

Impact of e-cigarette smoking on pulmonary functions among healthy male adults of Shah Alam, Malaysia

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Abstract

Background: The use of e-cigarettes is currently being very popular among young adults and this trend is increasing day by day. Some research studies have reported on prevalence of electronic cigarette smoker in Malaysia; however, no studies have yet been conducted on E cigarette smoking in relation to the functioning of the lungs in Malaysia. **Aim:** The aim of this study is to find out how electronic cigarettes affect the lung functions of healthy male adults in Shah Alam, Selangor. **Methodology:** 100 healthy male adults between the ages of 18 to 35 years participated in the study. They were split into two groups where there were 51 smokers and 49 non-smokers. Convenience sampling method has been used in this study since participants are chosen according to accessibility rather than at random. A computerized spirometer was used to measure the dynamic pulmonary functions. The results were analyzed using the SPSS version 29.0. Student's t-test were applied to test the difference of the means between the two quantitative variables. Pearson's correlation and regression tests were applied to find correlation between physical parameters and pulmonary function parameters. **Results:** All the five studied pulmonary function test (PFT) parameters, such as Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV₁), FEV₁/FVC (%), Maximum voluntary ventilation (MVV) and Peak Expiratory Flow Rate (PEF) of smokers were lower mean than non-smokers, however the difference was statistically significant (P<0.05) only for FEV₁/FVC (%). **Conclusion:** In this study, we found that smoking e-cigarettes for short duration do not have much significant impact on pulmonary functions except FEV₁/FVC (%) which is significantly lower among male e-cigarette smokers. **Keywords:** E-cigarette, Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV₁), FEV₁/FVC (%), Maximum voluntary ventilation (MVV) and Peak Expiratory Flow Rate (PEF), Smokers, Non-Smokers.

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Introduction:

The global surge in the use of electronic cigarettes (e-cigarettes), commonly regarded as a safer alternative to traditional tobacco smoking, has raised concerns about its potential impact on health, particularly pulmonary functions. Malaysia has witnessed a rise in e-cigarette use, especially among younger, healthy adults, with males being the predominant users. Electronic cigarettes encompass a range of devices which employ an electrically driven coil to heat e-liquid solution to generate an aerosol containing nicotine, flavors, propylene glycol, and vegetable glycerin that is inhaled. Different kinds of electronic cigarettes exist, called electronic nicotine delivery systems (ENDS) and electronic non-nicotine delivery systems (ENNDS). The International Tobacco Control Policy Evaluation Project (ITC Project) carried out a survey in ten different countries between 2009 and 2013, The results of this survey revealed that Malaysia had the

greatest prevalence of electronic cigarette users, with 14% of the population (Gravely et al., 2014). According to the findings of a study conducted by Wong and colleagues in Malaysia, electronic cigarettes were smoked by 36% of young professionals and 39.9% of young students attending higher education institutions in the regions of Selangor and Kuala Lumpur (Wong et al., 2016). Pulmonary function tests (PFTs) provide a reliable measure of lung capacity and airway functionality, making them a critical tool for assessing the potential health impacts of e-cigarette smoking. In healthy individuals, any significant changes in these parameters could indicate early physiological impairments and risk of future respiratory issues. The increasing popularity of e-cigarettes in Malaysia and the relative paucity of data regarding their effects on lung health among healthy adults, it is essential to explore this area. Young people are especially likely to use these cigarettes (Bold et

al.,2018). Although e-cigarettes are perceived to cause less harm than conventional cigarettes due to the absence of combustion-related toxicants, growing evidence suggests that they may still exert harmful effects on respiratory health. However, we don't fully understand yet how long-term use of e-cigarettes affects lung function. This is becoming a major public health issue, especially for young people.

Previous research has mostly studied the prevalence of e-cigarettes in Malaysia, but not much has been done on how they affect lung function. The prevalence of tobacco smoking among Malaysians aged 15 and older continues to be significant, even with the introduction of various anti-smoking initiatives over the years. The health impacts of tobacco smoking on Malaysian citizens are closely linked to their general attitudes as well as the smoking habits of their friends and family (Myat et al., 2019). Our previous study on obesity and pulmonary function revealed that obesity has no significant impact on pulmonary function among adolescent (Bhattacharjee et al.,2018].

Another earlier study concluded that compared to total relative obesity, abdominal obesity had a greater effect on the deterioration of pulmonary functioning among young non-smoker healthy female of Malaysia (Bhattacharjee et al.,2018).

This study aims to investigate the effect of e-cigarette smoking on pulmonary functions among healthy adult males in Malaysia, using PFTs as a key measure. Understanding the impact of e-cigarettes on lung health could help inform public health policies and interventions aimed at mitigating the risks associated with vaping in this population.

Materials and methods:

This cross-sectional comparative study was carried out among 100 healthy adults male aged between 18-35 years in Shah Alam, Selangor, Malaysia. Among the total 100 healthy male adults, where 51 were e-cigarette smoker who are smoking for minimum past 6 months and rest 49 were nonsmoker. This study compared and analyzed dynamic pulmonary function among these two groups. The sample size was calculated using the method of Das and Das (1998) (Das 1998) where the confidence interval was set as 95%. The computed sample size was 32 in each group. In this study we recruited a greater number of subjects than the computed sample size in each group.

A convenience sampling method was used to find participants for this study. Necessary ethical approval was obtained from university ethical committee (ref code: EA-L1-01-IMS-2024-05-0008). Participants were identified from restaurants, cafes, community outreach programs, colleges, and referral sources. Each participant filled out an American Thoracic Society questionnaire [Comstock et al., 1979] with their personal

information, health information, respiratory symptoms and research consent. Participants with any acute or chronic respiratory diseases such as chronic bronchitis, emphysema, bronchiectasis, asthma, and cystic fibrosis were excluded. Subjects with anemia, diabetes mellitus, malignancy were also excluded. Participants who had undergone vigorous exercise regularly or worked in an industry that generates dust or fumes were also excluded from the study.

Pulmonary function test (PFT)/ Spirometry:

A computerized spirometer (Spirobank II MIR, Del Maggolino 125, 00155 Roma, Italy) was used for testing pulmonary functions. All participants were given brief instructions before the test. The spirometer was calibrated every day using a 3 L calibration tube. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), FEV₁ as a percentage of FVC (FEV₁%), peak expiratory flow (PEF), and maximal voluntary ventilation (MVV) were all recorded. The measurements were performed while standing upright with the nose clipped according to the guidelines given by the American Thoracic Society (Miller et al.,2005). All measurements were calibrated at source at Body Temperature and Pressure Saturated with Vapor (BTPS). The tests were conducted at midday, prior to lunch, as expiratory flow rates reached their peak at this time (Hetzel et al.,1980). Each participant performed three good trials, with a minimum of 5 minutes of rest between each trial (Chatterjee et al.,1991). For at least two hours prior to the test, all participants were told not to eat or consume any hot or cold liquids. Additionally, they were instructed to refrain from using their ENDS device for at least an hour before to the test.

During spirometry test, subjects were instructed to take breathe in as deeply as they can and then breath out as strongly as they can. When the subject inhales, they should do so rapidly and completely, and they should insert the breathing tube into their mouth, making sure that their lips seal around the mouthpiece and that their tongue does not occlude it.

Statistical analysis:

In this study, the observed results were analyzed using the Statistical Package for the Social Sciences (SPSS) version 29.0 for Windows. The difference between the means of the experimental group (smoker) and control group (non-smoker) were measured by Student's t-test. For statistical significance, p-values less than 0.05 were considered as significant. Pearson's product-moment correlation was applied to find out the relationship between physical parameters and pulmonary function parameters. In order to calculate the norms for predicting pulmonary function measures from various physical parameters in the population under study, simple and multiple regression analysis were also used.

Results:

Table 1 depicts the physical characteristics of E-cigarette smoker (experimental group, EG) and non-smoker (Control group, CG) healthy young male of shah alam, Malaysia. The EG group consists of 51 E cigarette smokers and all participants were almost identical in terms of their age, height, body weight, ethnicity and race. The mean age of smokers (EG) was 23.00 years SD=2.60 years with mean body height 172.76 cm, SD=8.90 cm, body weight 70.00 kg SD=14.2 kg and body mass index 23.59 kg/m² SD = 4.90kg/m². The nonsmoker (CG) consists of 49 participants belonging to almost same age range (M= 22.33 years, SD=1.42), body height (M=168.15cm, SD=9.70cm) and weight (M= 69.30 kg, SD=3.92 kg). No significant difference was observed in the physical characteristics between smokers (EG) and non-smokers (CG) except height. **Table 1: Physical characteristics of e-cigarette smoker(experimental group) and non-smoker (control group) healthy young male of shah alam, Malaysia.**

Physical characteristics	Smoker (n=51) Mean ± SD	Non-smoker (n=49) Mean±SD	p values
Age (Years)	23.00±2.60	22.33±1.42	0.07NS
Height(cm)	172.76±8.90	168.15±9.70	0.01*
Weight (kg)	70.00±14.20	69.30±3.92	0.41 NS
Body mass index (kg/m ²)	23.59±4.90	24.31±3.92	0.22NS

*Significant at the 0.05 level, NS= not significant

The T-test analysis comparing the mean value of the dynamic pulmonary function parameters studied in 51 healthy male smoker and 49 male non-smokers is displayed in Table 2. It provides quantitative insights into the physiological effects of e-cigarette smoking on pulmonary function. As anticipated, the non-smoking male, mean values for all analysed pulmonary function test (PFT) parameters—FEV₁, FVC, PEF, MVV and FEV₁/FVC(%) were greater than those of the smoker students, however the difference was not significant except FEV₁/FVC % which was significantly lower in smoker than non-smoker.

Table 2. Comparison of dynamic lung function parameters between e-cigarette smoker and non-smoker (control group) healthy young male of shah alam, Malaysia.

Variables	Group	Frequency, n	Mean ±SD	P value
FVC (L)	Smokers	51	3.03±0.06	0.43 NS
	Non-smokers	49	3.05±0.11	
FEV ₁ (L)	Smokers	51	2.99±0.10	0.41 NS

	Non-smokers	49	3.02±0.06	
PEF (L/s)	Smokers	51	7.41±0.33	0.23 NS
	Non-smokers	49	7.76±0.35	
FEV ₁ /FVC (%)	Smokers	51	94.26±0.62	<0.05*
	Non-smokers	49	99.81±0.14	
MVV (L/min)	Smokers	51	97.23±4.51	0.23 NS
	Non-smokers	49	100.49±2.47	

*Significant at the 0.05 level, NS= not significant

Table 3 reports the correlation coefficient values between physical parameters and PFT parameters. Correlation coefficients were also calculated for the entire sample(n=100) because there was minimal intergroup variance in PFTs and the values of the correlation coefficients in the CG and EG were close to each other. A positive significant correlation was observed between body weight and PEF, whereas MVV had a significant positive correlation with body height and weight. Rest of the PFT parameters had no significant correlation with physical parameters. Since Body weight and body height had the significant correlation coefficient values with MVV and body weight had significant positive correlation with PEF, in order to calculate the simple regression norms for MVV and PEF prediction in the population under study, these two physical parameters were taken into consideration as the independent variables (Fig1, Fig2, Fig 3 & Table3).

Table 3. Correlation of physical parameters with pulmonary function measurements in young healthy male (N=100) of shah alam, Malaysia (values are Pearson's correlation coefficient r).

	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg/m ²)
FVC(L)	- 0.11 6	- 0.137	- 0.086	- 0.02 7
FEV ₁ (L)	- 0.10 3	- 0.147	- 0.098	- 0.03 7
PEF(L/s)	- 0.03 2	- 0.139	- 0.244 *	- 0.16 8
MVV(L/min)	- 0.00 5	- 0.205 *	- 0.249 **	- 0.15 1
FEV ₁ /FVC(%)	- 0.09 6	- 0.005	- 0.004	- 0.00 1

* Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level

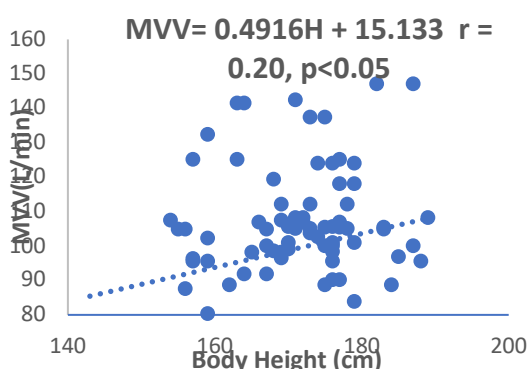


Figure 1. Relationship of Body height and MVV(L/min) in young healthy male of shah alam, Malaysia.

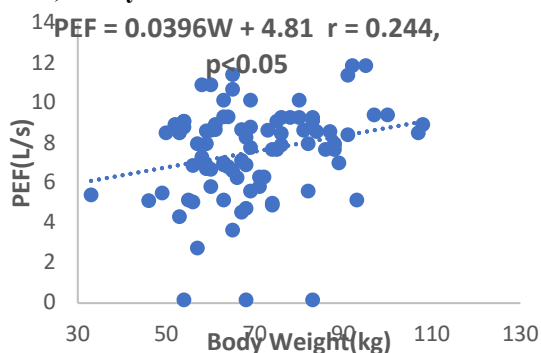


Figure 2. Relationship of Body weight(kg) and PEF(L/s) in young healthy male of shah alam, Malaysia.

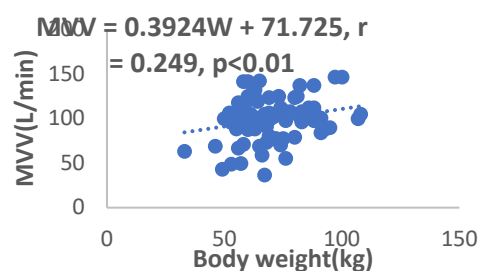


Figure 3. Relationship of Body weight(kg) and MVV(L/min) in young healthy male of shah

alam, Malaysia.

Discussion:

This is the first study on impact of e-cigarette smoking on spirometry among healthy male adults of Malaysia. Some recent studies have suggested that the use of e-cigarettes may have a detrimental impact on pulmonary function. E-cigarette aerosols contain a complex mixture of chemicals, many of which have yet to be fully characterized in terms of their health effects (Sanchez-Rosario et al., 2024). The potential for these aerosols to irritate the airways and disrupt normal lung function has raised significant concerns among healthcare professionals. The impacts of e-cigarettes on the immune system (Clapp et al., 2017) oral health (Pushalkar et al., 2020, Kumar et al., 2019), cardiovascular system (Skotsimara et al., 2019, Larue et al., 2021) and other systems (Szumilas et al., 2020) have been brought to light by recent studies.

Studies on physiological effects of acute e-cigarette use on human lung function are scanty and most of the studies focusses on the effects of e-cigarettes on only four lung-function indicators such as FEV₁, FVC, FEV₁/FVC, and FeNO (Meo et al 2019). In our study, we have measured PEF and MVV in addition to FEV₁, FVC, FEV₁/FVC however we did not measure FeNO. A systematic review conducted by Rao et al. showed that Cigarette smoking is associated with a negative relationship to body weight or body mass index (BMI). The act of quit smoking has been connected to weight gain, which is indirectly influenced by hormones that regulate appetite in the gut and fat cells (Mahadeva et al., 2019). Sook Park and Hee Yun conducted a study to investigate the factors related to the rise of smoking frequency of intermittent smokers. They found that “emotional factors”, “stress” and “smoking friends” are crucial factors to increase the frequency of smoking (In-Sook et al., 2017).

The purpose of this study was to determine whether or not electronic cigarettes smoking have an effect on the pulmonary function among the healthy male adults of Shah Alam, Malaysia. The result obtained from this study revealed that smokers had lower FVC (L), FEV₁ (L), PEF (L/s), FEV₁/FVC (%) & MVV(L/min) values compared to non-smoker. Obstruction of their airways and a weakening of their respiratory muscles due to e-cigarettes smoking may be the possible reasons behind this. However, the difference was not significant for all PFT parameters except FEV₁/FVC % which was significantly lower in smoker than non-smoker. The FEV₁/FVC ratio is a critical measure in pulmonary function tests, representing the proportion of a person's vital capacity that they can forcibly exhale in one second (FEV₁) to the total volume of air they can forcibly exhale (FVC). A lower FEV₁/FVC ratio suggests obstructive airway conditions, which are often associated with

smoking-related diseases. A similar study conducted in Riyadh, Saudi Arabia showed a significant decline in lung function parameters in e-cigarette users compared to their control group (Vardavas et al., 2012). However, Flouris et al. (2013) investigated the acute impact of both active and passive e-cigarette smoking on pulmonary function, which is consistent with the results reported in this study. They concluded that brief e-cigarette usage results in less significant alterations to lung function. Similarly in our study most of the lung function parameters in smoker were slightly lower than non-smoker and the differences were not significant except FEV₁/FVC (%). Vardavas et al. (2012) assessed the impact of short term acute (five minutes) impact of e-cigarette use on lung function metrics and they found no significant decrease in FVC, FEV₁, and the FEV₁/FVC ratio. On contrary, in our study, we found a no significant decline in FVC, FEV₁, PEF, MVV except FEV₁/FVC(%) which is significantly lower in e-cigarette smoker than non-smoker control group. There are many factors that contribute to this, including the duration of smoking, lifestyle, healthy food habit and adaptation of the aerosol in e-cigarette. Most smokers in this research study have been smoking for less than three years. Furthermore, Shahab et al. (2017) provide evidence that chronic exposure to e-cigarette vapor causes significant pulmonary changes, including increased airway hyper-reactivity and impairment of ciliary function. This suggests that long-term use may lead to chronic respiratory conditions, emphasizing the need for comprehensive understanding of these effects. It is crucial to further investigate the long-term effects of e-cigarette use on pulmonary health to ascertain whether initial declines in function persist or worsen over time, raising important public health considerations for this growing demographic. Moreover, most of the participants of this study are active in outdoor and indoor games, playing football, badminton, swimming, and other sports. This explains why most of the PFT parameters are not significantly lower in smoker than non-smoker. Numerous articles claim that exercise can enhance lung function. For instance, Garcia Aymerich et al., 2007 claimed that physical activity outdoors, such as exercise, contributes to general bodily health. Gotts et al. (2019) emphasized the importance of awareness and education regarding the risks associated with e-cigarette use, particularly in relation to pulmonary health. As the popularity of e-cigarettes grows, understanding the demographic factors influencing their use will be essential for effective public health interventions.

Limitation of the study:

The sample size of this study was only 100, which is quite small and fails to represent entire population of shah alam, Malaysia. Another limitation is most of the smoker participants in this study were short

duration smoker not smoking for longer duration. Further studies with greater sample size and inclusion of participants with long exposure of e-cigarette smoking is required to find out long term impact of e-cigarette smoking on pulmonary function.

Another area for future research is the comparative analysis between e-cigarette and traditional cigarette smoking in terms of pulmonary effects among healthy male adults of Malaysia

Conclusion: Our study concludes that smoking e-cigarette for short duration does not have significant impact on pulmonary functions except FEV₁/FVC(%) which is significantly lower thus indicating airflow obstruction in young healthy adults male e-cigarette smoker of Shah Alam, Malaysia. However further studies with large sample size and participants with longer duration of exposure to e-cigarette smoking /vaping is essential to understand the actual long-term impact of e-cigarette on lung functions.

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Conflict of interest:

The author declares no conflict of interest.

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