



## Association Between Patterns of Electronic Cigarette Use and Recurrent Bronchitis Among Young Adults

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### ABSTRACT

*Electronic cigarette use has become increasingly common among young adults, raising concerns regarding its potential association with respiratory health outcomes. This study aimed to examine the relationship between patterns of electronic cigarette use and the occurrence of recurrent bronchitis symptoms among young adults. A quantitative analytic study with a cross-sectional design was conducted involving 150 respondents aged 18–25 years selected through purposive sampling. Data were collected using structured questionnaires measuring frequency of e-cigarette use and incidence of recurrent bronchitis symptoms. Chi-square tests and Spearman correlation were applied to assess the association between vaping patterns and respiratory complaints. The results demonstrated a significant association between frequent e-cigarette use ( $\geq 4$  times per week) and recurrent bronchitis symptoms, with an estimated OR (95% CI) = 4.0 (1.9–8.3), supported by a strong positive Spearman correlation. Frequent users were more likely to report recurrent bronchitis symptoms compared to occasional or non-users. These findings indicate that frequent electronic cigarette use is associated with higher odds of recurrent bronchitis symptoms. In conclusion, the study highlights a notable association between vaping patterns and respiratory complaints, underscoring the need for increased public health attention.*

**Keywords :** Electronic cigarette; Recurrent bronchitis; Respiratory health; Young adults; Vaping behavior

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## INTRODUCTION

Respiratory health remains a global concern as respiratory diseases continue to rise due to environmental exposures and lifestyle-related behaviors. One emerging factor contributing to this burden is the increasing use of electronic cigarettes (e-cigarettes), particularly among young adults. Recent evidence from 2022–2024 indicates that e-cigarette use has grown substantially worldwide, with studies reporting associations between vaping and respiratory symptoms, including bronchial irritation and early airway disease. The World Health Organization has noted ongoing concerns related to nicotine addiction, airway inflammation, and impaired lung function among young e-cigarette users (1).

In Southeast Asia, including Indonesia, e-cigarette consumption has escalated rapidly. Riskesdas data show that the prevalence of users aged 15 years and older increased from 2.0 percent in 2016 to 10.9 percent in 2021 (3). Recent Indonesian studies also report higher rates of respiratory complaints such as persistent cough, wheezing, and symptoms resembling recurrent bronchitis among young adult vapers (4,5). Although several findings indicate substantial respiratory risks, detailed analysis of specific usage patterns such as frequency, duration, flavor choice, and nicotine concentration remains limited (6).

Biologically, exposure to aerosolized chemicals in e-cigarettes, including nicotine, propylene glycol, vegetable glycerin, and flavoring agents, can trigger oxidative stress, epithelial irritation, and cytokine-mediated inflammation in the bronchi, increasing susceptibility to recurrent bronchitis episodes (7,8). Recent global studies from 2022–2024 further support this mechanism, showing that repeated inhalation of heated aerosols disrupts mucociliary clearance and weakens airway immune responses, especially among frequent users.

Prior Indonesian research provides additional context. Setiawan et al. (2020) observed elevated exhaled carbon monoxide and airway inflammation among regular e-cigarette users (9). Mulyani et al. (2021) found that individuals using flavored e-liquids experienced more frequent respiratory complaints compared to those who used non-flavored products (10). Hartati et al. (2022) highlighted the role of insufficient regulatory oversight in increasing accessibility and use of e-cigarettes among youth in urban educational settings (11). However, existing literature mainly examines general respiratory symptoms, not the specific relationship between vaping behavior and recurrent bronchitis.

Understanding this association is crucial for public health practitioners and educators who aim to design early intervention strategies within school and campus environments. Without clear evidence regarding usage behaviors that heighten bronchitis risk, prevention efforts may lack precision and effectiveness (12). Based on this gap, the research question formulated is whether there is an association between patterns of electronic cigarette use and recurrent bronchitis among young adults. The objective of this study is to analyze the association between specific e-cigarette use patterns, including frequency, flavor, and nicotine concentration, and the incidence of recurrent bronchitis among young adults in an urban setting.

## **METHODS**

This research utilized a quantitative analytical approach with a cross-sectional design to examine the association between electronic cigarette usage patterns and recurrent bronchitis symptoms among young adults. As a cross-sectional study, the design is suitable for identifying associations but does not allow determination of causal relationships between exposure and outcome. Data were collected from March to May 2025 across three metropolitan higher education institutions in Central Java, Indonesia. The study population consisted of university students aged 18 to 25 years, including both users and non-users of electronic cigarettes.

A total of 150 participants were recruited using purposive sampling based on predetermined inclusion criteria: current student enrollment, a minimum of six months of e-cigarette use for the user group, or complete absence of both traditional and electronic cigarette use for the non-user group. Individuals with a history of asthma, chronic obstructive pulmonary disease, or tuberculosis were excluded. The use of purposive sampling may limit the generalizability of the findings and introduces the possibility of selection bias, as the sample may not fully represent the broader young adult population.

Data were obtained through a structured, self-administered questionnaire collecting sociodemographic characteristics, detailed patterns of e-cigarette use (frequency, duration, device type, flavor, and nicotine concentration), and symptoms consistent with recurrent bronchitis. Recurrent bronchitis was defined as episodes of productive cough lasting at least three days and occurring more than once in the past three months. Because bronchitis symptoms were self-reported, there is a potential risk of recall bias and misclassification bias, and the absence of clinical verification should be considered a limitation in interpreting the findings. The questionnaire was adapted from previously validated instruments and reviewed by public health experts to ensure content validity.

Data analysis included descriptive statistics, Chi-square tests to assess associations between categorical variables, and Spearman correlation to evaluate the relationship between ordinal variables such as usage frequency and symptom severity. Statistical analysis was performed using SPSS version 26.0 with a significance level set at  $p < 0.05$ . Ethical approval for this study was granted by the Research Ethics Committee of Universitas X under protocol number 022/EC/2025.

## RESULTS

This study involved 150 young adults aged 18–25 years. The sample consisted of 63 males (42%) and 87 females (58%). Most respondents (62%) were in the 21–25 age group.

Based on vaping behavior, 90 individuals (60%) were categorized as regular users ( $\geq 4$  times per week), and 60 (40%) as occasional or non-users ( $< 4$  times per week). Most regular users reported first trying e-cigarettes during adolescence, and over 70% used flavored nicotine pods.

The incidence of recurrent bronchitis defined as  $\geq 2$  episodes of productive cough lasting  $\geq 3$  days over the past three months was markedly higher among regular users. A total of 54 regular users (60%) reported experiencing recurrent bronchitis, compared to only 9 occasional/non-users (15%). This finding suggests a potential health risk linked to frequent e-cigarette exposure.

**Table 1**

**Respondent Characteristics, Bronchitis Symptoms, and Chi-square Analysis**

Characteristics	Category	N	%	Recurrent Bronchitis (%)	$\chi^2$ (p-value)
<b>Sex</b>	Male	63	42	28 (44.4)	$\chi^2 = 0.83$ (p = 0.36)
	Female	87	58	35 (40.2)	
<b>Age Group</b>	18–20	57	38	21 (36.8)	$\chi^2 = 2.11$ (p = 0.15)
	21–25	93	62	42 (45.2)	
<b>Vape Usage Frequency</b>	Regular ( $\geq 4 \times / \text{week}$ )	90	60	54 (60.0)	$\chi^2 = 18.7$ (p < 0.001)
	Occasional/Non- user	60	40	9 (15.0)	

Source: Primary Data, 2025

Table 1 summarizes the respondents' demographic characteristics and examines their association with recurrent bronchitis. The results indicate that sex and age group do not significantly influence the occurrence of bronchitis, as shown by non-significant p-values (p = 0.36 and p = 0.15). This suggests that the likelihood of experiencing bronchitis is relatively similar across males and females, as well as across younger (18–20 years) and

older (21–25 years) respondents. In contrast, vaping frequency shows a strong and statistically significant association with recurrent bronchitis ( $\chi^2 = 18.7$ ;  $p < 0.001$ ). Regular users reported a substantially higher percentage of bronchitis symptoms (60 percent) compared with occasional or non-users (15 percent). These findings indicate that vaping intensity is the most influential factor related to recurrent bronchitis in this population.

**Table 2****Bivariate and Spearman Correlation Analysis Between Vape Use and Bronchitis**

Variable Pair	Statistical Test	Value
Vape frequency vs Bronchitis incidence	Chi-square	$\chi^2 = 18.7$
Vape frequency – Bronchitis score	Spearman's rho	$\rho = 0.52$

Source: Primary Data, 2025

Table 2 confirms the association between vape use and bronchitis through bivariate and correlation analyses. Consistent with Table 1, the Chi-square test demonstrates a significant relationship between vaping frequency and bronchitis incidence ( $p < 0.001$ ). The Spearman correlation coefficient ( $\rho = 0.52$ ,  $p < 0.001$ ) indicates a moderately strong positive association, meaning that higher vaping frequency is linked with more frequent bronchitis symptoms. These findings reinforce that vaping intensity plays a substantial role in the development of recurrent bronchitis, while demographic factors do not.

**DISCUSSION****E-cigarette Use and Bronchial Inflammation**

The results of this study reveal a significant association between frequent e-cigarette use and recurrent bronchitis among young adults, highlighting the importance of understanding underlying biological mechanisms that may explain this relationship. Vape aerosols contain multiple potentially harmful substances, including nicotine, formaldehyde, acetaldehyde, and volatile organic compounds (VOCs), which are known to induce

cytotoxicity and trigger pro-inflammatory responses. Inhalation of these aerosols can disrupt the epithelial lining of the bronchial walls, impair mucociliary clearance, and provoke inflammatory cascades that manifest clinically as persistent coughing and bronchial irritation. The repeated insult from these compounds may also impair the barrier function of airway epithelial cells, allowing deeper penetration of harmful agents into the lower respiratory tract and increasing susceptibility to secondary infections. These mechanisms provide a plausible biological explanation for the observed higher prevalence of recurrent bronchitis among regular e-cigarette users.

Repeated exposure to propylene glycol and vegetable glycerin, the primary solvents in e-liquids, can produce reactive carbonyl compounds such as acrolein and formaldehyde, which directly damage bronchial epithelial cells. This cellular injury stimulates the release of inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- $\alpha$ ), while also promoting neutrophil infiltration and oxidative stress. The cumulative effect of these processes is chronic airway inflammation, excessive mucus production, and impaired mucociliary transport, all hallmarks of recurrent bronchitis. Studies in animal models have confirmed similar patterns, demonstrating peribronchial inflammation and mucus hypersecretion following repeated e-cigarette exposure, which aligns with the clinical manifestations observed in the current study.

Flavoring additives present additional risk, particularly sweet and fruity types containing diacetyl, cinnamaldehyde, or acetyl propionyl, which have been implicated in airway epithelial toxicity and bronchiolitis obliterans. In vitro studies show that bronchial epithelial cells exposed to flavored e-liquids undergo apoptosis, increased reactive oxygen species production, and impaired repair capacity, even in the absence of nicotine, emphasizing that nicotine-free vaping is not without harm. These findings suggest that the complex chemical composition of e-cigarette aerosols contributes to multiple pathways of respiratory injury.

Beyond chemical toxicity, the manner of vaping itself may exacerbate injury; frequent users often inhale more deeply and retain vapor longer in their lungs, facilitating deposition of harmful compounds in smaller airways and alveoli. This behavior, combined with repeated exposure over months or years, may amplify inflammatory responses, disrupt epithelial integrity, and hinder the lung's innate defense mechanisms. Consequently, chronic exposure to aerosolized compounds establishes a microenvironment conducive to repeated bronchial irritation and symptomatic bronchitis.

Overall, the mechanistic evidence supports the observed association in this study, illustrating how chemical and behavioral factors together increase the vulnerability of young adults to recurrent bronchial inflammation. These insights provide a foundation for understanding the biological plausibility of the epidemiological findings and underscore the need for interventions targeting both chemical exposure and usage patterns.

### **Frequency of Vaping and Respiratory Risk**

The present study demonstrated that 60% of regular e-cigarette users reported recurrent bronchitis, compared to only 15% of occasional or non-users, indicating a clear dose-response relationship. This suggests that higher frequency of vaping is associated with greater exposure to toxic compounds and consequently a higher likelihood of bronchial inflammation. Regular users also tend to inhale more deeply and retain vapor for longer periods, which facilitates deeper deposition of particles and chemicals into the lower respiratory tract. These behavioral patterns, in combination with repeated exposure over time, create cumulative insults that can exacerbate airway inflammation and respiratory symptoms.

Flavoring additives further complicate the risk profile, as aerosolized chemicals such as diacetyl, cinnamaldehyde, and acetyl propionyl have been linked to bronchiolar epithelial damage and impaired airway function. Laboratory studies indicate that these compounds increase oxidative stress, disrupt mitochondrial function, and enhance secretion of pro-

inflammatory mediators in bronchial epithelial cells. Even in nicotine-free formulations, these chemical exposures can provoke cellular injury, highlighting that frequency of use, independent of nicotine content, is a critical determinant of respiratory risk.

Epidemiological parallels reinforce this pattern. Several *in vitro* and clinical studies show that higher frequency of vaping correlates with increased airway inflammation, mucus hypersecretion, and oxidative injury. These findings suggest that repeated exposure, rather than occasional or casual use, drives the observed association between e-cigarette use and recurrent bronchitis in young adults. Such dose-dependent effects emphasize the importance of assessing not only the presence of vaping but also the intensity and frequency of use in evaluating respiratory risk.

The interplay between chemical composition and frequency of exposure may also influence long-term respiratory outcomes. Frequent inhalation of aerosols containing reactive aldehydes can compromise mucociliary clearance, increasing susceptibility to infection and sustaining inflammatory responses. This reinforces the hypothesis that cumulative exposure is a key determinant of airway pathology among regular users.

Taken together, the observed dose–response relationship indicates that interventions to reduce vaping frequency could have a meaningful impact on lowering the risk of bronchial irritation and recurrent bronchitis in this population. These findings highlight the behavioral dimension of respiratory risk and the need for public health strategies that address both chemical and usage patterns.

### **Comparison with Existing Literature**

The findings of this study align with existing clinical and epidemiological literature indicating that e-cigarette use is associated with respiratory symptoms. Gotts et al. reported that habitual e-cigarette users were more likely to experience cough, wheezing, and bronchitis symptoms, particularly among adolescents and young adults (19). Similarly, Lee et al. demonstrated that prolonged exposure to flavored vape aerosols reduces ciliary

function and increases oxidative injury in airway epithelial models (20). These parallels strengthen the biological plausibility of the current findings.

Contrasting evidence exists as well. Polosa et al. observed that adult smokers who switched to e-cigarettes reported fewer respiratory symptoms over 3.5 years (22). Their findings were context-dependent, as participants were former tobacco smokers, whereas this study focused exclusively on never-smokers, demonstrating that new-onset bronchial complaints are associated with vaping in this population.

Additional studies have highlighted the role of flavoring agents, nicotine concentration, and usage frequency in modulating respiratory outcomes. For example, exposure to sweet or fruity flavors has been linked to increased epithelial apoptosis and oxidative stress even in nicotine-free products (16). This supports the notion that chemical composition, along with behavioral intensity, drives the association with bronchial inflammation.

The current study further contributes to the literature by integrating both behavioral and biological perspectives, showing that the frequency and pattern of use, combined with chemical exposure, are important predictors of recurrent bronchitis. This multidimensional approach enhances understanding of why some young adults develop symptoms while others remain asymptomatic despite e-cigarette use.

Overall, the consistency with previous findings and the identification of contextual factors unique to non-smoking young adults provide a robust framework for interpreting the association between e-cigarette use and recurrent bronchitis, emphasizing the need for targeted interventions and monitoring.

### **Potential Confounders**

Several potential confounding factors may influence the observed association between vaping and recurrent bronchitis. Environmental exposures, such as secondhand smoke or urban air pollution, can contribute to bronchial irritation independent of personal

e-cigarette use. These exposures may exacerbate respiratory symptoms, particularly in densely populated urban settings where air quality varies.

Concurrent respiratory infections, including viral or bacterial upper respiratory infections, could mimic or amplify bronchitis symptoms, potentially influencing self-reported outcomes. Although participants with chronic respiratory diseases were excluded, transient infections may still have affected symptom prevalence.

Behavioral and lifestyle factors, including diet, physical activity, and co-use of other inhaled substances, could modify the risk of recurrent bronchitis. These variables were not fully controlled in this study, suggesting that residual confounding may partially explain observed associations.

Despite these limitations, the strong statistical association between frequent vaping and recurrent bronchitis suggests a meaningful relationship, while acknowledging that causality cannot be inferred from a cross-sectional design. Recognizing these potential confounders is essential for cautious interpretation and for designing future longitudinal studies that can more rigorously assess causation.

Addressing these confounders in public health planning may involve monitoring environmental exposures, promoting awareness of infection risks, and providing guidance on behaviors that exacerbate respiratory symptoms, thereby enhancing the effectiveness of interventions aimed at reducing vaping-related harm.

### **Public Health and Regulatory Implications**

The findings underscore the urgent need for targeted public health interventions among adolescents and young adults. Education campaigns should highlight the respiratory risks of e-cigarette use, including the chemical and inflammatory mechanisms underlying recurrent bronchitis. Programs tailored to youth in schools and universities can increase awareness of flavoring chemicals, nicotine content, and potential long-term consequences.

Regulatory measures in Indonesia should be strengthened to reduce exposure among vulnerable populations. This includes stricter age verification protocols, restrictions on flavor additives, transparent labeling of e-liquids, and enhanced surveillance of vaping trends. Enforcement of these measures is essential to mitigate exposure and protect respiratory health.

Behavioral interventions should also focus on reducing frequency and intensity of vaping, which has been shown to correlate with greater risk of bronchial inflammation. Public health campaigns could integrate peer education, counseling services, and digital outreach to promote cessation or reduction of use among regular users.

The observed dose–response relationship suggests that even modest reductions in vaping frequency may significantly reduce the risk of recurrent bronchitis. Coupling behavioral interventions with regulatory enforcement and environmental monitoring can provide a comprehensive strategy for protecting lung health among young adults.

In conclusion, regular e-cigarette use is associated with recurrent bronchitis among non-smoking young adults, representing a preventable public health concern. Coordinated efforts involving education, regulation, and monitoring are urgently needed to safeguard respiratory health and prevent long-term pulmonary complications in this population.

## **CONCLUSIONS AND RECOMMENDATIONS**

This study concludes that frequent use of electronic cigarettes among young adults is significantly associated with the incidence of recurrent bronchitis symptoms, independent of prior tobacco exposure. The findings indicate that regular exposure to vape aerosols is linked to airway irritation and inflammation, supporting the notion that e-cigarette use may pose risks to respiratory health even among healthy, non-smoking populations. Observed bronchial disturbances align with emerging evidence regarding the cytotoxic and pro-inflammatory effects of chemicals commonly present in vape liquids,

particularly those containing flavoring agents. Despite these insights, several limitations should be acknowledged. The cross-sectional design prevents causal inference, and the reliance on self-reported bronchitis symptoms may introduce recall or misclassification bias. Additionally, the use of purposive sampling limits the generalizability of the findings, and potential confounders such as environmental exposures or concurrent infections were not fully controlled. Based on these results, health promotion initiatives should emphasize education for adolescents and young adults regarding the potential respiratory hazards associated with vaping, while regulatory authorities may consider stricter policies on product formulation, flavor restrictions, and marketing aimed at youth.

Future research should employ longitudinal or interventional designs to examine the temporal relationship between e-cigarette use and bronchial health, as well as explore underlying biological mechanisms in larger and more diverse populations. Such studies would provide more robust evidence to guide policy and preventive strategies. In summary, frequent e-cigarette use is associated with recurrent bronchitis among young adults, highlighting a preventable public health concern that warrants continued attention from healthcare professionals, educators, and policymakers.

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