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PULMONARY FUNCTION CHANGES AMONG CIGARETTE SMOKERS IN DHAKA CITY& BANGLADESH

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ABSTRACT

Background: In recent years, the pattern of tobacco use has changed a lot, especially among young adults in Bangladesh, mainly in Dhaka City. Many people assume that e-cigarettes are healthieralternative to traditional smoking so, they choose to consume it. Investigation of pulmonary profiles of our body by regular e-cigarettes usage is crucial**. Objective:** To assess the impact of e-cigarette vaping on pulmonary parameters in healthy young adults of Dhaka city**. Materials and Method:** A total of 180 subjects, including 60 e-cigarette smokers, 60 traditional cigarette smokers, and 60 healthy controls, aged 18-30 years, were opted from different public and private colleges and universities, as well as e-cigarette sales locations in Dhaka Metropolitan City, for this cross-sectional study. For a span of half a yearthe study was executedand recorded several parameters, including respiratory parameters of oxygen saturation, Peak Expiratory Flow Rate (PEFR), Forced Expiratory Volume in 1st second(FEV1), and Forced Vital Capacity (FVC).The Institutional Review Board (IRB) of Ad-Din Women's Medical College, Dhaka imparted the Ethical approval. The data were coordinated, programmed and analyzed using Microsoft Excel and SPSS version 22. Descriptive statistics, such as frequencies, percentages, means, and standard deviations, were used. One-way ANOVA and chi-square tests were used to compare between groups. A *p*-value of ≤ 0.05 was regarded statistically significant. **Results:** In terms of lung function, e-cigarette users showed worse lung function, with reduced FEV1 and PEFR. **Conclusion:** The lung function test speciallyFEV1 and PEFR indicated significant reduction in contrast to non- smokers. However, this reduction was not as severe as traditional smokers, hence e-cigarettes still pose potential risks to respiratory health.

Keywords: E-cigarette vaping, Vaping effects, Young adults, Pulmonary parameters, Dhaka city.

INTRODUCTION

From the patent submission, in 1963 by Herbert A Gilbert, to the formulation in the early 2000s by a Chinese pharmacist Hon Lik, E-cigarettes purported as a harm reduction alternative to traditional tobacco cigarettes[1]. Though, considered as a safer option, several clinical evidences suggested that electronic cigarette or vaping induces significant pulmonary function alterations through mechanism such as oxidative stress, airway inflammation and impaired gas exchange[2]. Electronic cigarettes (e-cigarettes; EC) are a new and developing electronic nicotine delivery system, also known ENDS. It is an electronic device that allows the user to inhale a vaporized nicotine solution or salt; ultimately, the user breathes in the nicotine without combustion.

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However, a battery gives strength to the device by controlling the heating of E-liquid, which then transforms into an aerosol. The user then puffs the aerosol in and out[1]. This process recognized as 'Vaping'. The e-liquid is composed of three main elements–nicotine, propylene glycol & vegetable glycerin. It also contains some flavoring agent, and other chemicals[3].

There are four generations of E-cigarettes. First-generation e-cigarettes were a blueprint of conventional cigarettes; their battery strength was low, also called cig-like. On the contrary, The Second-generation e-cigarettes are larger, pen shaped containing a rechargeable battery along with a refillable reservoir. Third-generation e-cigarettes are different and more updated from previous generations in size and shape; they are also called mods. Mods contain large refillable tanks and batteries with adjustable power outputs. Nowadays, modern e-cigarettes, also known as pods, characterized by prefilled cartridges that contain concentrations of nicotine, are quite different from conventional cigarette. Moreover, they are flavored with different flavors[4].

The plasma nicotine amount (3-5 ng/mL) could not increase considerably as in the first two generations of e-cigarettes, as combustion of conventional cigarettes does (10-30ng/mL); on the other hand, high-powered third-generation devices achieved similar plasma nicotine levels and pharmacokinetics as tobacco cigarettes (TC). However, Fourth generation ENDS can deliver a higher amount of nicotine (7-18 ng/mL), because it contains nicotine salt and benzoic acid instead of freebase nicotine to increase its nicotine delivery efficiency[5,6].

The liquid for e-cigs comes in a range of flavors, adding to its allure for young users. The vapor is inhaled in the same fashion as when smoking a traditional tobacco cigarette. Other than a common ingredient, nicotine, e-cigarettes and traditional cigarettes are fundamentally different. Traditional Tobacco cigarettes contain over 7000 chemical compounds and involve the combustion of tobacco. However, studies state that e-cigarettes are as toxic as tobacco cigarettes and can cause significant lung damage. Some research finding shows the lungs of e cigarette userscontains ultrafine particles formed from propylene glycol. Furthermore,inhalation of e- cigarette aerosols could alter lung homeostasis[7]. Another study suggested that pulmonary functions of e-cigarette user resembles the lung function of conventional tobacco smokers, althoughthe effects are less in e- cigarette[8].

The exact mechanisms responsible for lung impairment caused by e-cigarette use are not completely understood. However, it is believed that inhalation of aerosol particles and various chemicals present in e-cigarettes can lead to airway inflammation and gradual damage to lung tissues. Besides, severe respiratory complications can develop by the existence of harmful substances such as formaldehyde and acrolein, even in trace amount. The outcome of our study reveals, that respiratory complications are grievous when a person vapes for a sustained period, even though short-term vaping can affect lung function moderately[9].

Both instant and prolonged exposure of e- cigarette can evokeseveral specific changes in lung function. There are some immediate effect associated with acute exposure, such asdecreases in FEV_1 , FVC, and Peak Expiratory Flow (PEF)[10]. Furthermore, exacerbated reductionsin this lung function parameters have been detected in chronic use of e- cigarette and it mightbe strongly associated with obstructive lung function impairment, even after withdrawal of conventional smoking[11]. E-cigarette aerosols significantly impair peripheral airway function, typically measured by reductions in forced expiratory flow at 25%–75% of FVC (FEF_{25-75})[12]. Vaping can cause an increase in ventilation-perfusion (V/Q) mismatch and a transient decrease in arterial oxygen tension[13].

The prevalence of adolescent e-cigarette use in the United States was 4.2% in 2008, which increased to 16.0% in 2015. However, in Taiwan, adolescent e- cigarette use was 2.1% in 2014, and it almost doubled to 4.5% in 2017[14].

On these premises, the safety of e-cigarettes has become a subject of fierce ongoing debate. Traditional tobacco cigarette smoking is known to cause deleterious effects on the pulmonary systems. On account of the widespreadpractice of vaping in young generation, students and adults,it is necessary to evaluate the health impacts of e-cigarette[15]. A safety assessment of electronic cigarettes was requested by the World Health Organization. There is not much information available at the moment about the potentially harmful effects of the chemicals used in e-cigarettes. Only a small number of studies have looked at specific aspects of the health implications of using e cigarettes[16].

In contrast to traditional cigarettes, there is currently little research on how e- cigarettes affect personal health and normal physiology. At present very limited data is availableconcerning the health hazards associated with using e-cigarettes. With appealing flavors, designs, and marketing targeted at a younger audience, usage is rising rapidly, particularly among the younger population. It is also linked to positive social acceptance and is easily attained. At this stage the expertise are facing challenges to set upguidelines on commercial use of e- cigarette, because there is a shortage of clinical studies which can give idea about harmful health effects. Hence, this analysis is formulated to examinethe pulmonary parameters of healthy young adults who actively uses e-cigarettes to determine any aberration. Many people switch to e-cigarettes believing they are safer than traditional cigarettes. Our study can help to determine whether this belief is valid by comparing the impact of e-cigarettes and traditional cigarettes on these health parameters. However, this research inquires the diverse regulatory frameworks for e- cigarettes to establish evidence based strategies that safeguard the health of future generation.

MATERIALS AND METHOD

This study is cross sectional and it is conducted in different public and private colleges and universities, and e-cigarette sales spots of Dhaka Metropolitan City from January 2025 to June 2025. A total of 180 subjectswere enrolled in the study by purposive sampling, among which 60 were e-cigarette smokers, 60 were Traditional burnt cigarette smokers, and 60 were non-smoker individuals as controls. Anyone having systemic disease, e.g., Diabetes Mellitus(DM),Hypertension(HTN), bronchial asthma, Chronic Obstructive Pulmonary Disease (COPD), duration of smoking < 12 months, Dual users at a time (both e-cigarette smoking and traditional burnt smoking) and current substance abusers, along with cigarettes are excluded from the study.Vaping and smoking history and volume were assessed by a structured questionnaire. The questionnaire comprises open-ended and closed- ended questions. Pulmonary function tests were performed in accordance with established standard procedures to assess theForced Expiratory Volume in 1st second (FEV1), Forced Vital Capacity (FVC), and the FEV1/FVC ratio by Auto spirometer. Following data collection, organization and coding, relevant statistical tests were applied to evaluate the findings. The statistical processing was conducted through Microsoft Excel, while more complex analyses were executed using SPSS Version 22.Presentation of data was done by using descriptive statistics, where categorical data were displayed in the form of frequencies and percentages andquantitative datawere demonstrated by the mean (X) and standard deviation (SD).Besidescomparative data analyses were done by one-way ANOVA test and chi-square test (X2), to compare the qualitative variables of e-cigarette smokers, traditional cigarette smokers, and non- smokers. To examine association between two variables *p*-value was used.

RESULTS

The study included three groups of participants: 60 e-cigarette users, 60 traditional cigarette users, and 60 non-smokers. With regard to age, Body mass index (BMI), Level of education and marital status there were no statistically significant differences between the studied groups. However, gender distribution showed a significant difference ($p< 0.001$), with a higher proportion of males among e-cigarette users (88.3%) and traditional cigarette users (90%), while females constituted 11.7% and 10%, respectively; the non-smoker group had a more balanced gender distribution with 38 females (63.3%). Regarding employment status, a significant variation was observed ($p< 0.001$), with a higher proportion of students among e-cigarette users (33.3%) and traditional cigarette users (16.7%), whereas non-smokers were mainly employed full-time (20%) or unemployed. Education levels did not differ significantly among groups ($p = 0.19$). Marital status was similar across groups, with most participants being single (over 70%), and no significant difference was found ($p = 0.45$) as is displayed in Table 1.

Table 1: Demographic finding of respondents

Parameters	E-Cigarette User (n = 60) n (%)	Traditional Cigarette User (n = 60)	Non-Smoker (n = 60)	Significance
Age (years) (Mean ± SD)	23.42 ± 4.14	25.18 ± 3.05	25.32± 4.65	0.016
BMI (kg/m2)	22.82 ± 3.23	23.92 ± 4.17	22.54 ± 5.22	0.18
Gender n (%)				
Male	53 (88.3%)	54 (90.0%)	48 (63.3%)	p < 0.001) Chi- Square test
Female	07 (11.7%)	06 (10.0%)	12 (36.7%)	
Employment status				
Student	20 (33.3%)	10 (16.7%)	30 (50.0%)	p < 0.001 Chi-Square test
Unemployed	05 (8.3%)	08 (13.3%)	12 (20.0%)	
Employed (full time)	05 (8.3%)	30 (50.0%)	12 (20.0%)	
Employed (part time)	30 (50.0%)	12 (20.0%)	06 (10.0%)	
Level of education				
Didn't complete high school	06 (10.0%)	11 (18.3%)	07 (11.7%)	0.19 Chi-square test
Completed higher secondary	33 (55.0%)	19 (31.7%)	24 (40.0%)	
Studying but have not graduated yet	19 (31.7%)	24 (40.0%)	24 (40.0%)	
Graduation and above	02 (3.3%)	06 (10.0%)	05 (8.3%)	
Marital status				
Single, never married	49 (81.7%)	45 (75.0%)	44 (73.3%)	0.45 Fisher's Exact Test p-value
Single, divorced	0 (0%)	0 (0%)	2 (3.3%)	
Married	11 (18.3%)	15 (25.0%)	14 (23.3%)	

Baseline characteristics of the smoker subjects' differences. Data are presented as mean ±SD. BMI- body mass index, SD -Standard deviation. Fisher's Exact Test, Chi Square test, and One-way ANOVA* test was used to analyze the data

The study evaluated lung function parameters among different groups: e-cigarette smokers (n=60), traditional cigarette smokers (n=60), and non-smokers (n=60). The results displayed in Table 2 showed that e-cigarette smokers had significantly lower FEV1 (3.35 ± 0.54 L/s) compared to non-smokers (3.79 ± 0.18 L/s), while traditional smokers also showed reduced FEV1 (3.11 ± 0.32 L/s). Similarly, the FEV1 percentage predicted was lower in both smoker groups compared to non-smokers, with significant differences observed. Peak Expiratory Flow Rate (PEFR) was notably lower in both e-cigarette and traditional smokers compared to non-smokers, with highly significant differences (p=0.001). FVC values were not significant, with smokers showing reduced FVC compared to non-smokers. Overall, these findings suggest that both e-cigarette and traditional cigarette smoking are associated with decreased lung function, particularly in measures of airflow, indicating potential respiratory impairment among smokers.

Table 2 Comparison of Pulmonary function test results among e-cigarette users, Traditional Cigarette users, and non-smokers.

Parameters	E-Cigarette Smokers (n = 60) (Mean ± SD	Traditional Cigarette Smokers (n = 60) (Mean ± SD)	Non-Smoker (n = 60) (Mean ± SD)	p-Value	Significance
FEV1 (L/s)	3.35 ± 0.54	3.11 ± 0.32	3.79 ± 0.18	0.01	**Statistically significant**
FEV1 (% predicted)	75.2 ± 11.25	72.9 ± 9.05	80.2 ± 9.05	0.02	**Statistically significant**
FVC (L)	3.98 ± 0.24	3.86 ± 1.2	4.42 ± 0.96	0.05	Not significant
FVC (% predicted)	84.84 ± 9.38	80.63 ± 12.11	88.64 ± 18.62	0.07	Not significant
FEV1/FVC (%)	77.2 ±8.85	76.9 ± 6.65	80.9 ±2.65	0.15	Not significant
PEFR (L/min)	439.80±27.54	420±30.88	504.20±66.83	0.001	Highly significant

At p = 0.05 level of significance**,** parameters with p ≤ 0.05 are statistically significant**,** while p > 0.05 are not significant. Data are presented as mean ± SD. SD -Standard deviation. One way ANOVA test was used to analyze the data. FEV1=Forced expiratory volume in 1 second, FVC=Forced vital capacity, FEV1/FVC%=FEV1/FVC ratio.

DISCUSSION

Measurement of FEV1 and PEFR provides an objective assessment of ventilatory capacity and potential airway obstruction.In this studyFEV1 and PEFR showed significant reductions in e-cigarette users. A decrease in these parameters suggests that vaping can impair lung capacity and airflow. In the contrary, some researchers reported that, inhalation of e-cigarettes for short term did not significantly affect lung ventilation in different populations. This observation is similar with some previous research indicating minimal short-term effects[17]. Moreover, other researchers observed the long-term effect of e-cigarette use, which showed significant declinein lung function. Also, in some recent study it was observed that individuals who used e cigarettes for more than three years had significantly lower FEV1 and FVC in comparison to short-term users[18]. These observations put forward an idea that the duration of vaping plays an important role in pulmonary health, along with development of chronic respiratory issues by prolonged exposure to vaping.

Our study, involving mainly young and relatively short-term users, supports the idea that initial vaping may cause some lung function changes, but more research is needed to understand the long-term effects. Although the specific biological pathways are not yet entirely clear, current evidence indicates that the inhalation of e-cigarette aerosols contributes to pulmonary inflammation and the progressive degradation of lung tissue. The presence of harmful substances, such as formaldehyde and acrolein, even in small amounts, could contribute to respiratory problems. The study shows that even brief vaping affects the lungs, while continued use risks more severe health problems.

In the present study significant FEV1 and PEFR decreases prove that even young, healthy lungs are at risk by e-cigarette use. Moreover, increased duration and frequency of vaping may exacerbate these outcomes.Additionally, individual variabilitydriven by age, genetics, and health statusprevented significant changes in other parameters examined in this research.

Regarding pulmonary function, previous research presents mixed results. Some studies have shown short-term declines in lung function following e-Cigarette use[12,19], while others have failed to observe significant changes[20]. Various integrative review indicate that while e-cigarettes trigger acute respiratory responses, chronic effects are not yet established. Notably, some researcher reported no significant decline in lung function over 3.5 years among exclusive e-cigarette users, indicating potential differences based on usage duration and composition of EC aerosols[12]. However, some studies highlight decreases in airway function and respiratory symptoms post-use, emphasizing the need for longitudinal assessments[19].

While the exact causes of vaping-related lung damage remain unclear, experts believe inhaling e-cigarette aerosols and chemicals triggers chronic inflammation and tissue injury. The presence of harmful substances, such as formaldehyde and acrolein, even in small amounts, could contribute to respiratory problems. The outcome of the study highlights that, short-term vaping causes immediate inflammation and airway constriction, while long-term use is linked to chronic respiratory diseases and cardiovascular damage.

In Dhaka, young adults hold divided views on the safety of e-cigarettes, influenced largely by individual experiences, health literacy, and social norms. These findings mirror global trends, underscoring the need for continued monitoring, public awareness campaigns, and extensive research into long-term health risks.

CONCLUSION

This study found that e-cigarette users have poorer lung function than non-smokers, specifically regarding airflow metrics like FEV_1 and PEFR. While the respiratory damage was less intense than that seen in traditional smokers, e-cigarettes still negatively impact pulmonary health. Ultimately, while they may be less harmful than tobacco, e-cigarettes are not risk-free and pose a genuine threat to lung function.

CONFLICT OF INTEREST

There is no conflict of interest.

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