaths/year globally	No large confirmed global death epidemic	EVALI cases drop sharply after regulation changes
2023–2024	~8 million deaths/year globally	Sporadic case reports only	No confirmed large-scale mortality trend
2025–2026 (est.)	~8 million deaths/year globally	No confirmed global mortality trend	Long-term effects still under research

Table 4: Deaths Caused by Traditional Cigarettes vs. E-Cigarettes (2013–2026)

However, there is still much uncertainty regarding the long-term respiratory effects of e-cigarette usage. Evidence from some longitudinal studies, such as those conducted using large cohorts, indicates that people who use e-cigarettes are at greater risk of developing chronic respiratory conditions, such as COPD, emphysema, chronic bronchitis, and asthma [60]. Nevertheless, early cross-sectional research was unable to prove causation, and even longitudinal studies have been restricted by factors like inadequate control for prior smoking habits as well as challenges in defining disease outcomes [60,61]. Population-based trends highlight the public health impact that is increasing in significance. The use of electronic cigarettes has been on the rise, surpassing the prevalence of cigarette smoking in adolescents to maintain high levels of tobacco use among the

youth [41,48,62–67]. Similar trends can be seen in adults, as reductions in cigarette smoking have come to a halt while use of e-cigarettes increases [68,69]. The issue is troubling since exposure to nicotine during the adolescent period could have negative impacts on brain development and lead to addiction problems in the future. Moreover, sociocultural and situational factors can play a role in determining the behavior of vaping. Studies show that marketing targeting certain populations, socioeconomic status, and secondhand exposure to vaping result in increased rates of vaping among at-risk populations, such as Hispanic youth, with respiratory problems as well [70–74]. Moreover, vaping has been associated with other behavioral risks, such as consumption of alcohol and marijuana [44]. In summary, based on the current literature, it can be concluded that although combustible cigarettes continue to show consistent associations with respiratory diseases, there is no doubt that e-cigarette use poses its own set of risks, with an

increasing number of associations being established between e-cigarette use and respiratory symptoms. Nevertheless, the inconsistency of study designs, as well as the lack of longitudinal research, reveals numerous gaps in the current literature that require further investigation, especially with regard to youth and other high-risk groups [74].

CONCLUSION

In summary, the results of the systematic literature review conducted indicate that both cigarette smoking and e-cigarette vaping have an association with harmful effects on respiratory health in adolescence. Based on the information provided by the analyzed studies, it can be concluded that cigarette smoking still has a strong association with chronic respiratory symptoms, reduced lung function, airway inflammation, asthma development, and the risk of pulmonary diseases. Despite the fact that some studies indicated that e-cigarettes might cause lower exposure to some chemicals compared with combustible cigarettes, they were still associated with adverse respiratory health outcomes such as cough, wheezing, bronchitis, pulmonary function impairment, and vulnerability to respiratory diseases. As a result, although the use of e-cigarettes might be seen as safer than smoking regular cigarettes, they are not completely harmless, especially when concerning adolescents, whose respiratory system is at the stage of active development.

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