

Comparison of Pulmonary Function Test between Smokers and Nonsmokers at Hawler Medical University, Erbil, Iraq

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Abstract

Introduction: Cigarette smoking has extensive effects on pulmonary function. Pulmonary function testing is a routine procedure for the assessment and monitoring of respiratory diseases. The pulmonary functions were compared between apparently healthy smoker and nonsmoker persons in this study. **Materials and Methods:** This case-control study was conducted among apparently healthy smoker and nonsmoker students and staff of the university between the first of April and the end of June 2018. A total number of 131 persons were taken, in which 71 of them were nonsmokers (controls) and 60 were smokers (cases). The reference ranges for the pulmonary functions were used following the below criteria: forced vital capacity (FVC): normal (80%–120%) and reduced (<80%); FEV1 (forced expiratory volume in one second): normal (≥ 75) and reduced (<75); FEV1/FVC: normal ≥ 80 and reduced <80. **Results:** The study showed that smoker persons had a lower level of FVC (84.38 vs. 94.75; $P = 0.026$) and peak expiratory flow rate (PEFR) (67.08 vs. 84.18; $P < 0.0001$) compared to nonsmoker persons. Whereas, there was no significant difference in FEV1 (the first second of forced expiration) (80.42 vs. 86.86; $P = 0.139$) and the FEV1/FVC ratio (96.13 vs. 94.48; $P = 0.589$) between smokers and nonsmokers, respectively. The mean pack-year smoked by the smokers was 34.89. **Conclusions:** Cigarette smoking has a significant adverse effect on FVC and peak expiratory flow rate, while it was not confirmed to have an adverse effect on other pulmonary function tests.

Keywords: Nonsmokers, respiratory disease, spirometer, pulmonary function test

INTRODUCTION

It is estimated that tobacco-associated mortality becomes the most common in developing countries by the year 2020.^[1] Compared to 100 million tobacco-related deaths in the 20th century, it is expected that this rate will be reached 1 billion in the 21st century. It is projected that 1 person dies per 6 s owing to tobacco-related disease.^[2] Cigarette smoking has been considered to be the major responsible for several chronic diseases such as stroke, cardiac diseases, chronic obstructive pulmonary disease (COPD), pneumonia, lung and oral cancer, peripheral vascular disease, and periodontal disease.^[3]

Cigarette smoking directly affects the lung. The effect of smoking on lung function and respiratory disease severity is measured by pulmonary functions tests (PFTs). PFTs measure the volumes of air a person inhales or exhales. The main indicators of PFTs are forced expiratory volume (forced vital capacity [FVC]), peak expiratory flow rate (PEFR), forced expiratory volume in 1 s (FEV1), and the ratio between FEV1/FVC.^[4]

PFTs assess how well the person's lungs are able to perform their intended role. Of the available PFTs, spirometry is by far considered the most commonly used procedure owing to its relative simplicity, easy equipment availability, and the good standardization of test performance and interpretation algorithms. The PFT has been showing the effect by several factors such as age, height, gender, race, and cigarette smoking.^[5] Moreover, the nutrition of a person can impact lung function like low fruit intake.^[2]

Smoking in Iraq is a common prevalent behavior in both urban and rural geographic locations. Smoking is significantly more common in males than that of females. The reported prevalence of smoking in Iraq is 15%–25% for males and 1%–10% for females. Siziya *et al.*^[6] estimated the prevalence of current

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cigarette smoking in school adolescents in Iraqi Kurdistan in 2006. They reported that the overall prevalence of smoking is 15.3%, including 25.1% in boys and 2.7% in girls, and Ismail *et al.*^[7] reported 22.6% in Kut city in 2007. There is dearth on the difference of pulmonary functions between smokers and nonsmokers in this region.

The aim of the study

The aim of this study is to know the differences of pulmonary function test between smokers and nonsmokers at Hawler Medical University in Erbil, Iraq.

MATERIALS AND METHODS

Study design and sampling

This case-control study was conducted at Hawler Medical University in Erbil city, Iraq, during a period of the first of April to the end of June 2018, on different age groups and both genders. The study persons were reported to be 60 healthy smokers assigned in the case group and their 71 age-matched healthy nonsmokers assigned in control groups. Persons were invited following study purpose explanation and taking verbal consent. Persons were selected purposively among the employees, medical students, and their instructors in Hawler Medical University in Erbil city.

Inclusion criteria

Adult persons who aged 18 years and older of both genders and working/practicing clinical apprenticeship and their instructors at Hawler Medical University were invited to participate in the current study.

Exclusion criteria

Persons with a history of respiratory diseases, such as asthma, COPDs, and chronic chest infection, pregnant women, patients with congenital anomalies, ex-smokers or starting smoking for <1 year, and those were smoking hookah during data collection were excluded from the study.

Spirometer procedure

The invited persons underwent the test by portable. They were asked to sit comfortably and the procedure was explained. They breathed fully through a deep inspiration with their nostrils closed with the nose clip. Accordingly, they were asked to close their lips around the sterile mouthpiece of the spirometer. Finally, they forcefully expired air out.^[8]

Assessment and measurement criteria

The invited persons were screened for the eligibility criteria through conducting physical and clinical examinations by the first author. The baseline information of those met the eligibility criteria were obtained by a self-reported technique and recorded in a predesigned questionnaire. The baseline information was age, gender, residency (categorized as urban and rural), occupation (medical student, instructor, and others/hospital staff), marital status (married, single, divorce, and widow), social class (low, medium, and high), and exercise as yes or no. Body mass index (BMI) was measured by

dividing weight in kg by the square of height in meters. The BMI was categorized as follows: BMI <18.5 (underweight), BMI 18.5–24.9 (normal weight), BMI 25–30 (overweight), and BMI >30 (obese).

In the current study, study persons with a history of smoking for at least 1 year were categorized as a smoker and those did not smoke at all were assigned as healthy persons. The persons in both groups had undergone spirometry (MIR: Medical International Research company, Italy) to measure the pulmonary functions. The pulmonary functions were FVC, forced expiratory volume in 1 s (FEV1), FEV1/FVC ratio, and PEFR. FVC was defined as the total and maximum air exhaled by the persons that are expressed in liters/seconds, and the volume delivered in the 1st s was defined as FEV1. PEFR was defined as the maximum expiratory flow delivered from a maximum forced expiration without full inspiration hesitation.^[9]

In the pulmonary function test, the amount of air that a participant breathes in and out was measured. The clinician asked the participants to sit in the front of the spirometer. The persons were asked to breathe in and out as deeply as quickly as he/she can for several seconds. The flow rates were measured from the three force expiratory curves with the acceptable start of the test. The references ranges for the pulmonary functions were used following the below criteria.

FVC: normal (80%–120%) and reduced (<80%); FEV1: normal (≥ 75) and reduced (<75); and FEV1/FVC: normal ≥ 80 and reduced <80. The pack-year was defined as the number of packets smoked per year by the smoker.

Statistical analysis

The numerical characteristics of the study persons were displayed in the mean and standard deviation and categorical features and frequency and percentages. The comparison of baseline information of the persons between the cases and controls was examined in the independent *t*-test, Pearson Chi-squared, or Fisher's exact tests. The difference in pulmonary functions of the persons between the smokers and nonsmokers was determined in an independent *t*-test. $P < 0.05$ was considered as statistically significant difference. The statistical calculations were performed in the Statistical Package for Social Sciences version 25:00 (SPSS 25:0; IBM Corporation; USA).^[10]

Ethical considerations

The scientific clearance of the present study was obtained from the College of Medicine, Hawler Medical University. The investigation was done after signing written consent of the participant and talking to the participant was by their own language, and full privacy of the client was protected and kept top secret. The official agreement of the Research Ethical Committee of the Kurdistan region of medical specialty was also obtained.

RESULTS

Table 1 shows that the persons in nonsmoker and smoker groups were comparable in age (39.62 vs. 39.98 years;

$P = 0.882$), BMI (28.02 vs. 26.37; $P = 0.104$), residency (urban: 63.4% vs. 65.0%; $P = 0.847$), marital status (married: 53.5 vs. 48.3; $P = 0.875$), and exercise (38.0% vs. 25.0; $P = 0.111$), respectively. However, male persons were more smokers (75.0%) compared to that of females (25.0%), $P = 0.004$. In addition, the persons in nonsmoker group were more likely to be a teacher (39.4%) and in a moderate social class (59.2%) compared to 55.0% of others and in a low social class (50.0%) in smoker groups ($P = 0.042$ and $P \leq 0.0001$, respectively).

Table 2 shows the comparison of pulmonary functions between smoker and nonsmoker groups. The study revealed that the smoker persons had a lower level of FVC (84.38 vs. 94.75; $P = 0.026$) and PEFR (67.08 vs. 84.48; $P < 0.0001$) compared to that of nonsmoker persons. Whereas, there was no statistically significant difference in FEV1 (80.42 vs. 86.86; $P = 0.139$) and the FEV1/FVC ratio (96.13 vs. 94.48; $P = 0.589$) between smokers and nonsmokers, respectively. The mean of the pack-year smoked by the smokers was 34.89.

In Table 3, the pulmonary functions were considered dependent variables and age, sex, exercise, and BMI as independent variables in the multivariate analysis model. The study showed that the older age predicts the lower PEFR in smoker participants ($P = 0.001$).

DISCUSSION

The current study found that smokers had a lower level of FVC and PEFR compared to nonsmoker persons. Whereas, there was no statistically significant difference in FEV1 and FEV1/FVC ratio between smokers and nonsmokers, respectively.

Other studies conducted across the world have shown that smokers have a lower PFTs value compared to nonsmokers in addition to respiratory symptoms such as a cough, wheeze, and tightness.^[11] The respiratory symptoms were not examined in the present study; however, it must be taken into account that the smoker persons are considerably at a risk of more respiratory symptoms compared to that of nonsmokers.

Nawafleh and Zead^[12] compared the pulmonary functions between smokers and nonsmokers in the staff of a university in Jordan. They showed that the participants in smoking group have a lower level of FVC, FEV1, FEV1/FV, and PEFR (3.22 ± 1.15 , 2.23 ± 1.11 , 82.2 ± 20.51 , and 382.50 ± 60.69 , respectively) compared to nonsmokers (4.55 ± 1.47 , 2.21 ± 1.23 , 70.06 ± 5.03 , and 535.3 ± 45.26 , respectively).

The similar study conducted by Mistry *et al.*^[13] in 51 smokers and 54 nonsmokers to evaluate the influence of smoking on pulmonary functions. They found that pulmonary functions, including FVC, FEV₁, PEFR, and FEF_{25-75%} and maximal voluntary ventilation (MVV) were significantly lower in smokers compared to that of nonsmokers. The pulmonary functions were substantially decreased with an increase in the number of cigarette smoking and smoking duration.

Table 1: Comparison of biodemographic information between smoker and nonsmoker groups

Persons' characteristics	Nonsmoker (n=71)	Smoker (n=60)	P (two-sided)
Age; range: 18-73 years	39.62±13.60	39.98±14.25	0.882*
BMI	28.02±6.46	26.37±5.06	0.104*
<18.5 (underweight)	3 (4.2)	3 (5.0)	0.306**
18.5-24.9 (normal)	19 (26.8)	25 (41.7)	
25-29.9 (overweight)	28 (39.4)	17 (28.3)	
>30 (obese)	21 (29.6)	15 (25.0)	
Gender			
Male	36 (50.7)	45 (75.0)	0.004**
Female	35 (49.3)	15 (25.0)	
Residency			
Urban	45 (63.4)	39 (65.0)	0.847**
Rural	26 (36.6)	21 (35.0)	
Occupation			
Student	19 (26.8)	13 (21.7)	0.042**
Teacher	28 (39.4)	14 (23.3)	
Other	24 (33.8)	33 (55.0)	
Marital status			
Married	38 (53.5)	29 (48.3)	0.875***
Single	23 (32.4)	22 (36.7)	
Divorce	3 (4.2)	4 (6.7)	
Widow	7 (9.9)	5 (8.3)	
Social class			
Low	14 (19.7)	30 (50.0)	<0.0001**
Moderate	42 (59.2)	16 (26.7)	
High	15 (21.1)	14 (23.3)	
Exercise			
Yes	27 (38.0)	15 (25.0)	0.111**
No	44 (62.0)	45 (75.0)	

*Independent *t*-test, **Pearson χ^2 , ***Fisher's exact tests were performed for statistical analyses. The bold numbers show the higher percentages. The data were presented in mean±SD and frequency (%). BMI: Body mass index, SD: Standard deviation

Table 2: Comparison of pulmonary functions between smoker and nonsmoker groups

Person's characteristics	Nonsmoker (n=71)	Smoker (n=60)	P (two-sided)
FVC	94.75±29.58	84.38±21.40	0.026
FVC <80% (reduced)	22 (31.0)	27 (45.0)	
FVC 80-120 (normal)	37 (52.1)	30 (50.0)	
FVC >120 (increased)	12 (16.9)	3 (5.0)	
FEV1	86.86±29.52	80.42±19.12	0.139
FEV1 <75 (reduced)	21 (29.6)	23 (38.3)	
FEV1 ≥75 (normal)	50 (70.4)	37 (61.7)	
FEV1/FVC	94.48±20.36	96.13±14.49	0.589
FEV1/FVC <80 (reduced)	13 (18.3)	8 (13.3)	
FEV1/FVC ≥80 (normal)	58 (81.7)	52 (86.7)	
PEFR	84.18±8.00	67.08±12.41	<0.0001
Pack-year	0.00±0.00	34.89±23.35	<0.0001

Independent *t*-test was performed for statistical analyses. The bold numbers show a significant difference. PEFR: Peak expiratory flow rate, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s

Table 3: Predictors of pulmonary function tests in smoker participants

Predictors	Dependent variables	F score	P	Partial η^2 (effect size)
Sex	FVC	0.033	0.856	0.001
	FEV1	0.016	0.899	0.000
	PEFR	2.703	0.106	0.047
Age	FVC	0.320	0.574	0.006
	FEV1	0.094	0.760	0.002
	PEFR	12.688	0.001	0.187
BMI	FVC	0.397	0.531	0.007
	FEV1	0.034	0.855	0.001
	PEFR	0.294	0.590	0.005
Exercise	FVC	0.309	0.580	0.006
	FEV1	0.023	0.881	0.000
	PEFR	0.052	0.820	0.001

The multivariate analysis model was performed for statistical analysis. The bold number shows the predictor. BMI and exercise are not biodemographic characteristics. PEFR: Peak expiratory flow rate, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s, BMI: Body mass index

In the present study, the PFTs were not affected by exercise and BMI statistically significant. The evidence has shown that there is a direct association between BMI and PFTs.^[14] We did find this kind of significant association between BMI and pulmonary functions. The association of BMI with the prevalence of asthma has been reported as well,^[15] and its prevalence is increased with increased obesity.^[16] The presence of adipose tissue in the rib cage and abdominal area and in the visceral cavity inserts the load on the chest wall and decreases functional residual capacity (FRC). This decrease in FRC and expiratory reserve volume is detected by clinicians, even in persons with a moderate weight increase.^[17]

Spirometric values are decreased in proportion to lung volumes, but the overall values are rarely below the normal ranges, even in persons with extreme obesity. Whereas, the decrease in expiratory flows and increased airway resistance are considerably normalized through lung volumes adjustment. It must be considered that the reduction in FRC has adverse impacts on other aspects of lung functions. The low FRC rises the risk of both expiratory flow limitation and airway obstruction.^[17-19]

A considerable decrease in expiratory reserve volume can lead to ventilation distribution abnormalities and airway obstruction in the lung and zones and inequalities in ventilation perfusion. It has been approved that broader airway closure during tidal breathing is related to lower arterial oxygen saturation in some persons. In patients with bronchoconstriction, obesity increases the impacts of obesity in airway closure and ventilation distribution. Therefore, obesity can impact on lung function and result in a reduction in respiratory well-being, even in patients with specific respiratory diseases and can lead to an escalation of existing airway diseases.^[17,20] The discrepancy of the current findings with those reported in the present study

may back to the difference in persons' characteristics. The effect of obesity on respiratory well-being backs to its impact on increasing consumption and carbon dioxide production, and stiffness of the respiratory system leading to the mechanical increasing need for breathing.^[19,20]

Moreover, the present study did not have an association between exercise and respiratory functions. The role of exercise on better cardiorespiratory fitness and respiratory functions has been confirmed in both men and women. Cheng *et al.*^[21] demonstrated that those persons remain active have a higher forced expiratory volume in 1 s and FVC compared to nonactive persons. They reported that smoking is responsible for lower cardiorespiratory fitness and respiratory function. The difference with the present study may refer to the difference in persons' characteristic or study design.

Athletes have an increase in pulmonary functions compared to nonactive individuals owing to regular exercise, particularly in strenuous activities. The extent of strengthening of the inspiratory muscles is determined by sports intensity and severity and lead to an increase in the lung functions and capacities.^[22] George *et al.*^[23] showed that FEV1, FEV1/FVC, PEFR, and MVV are significantly higher in active persons compared to nonathletics.

In the present study, we showed that the older age is a predictor of lower pulmonary functions in smokers. This phenomenon has been reported in other investigation as well.^[12] Nawafleh (2012) examined the levels of pulmonary functions in different age groups and showed that pulmonary functions are decreased with an increase in age. For example, PEFR levels were 474 ± 42.25 , 412 ± 67.35 , and 382 ± 43.56 in age groups <20, 20–29, and 30–39 years, respectively.

Recommendations, strengths, and limitations

It is recommended that the smoker persons be followed up for the upcoming complications. The findings reported in the present investigation must be analyzed in the view of study design and persons. It was not possible to establish the matching process for the gender between the study groups, as smoking is significantly more prevalent in males compared to that of females in this region.

CONCLUSIONS

The current study found that the lower FVC and PEFR pulmonary functions in smoker persons compared to nonsmokers with no significant difference in other pulmonary tests. The study did not confirm the effect of BMI and exercise on pulmonary functions in smokers.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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