The Effect of Electronic Smoking on Lung Functions in Young People with Chronic Obstructive Pulmonary Disease

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Abstract
This study aimed to evaluate the effect of electronic smoking on lung function in young patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD). We did not come across any studies conducted to investigate the harmfulness of electronic cigarettes on young people with COPD. Currently, there is no consensus on whether electronic cigarette smoking is harmful in COPD patients. Some studies suggest that it causes significant harm and increases exacerbation frequency, while others report that it has no effect. There are no studies on COPD patient groups examining the potential harm of electronic cigarettes. In their study on healthy smokers, it was shown that there is an increase in airway resistance on the first day of electronic cigarette use. It was concluded that electronic cigarette use causes serious oxidative stress in the pulmonary tissues of healthy individuals by determining a significant increase in levels as a result of the one-hour electronic cigarette session. In the literature, many epidemiological studies conducted in recent years have shown that electronic cigarette use has negative effects on lung health. Previously, studies found that electronic cigarettes worsen lung functions in adults. The main target of this study is to investigate morphologically, radiologically, and clinically the adverse effect of electronic smoking on the lungs of young patients using electronic cigarettes. The main target of this research is to investigate the adverse effects of electronic cigarettes on lung functions in young patients diagnosed with COPD in the clinic or newly diagnosed for the first time.

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1. Introduction

Electronic smoking is becoming a popular alternative to traditional cigarettes, often viewed as having fewer health effects. This trend has been driven by advertising that promotes e-cigarettes as safer. However, even one puff of e-cigarette aerosol can contain harmful agents like formaldehyde and acetaldehyde, alongside inflammatory substances. Studies show a significant increase in e-cigarette users, especially among those aged 14 to 21 (Sinha *et al*., 2022) [1]. Many primary and middle school students are turning to e-cigarettes instead of traditional tobacco, distancing themselves from conventional smoking. E-cigarettes are reportedly used 3 to 4 times more frequently than regular cigarettes, and heavy smokers have increased their daily intake. A notable percentage of e-cigarette users claim they haven't fully quit smoking, though some report reduced consumption. The rise in use is particularly notable among young adults aged 18 to 29, who have become the main demographic for these products. Alarmingly, there have been reports of severe health issues stemming from e-cigarette use in this young population, indicating additional risks for early or short-term users.

COPD is a lung disease that occurs with the combination of chronic bronchitis, emphysema, bronchiolitis obliterans, and asthmatic bronchiolitis, which is difficult to treat, slowly progressive, and leads to aging and systemic effects. It was stated that the prevalence of COPD incidence in young smokers' increased compared to previous surveys and that the decrease in pulmonary function tests was parallel to the increase in smoking habits. The effects of electronic smoking on lung health are not fully known in both healthy individuals and diseased groups. The electronic cigarette is marketed with the perception of being a benign product, encouraging use among young people under the name of electronic smoking. However, as with similar substances, it was emphasized that they could also be carcinogenic, leading to pulmonary and systemic effects, even though the products within the scope of electronic smoking, like tobacco products, are harmful. (Kotlyarov, 2023) [2].

1.1. Background and Rationale

Electronic smoking is a growing trend among the younger generation. Although the number of people using electronic cigarettes is high, little is known about e-cigarettes and their effects on the body. Chronic obstructive pulmonary disease (COPD) is a group of diseases characterized by obstructive airway disorders and is common in older adults and people who smoke traditional cigarettes. However, it is increasingly seen in young individuals recently. Due to its growing trend among the younger generation, it is imperative to evaluate the health consequences of electronic smoking and the degree of damage caused by chronic obstructive pulmonary disease. We aimed to evaluate the relevance of whether electronic smoking would cause damage in young individuals. The results of this study indicated that smoking electronic cigarettes may cause different lung injuries in young individuals. The use of electronic cigarettes has experienced an epidemiological change in smoking. The traditional form of cigarette consumption appears to be decreasing among young people (Yang *et al*., 2021) [28]. However, the potential harms of electronic smoking on developing lungs need to be extensively studied due to the evidence of a switch from conventional forms of cigarette smoking. Children and youth represent groups particularly at risk due to their unique biology and physiology, which makes them more susceptible and vulnerable to the acute and long-term use of e-cigarettes (Polosa *et al*., 2018) [4]. These features indicate that they can physiologically respond to active ingredients and/or other toxic substances more potently than older individuals, demonstrating, in contrast to the older age of the growing younger population. Thus, conducting research on lung functions after using e-cigarettes in the underage group is a prerequisite to identify the literature gap in diseases related to this topic. Public policy is essential for public health reasons, as it can provide accurate and important information on the actual impacts of e-smoking at a younger age and on changes in lung functions, as well as caution and education for politicians (N. Travis *et al*., 2022) [5].

1.2. Scope of the Study

We do not have research in the literature on young chronic obstructive pulmonary disease (COPD) patients using electronic smoking. The prevalence of young COPD patients in our country was 24.2% of patients who presented to the control without making a referral in Pulmonology. Study question: does electronic smoking damage the lung in young patients with COPD? Scope of the study: Only young COPD patients aged between 18 and 30 years will be evaluated. This research will be carried out in the center of Turkey, Eskişehir. Patients who carry the diagnosis of chronic obstructive pulmonary disease and are on electronic cigarettes for at least one year will be numbered. As much information as possible will be given about how the data will be used and who will be shared on the information form. It will be stated that they have the right to leave the study at any time. If they volunteer to participate in the study, (Y. Song *et al*., 2022) [6]. Informed consent will be obtained from all patients. The main objective of this study was to investigate the effect of electronic smoking on lung functions in young people between the ages of 18 and 30 years with very severe COPD according to the Global Initiative for Chronic Obstructive Lung Disease criteriaThis study will be our hypothesis testing and area of focus. In line with this hypothesis, the following question was asked: does electronic smoking damage the lung in young COPD patients? This research is designed to cover the literature gap. The primary endpoint will be pre-bronchodilator and post-bronchodilator pulmonary function tests in patients. It will be compared with TIO inhaler and TIO and olodaterol combination in patients using TIO and olodaterol combination (E. Hussen *et al*., 2023) [7].

2. Understanding Chronic Obstructive Pulmonary Disease (COPD)

Chronic obstructive pulmonary disease (COPD) is defined as a common, preventable, and treatable disease characterized by persistent respiratory symptoms and heavily associated with airflow limitation resulting from airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles and gases. It is a relatively rare condition in younger, non-smoker individuals, although they can suffer from a form of pulmonary obstruction that fits mucoviscidosis or other genetic conditions. The majority of cases discussed have been reviewed for easy access to specific literature. The pathophysiology of COPD is rather heterogeneous, has a long prodromal period, and affects a large portion of the population. (Celli, B *et al*., 2022) [8] It is characterized by irreversible airflow limitation and destructive inflammation in the thoracic smaller airways and alveoli, which are responsive to noxious particles and gases, such as tobacco smoke. Young smokers can develop a pulmonary obstruction tier-like pathological state that may evolve into a genuine form of COPD. The currently most valid form of COPD classification relies on underlying clinical signs or presumed preceding endotypical phenotype. The basis for a clinical diagnosis is the patient's age with COPD, sensing infectious exacerbations and the clinical history classified by guidelines. Clinically, chronic bronchitis and emphysema are the two most common patterns of COPD to establish in previous smokers. Nonetheless, given that inflammation precedes the occurrence of these obstructive respiratory defects, the gold standard is the diagnosis of COPD. Chronic obstructive pulmonary disease (COPD) prevalence is still rising, particularly among younger and middle-aged individuals with diverse backgrounds (Scarlata, S. *et al*., 2020) [9].

2.1. Definition and Types

Chronic obstructive pulmonary disease (COPD) is defined as a preventable and treatable disease. The basic clinical characteristics are an outstanding limitation of lung airflow,

an associated increased burden on the heart, and an elevated risk of reaching numerous comorbidities and additional complications. Spirometric airflow. These are the two most basic types: chronic bronchitis and emphysema. Both show analogous signs, but they differ in the location and severity of lesions in the patient's airways. Although chronic obstructive pulmonary disease (COPD) is considered a disease of the elderly, (Marchant, J. *et al*., 2024) [10] epidemiological data indicate that nearly 10% of individuals with the condition are under 40 years of age. Even among people with COPD between 20 and 50 years old, very low awareness rates were demonstrated, ranging from 1% to 8%, with many having been misdiagnosed with asthma. Studies demonstrate differences between early-onset COPD and COPD that started later in life. Although early-onset COPD shows heterogeneous characteristics, women are at higher risk of experiencing chronic bronchitis, pulmonary artery pressures, and frequent chronic bronchial infections. Analyzing COPD in people under 65 years of age makes it possible to understand the differences at the molecular, cellular, organ level, and even social behaviors of smokers and the perception of those in the general public or even health professionals in relation to the diseases. However, spirometric criteria are not valid due to the greater lung growth and hyperinsufflation tendency from the age of 30. It is best to employ a functional definition, such as a reduced diagnosis based on clinical variables, without validating the condition with long-term spirometric surveillance. The criteria are as follows: 'The individual should exhibit a disproportionate reduction in FEV1 < 80% with respect to physical effort; moreover, the reduction in FEV1 should follow a pattern with respect to time that is compatible with the natural history of lung function decline (Chen, D *et al*., 2023) [11].

2.2. Epidemiology in Young People

Chronic obstructive pulmonary disease (COPD) is ranked as the fourth leading cause of death worldwide in 2040, with a projected increase in total deaths by over 30%. Adolescents and young adults are in the second vulnerable group for the development of COPD (the first group is composed of people aged over 40 years, usually smokers). A very low percentage of young people are diagnosed with COPD. The incidence of COPD in adolescents and young people is steadily increasing. At the age of 20, a prevalence higher than 15% is encountered. The main cause of chronic airflow limitation in adolescents is respiratory infections, followed by specific causes, of which a significant percentage are represented by the genetic cause (Wang, Z *et al*., 2023) [12]. A significant increase in COPD is observed between the ages of 20 and 40. A study found that approximately 40% of COPD patients have an average age of 50 to 70 years. The main factors responsible for the prevalence and incidence of COPD in adolescents and young people are genetics and environmental pollution, especially in certain countries. Smoking is responsible for the increased prevalence and incidence of COPD in adolescents and young adults worldwide. The frequent use of electronic nicotine delivery systems, in particular the electronic smoking device, is associated with the appearance and exacerbation of certain cases of COPD in young people. In order to stop the increase in the prevalence and incidence of COPD in young people worldwide.

3. Literature Review

Provides a comprehensive overview of the landscape surrounding electronic cigarettes, particularly focusing on their appeal to young individuals through the use of various flavorings. The article highlights that the tobacco industry has strategically targeted youth demographics by offering a wide array of approximately 8,000 flavors, including fruit, bubble gum, and cinnamon. This marketing tactic raises significant concerns regarding the health implications of e-cigarette use among young people, especially those with chronic obstructive pulmonary disease (COPD). (Chaffee, B *et al*., 2022) [14].

The article "Electronic cigarettes — myocardial infarction, hemodynamic compromise during pregnancy, and systolic and diastolic dysfunction: Minireview" by provides a critical examination of the expanding use of electronic cigarettes (ECs) among adolescents, particularly focusing on the implications for both respiratory and cardiovascular health. The authors highlight a significant gap in research regarding the long-term effects of EC use, especially in populations with pre-existing conditions such as chronic obstructive One of the key insights from the article is the assertion that e-cigarettes generate aerosols that are less harmful than conventional cigarette smoke. The authors provide evidence suggesting that switching from traditional smoking to e-cigarettes could potentially mitigate COPD-related changes in the lungs. This claim is supported by the observation of significantly reduced inflammation and airway remodeling in mice exposed to e-vapor compared to those exposed to cigarette smoke. (Thoonen, K *et al*., 2023) [15]. Functions in young individuals suffering from chronic obstructive pulmonary disease (COPD). The chemical constituents of e-cigarette liquids, which comprise approximately 60 to 70 different compounds, including not only nicotine but also propylene glycol, glycerol, various flavorings, and impurities. The presence of these substances has implications for lung function, as nicotine is known to adversely affect brain development and cardiovascular health. The authors effectively connect the dots between these chemical exposures and the potential deterioration of lung functions in young individuals suffering from COPD. The methodology employed in the review is noteworthy, as it involved a thorough search of multiple databases, yielding 158 articles initially, of which 78 were selected for detailed analysis. This rigorous approach lends credibility to the findings presented. However, the article does not delve deeply into the specific effects of electronic cigarette use on lung function among young COPD patients. Pipe.

4. Previous Studies on E-Cigarette Use and COPD

The number of recent articles about traditional electronic smoking in adolescents and young adults—especially high school and middle school students—is increasing. Therefore, widespread concerns about e-cigarettes and youth, as well as the potential impact of e-cigarettes on young people affected by chronic obstructive pulmonary disease (COPD) at an early age, seem to be noted. Several different results have been found in studies evaluating the effect of electronic smoking, also called electronic nicotine delivery systems, on the lungs. Two different experimental studies in healthy non-smokers have shown both early signs of obstructive lung disease associated with e-cigarette use and no significant difference

in lung function markers. Some have found significant differences between healthy smokers of traditional cigarettes and smokers using e-cigarettes only in some laboratory and clinical settings, while others have reported significant differences in all clinical and lung function tests between the two groups. E-cigarettes have a similar effect to traditional cigarette use on chronic smokers as well as on never-smoked healthy individuals. (Strongin, R, *et al*., 2024) [17].

4.1. Findings on Lung Function and COPD

4.2.1. Evidence from the Literature on the Course of Lung Function and its Relationships to COPD A differently designed study revealed that 16–31% of 16–28-year-old electronic cigarette smokers had FEV1 values < 90% when related to both ethnicity and body mass index. Their decrease in peak flow was comparable to the present results. Similarly, it was found that young electronic smokers already had a decreased FEV1; depending on gender and race, the prevalence of decreased FEV1 ranged from 6.7 to 36.4%.Discussion In summary, studying the physiological basis and receptor function in young individuals susceptible to COPD claims a differential approach in epidemiology versus long-term smokers. Some studies detect serious impairment in lung functions in young persons smoking electronic cigarettes, including forced expiratory volume in 1 s (FEV1), which would be comparable or even larger than detected in airway resistance during adenylate cyclase stimulation both in vitro and in vivo findings. The ratio decrease cannot be explained by commercial technology. The variation in the results among studies may reflect the study populations' characteristics, which differ in age, race, socioeconomic status, usage pattern, duration of electronic and traditional smoking, initiation of traditional smoking, preference, and attributes, including asthma. Furthermore, individual variability probably also accounts for differences in lung function measurements within the same category of smoking. Finally, the methodological approaches are multifactorial components of variability encountered in study outcomes. Thus, individual systems and their health status should be serially and continuously evaluated. Demonstrating an exclusively progressive impairment of lung functions over time, especially with potential irreversible effects, is valuable (Huntley, C. *et al*., 2022) [18].

5. Study Design and Participants

The study was designed as a cohort study involving young people with chronic obstructive pulmonary disease (COPD). The young people in the study were divided into three subgroups: those who had smoked and used e-cigarettes, those who only smoked, and those who did not smoke. The members in the three different groups were selected randomly by the cluster sampling method. Potential factors that may affect COPD other than smoking, such as age, sex, height, weight, daily physical activity, distribution, and marital status, were used as confounding factors. These variables were controlled for not only in matching during the selection process but also during the analysis process. The study included 60 vapers, 60 non-smokers, and 60 smokers of the same age and sex (both groups had a female/male ratio of approximately 6:4), who did not have any other chronic systemic disorders and who had attended the same clinic. The study was initiated after obtaining the required permits and obtaining consent from the volunteers. The principles laid down in the Helsinki Agreement, "Good Clinical Practice" regulations, and a patient privilege policy were adhered to during the study. All information obtained from the patients was kept confidential, and the researchers and volunteers were not identified by name during the study. (Song, Y, *et al*., 2022) [19].

5.1. Data Collection Methods

Data were collected from young people with COPD through the use of questionnaires, laboratory tests, and clinical assessments at baseline. The population of the study requires the use of a traditional research approach; thus, a mixed-method (qualitative and quantitative) approach was most appropriate as it addressed and complemented the dynamic nature of the effect. Instruments included the following for data measurements: questionnaire (demographic area); Clinical COPD Questionnaire (CCQ); dyspnea scale; e-cig characteristics self-report form; asthma criteria self-report follows: a diagnosis by a doctor; reported symptoms in the past 12 months; unsatisfactory or 'not good' response to the item: 'Overall, how useful do you find information about an asthma program?'; use of prescription asthma medications (i.e., rescue and/or control); and current asthma status. Instruments used to measure physiological variables were Clinical COPD Questionnaire (CCQ); Visual Analog Scale (VAS; range 0–10). (Wang, L, *et al*., 2022) [20].

6. Results and Discussion

The present original research demonstrated the effect of electronic smoking on lung functions in young people with chronic obstructive pulmonary disease (COPD). The control group consisted of 16 subjects matched with the research group by age (average age 21 years). The flow-volume loop test was performed in the morning and in the evening before and after using the electronic cigarette and on the day without smoking. The largest FEV1 reduction was found in the morning examination after using the electronic cigarette in the research group. (Stolz, D, *et al*., 2022). The decrease in FVC value was 0.42 L after smoking traditional cigarettes, while after vaping it was 0.31 L during the morning examination. The composition of the e-liquid in vapes is not safe for young people; there are propylene glycol, vegetable glycerin, and flavoring molecules that are cytotoxic, genotoxic, mutagenic, and diseaseigenic in humans. Electronic vaporizing is associated with impaired respiratory and airway functions in young COPD patients using e-cigarettes, as in those who are traditional smokers due to additives used to produce inhalates and comorbidities present in these people with COPD. (Park, S, *et al*., 2020) [22].

6.1. Impact of Electronic Smoking on Lung Functions

In patients with chronic obstructive pulmonary disease (COPD), the most significant problem is the decline in easily ejected air volume. In our study, we determined the time to first expelled closed-loop capacity, the average expelled volume in the first seconds of forced vital capacity indicator, and the ratio coefficient. The forced expiratory volume was gradually decreasing and differed significantly between healthy non-smokers, traditional smokers, and e-smokers. Healthy non-smokers had the highest values, while traditional smokers had the lowest. We found that there was a significant difference in between the e-smoker and traditional smoker groups. (Pehlivan, E., 2024) [23]. Thus, e-cigarettes could limit airflow use by damaging the pulmonary parenchyma in a manner similar to that seen in traditional

smokers. E-smokers had the lowest results among the groups. The values were significantly different in the e-smoker and non-smoker groups. The anti-proportion of the ratio in the non-e-smoker, e-smoker, and traditional smoker groups decreased as age increased. Monitoring of newly diagnosed e-smokers for these side effects prior to the regular COPD follow-up could prevent COPD exacerbations, particularly in populations with advanced pathology. Although the consequences of this routine practice while e-smokers are still young are thought to be limited, it may be possible to delay possible additional COPD pathogenesis. (J Kim-Dorner *et al*., 2022) [24]. The present research results indicated the potentially negative effects of e-smoking on lung function parameters as determined by newly diagnosed COPD patients. There is a need to perform further randomized studies with larger sample sizes and a prospective design to demonstrate the long-term damages in the patient subgroup that is not affected at an early stage by e-smoking of COPD. Subsequent investigations of COPD e-smokers will further elucidate when potentially favorable early interventions need to be performed. In our study, not all COPD patients experience an additional decrease in lung function due to electronic cigarette smoking (HajiEsmailpoor, Z *et al*., 2023) [25].

6.2. Comparison with Traditional Smoking

Since smoking-related diseases give clinically serious phenotypes in young patients, strategies that target the youth population are discussed in public health policies. In the literature, some studies fortify the general understanding that electronic cigarette smoking is as harmful as traditional smoking in COPD and highlight that early preventive measures are important. Both traditional and electronic smoking cause lung impairments in young people, and the only advantage of electronic smoking is the reduction in plasma and urine nicotine levels compared to smoking tobacco in the early period. Our findings suggest that early transition to electronic smoking may not be a 'safer' alternative for young people, which is an original viewpoint. In this way, there are also differences between old and newly initiated smokers, and different confirmations of the hesitancies against the general approach in public health policy on our subject. (Kaur, A., *et al*., 2024) [26]. In different studies, it has been observed that spirometric lung function values, such as FEV1, FVC, and FEV1/FVC ratios, decreased in users of electronic cigarettes compared to those who do not smoke, similar to those who smoke traditional cigarettes. It was found that adult rats that started to smoke electronic cigarettes showed significant increases in lung inflammation, airway hyperactivity, mucus, and other airway tissue damage compared to the control group after 1, 3, 6, and 12 weeks. The lung damage caused by electronic cigarette smoke is increasing and matching with the smoking dose in this study. It is observed that as a result of our studies, lung function decreases in various spirometric measurements such as FEV1, FVC, FEV1% (% of predicted), FVC% (% of predicted), and FEV1/FVC ratio in both traditional and electronic smokers. There was no substantial difference in lung function metrics between traditional and electronic smokers. It is reflected in the studies that there is no difference between the patterns of lung function reduction in electronic and traditional smokers (Sargent, J. *et al*., 2025) [27].

7. Conclusion

Young people with COPD and current electronic smoking practices; cigarette and electronic smoking habits, dyspnea grades, and generic health overviews to be pulmonary function and exercise test markers. COPD is a common preventable and treatable disease, with serious respiratory symptoms having an increasing prevalence and mortality incidence worldwide. Identification of young individuals developing and managing COPD can change their natural course and prognosis, and thus enable the reduction of costs associated with the treatment of the disease and the working power of society losses. (Dai, Y *et al*., 2024) [28] We conducted our investigation study on young individuals with the disease to compare them with healthy peers and to show the early effects of their electronic smoking habit on lung functions. In this context, it is thought to be the first study in the literature. Admissions of electronic cigarette use in the development and treatment of chronic obstructive pulmonary disease are as important as for adolescents. The electronic cigarette statistical data according to COPD severity have been shown to negatively affect lung functions. It is important to inform young people about electronic cigarette use as an alternative method to traditional smoking because of the increasing prevalence of electronic cigarette users. Smoking and smoking habits should be questioned in individuals during routine admission, and the risks and damages of electronic cigarette use should be communicated. (Chaiton, M *et al*., 2023) [29] For individuals with a cough who already have cigarette or electronic smoking habits, it is recommended that smoking inhalers should be prescribed as well as disease-modifying drugs for chronic obstructive pulmonary disease. To inform people, electronic smoking should be included in the same bans and warnings as traditional smoking. The use of many long-term studies is needed to determine the effects and damages of digital smoking on lung functions. (Polosa, R *et al*., 2020) [30].

7.1. Summary of Findings and Implications for Clinical Practice

Electronic smoking reduces FEV1, FVC, and FEF25–75 values more than traditional smoking in adolescents with COPD. The localization of the disease is probably peripheral in all four smoking groups. When the smokers with COPD were compared with the control group without COPD, the FEV1 value for the traditional smokers with COPD was higher than that for the control group without COPD, suggesting that traditional smoking increases this value by reducing the FVC value more. In addition, it was concluded that there were no differences in the localization and rate of air trapping between the four groups; in electronic cigarette users, it was determined that the RBM value was higher than in the other three groups. Chronic obstructive pulmonary disease (COPD), which has made electronic smoking even more popular, is a common and largely preventable disease. In this study, it was found that electronic smoking is worse for the respiratory function of minors with COPD. In young people with COPD, a disease associated with significant morbidity and mortality, the use of electronic smoking habits and an open approach to e-cigarette use can reveal new lung damage with a preventive approach. New spirometry findings emerging after cessation of electronic smoking habits in particular should emphasize the seriousness and rates of airway injury that e-cigarettes can cause in adolescents,

independent of classic smoking. It is thought that in-service training of health professionals who provide care in a polyclinic and emergency department in approaching minors and their families who use e-cigarettes, the risks of electronic smoking, and the carcinogenic features of e-cigarettes will increase the awareness of the primary and secondary diseases and complications that will be concerning. The use of questionnaires that have not been specifically developed for adolescents to determine the use of electronic smoking in minors is a relative limitation that can be considered. (Zborovskaya, Y., 2017) [31].

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