Pulmonary Function Tests Abnormalities Predictors In Smoker Patients

Hawa A.A. Al-Dhahir*, Ali.S.Baay **and Amjed H. Abbas***

الخلاصة

خلفية الدراسة: يعتبر التدخين من اهم اسباب التي تؤدي الى الامراض والوفاة المبكره كما انه يعتبر من اهم الاسباب التي تؤدي الى نقصان في وظائف الرئة.

الهدف من الدراسة: استهدفت هذه الدراسة تقييم تأثيرات التدخين على وظائف الرئة في حالة الأمراض الاعاقيه والتقييديه .

المواد والطرق: تمت الدراسه في مستشفى مرجان التعليمي في محافظة بابل في الفتره من كانون الاول 2010 الى اذار 2012. شملت الدراسه 182 مريضا والذين توزعوا بين مجموعتين المجموعة الأولى سميت بالمجموعة الاعاقيه وشملت 114 مرضا اما الثانيه فسميت بالمجموعه التقييديه وشملت 68 مريضا.

تم تقييم مدة وكمية التدخين بواسطة سنوات العلبه كذلك اجري فحص وظائف الرئة على كل المرضى كما تمت مقارنة تأثيرات التدخين بين المجموعتين.

النتائج:شملت الدراسة المرضى الذين تتراوح اعمارهم من 31-70 سنه والذين كان معظمهم من جنس الذكور (65% في ألمجموعه الاعاقيه) و (58% في المجموعه التقييديه) . اثبتت الدراسه ان مستوى التدخين في الذكور اكثر من الاناث لكن تاثير التدخين في الاناث يحث بمستوى اقل من التدخين مما هي عليه في الذكور، من ناحية أخرى، اثبتت الدراسه ان هناك ارتباط معنوي بين زيادة مستوي التدخين وشدة المرض في كلا المجموعتين.

الاستنتاج: أثبتت الدراسة ان التدخين يؤثر على كلا الجنسين وان تأثيره في الإناث يحدث بمستوى اقل من التعرض للتدخين مما هي عليه في الذكور كما ان التدخين يؤثر على امراض الرئة الاعاقيه والتقييديه لكن تأثيره في الاولى اكثر من الثانيه.

Abstract

Background: Smoking remains the most preventable cause of premature death and morbidity in the US and the developed world. Cigarette smoking is the most well known risk factor for accelerating lung function decline in adults. This study aimed to evaluate pulmonary function tests abnormalities predictors in smoker patients

Materials and methods: This case-control study was done in Merjan teaching Hospital, Babylon, Iraq, in the period from December 2010 to March 2012. The study included 182 patients who were divided into 114 patients in obstructive group and 68 patients in restrictive group. Duration and amount of smoking were evaluated by pack years. Spirometry was done for each patient. The effects of smoking were compared between obstructive and restrictive chronic lung diseases.

*Department of physiology/ College of Medicine /Baghdad University
**Department of Medicine/College of Medicine/Babylon University
***Department of Physiology/College of Medicine/Babylon University

Results: The ages of patients in both groups ranged from 31-70 years. Most of patients were males (65% in obstructive group while 58% in restrictive group). There was significant correlation between pack years and degree of dyspnea (functional state),in addition there was significant correlation between pack years and severity of obstructive and restrictive diseases.
Conclusions: The results of this study indicate that effects of smoking were more in obstructive group than restrictive group. It was established that lung function (FEV1,FVC and FEV1%FVC) decreases with increasing number of pack years. Lung function was related inversely to pack years of cigarette use
Keywords: Pack years, obstructive diseases, restrictive diseases.

Introduction

Cigarette smoking is the leading preventable cause of death in the United States. It accounts for almost 500,000 deaths per year, or one in every five deaths. Cigarette smoking contributes to a remarkable number of diseases, including coronary heart disease, stroke, chronic obstructive pulmonary disease, peripheral vascular disease, peptic ulcer disease, and many types of cancer (1; 2).

Every smoker experiences a slow decline in lung function starting at about age 30. In smokers this gradual decline starts both from a lower baseline and at an earlier age. Smokers suffer from decreased lung reserve. Smokers thus can expect permanently impaired lung function relative to their nonsmoking peers (3; 4;5).

A recent study in more than 10,000 males and females patients confirmed that cigarette smoking is associated with mild airway obstruction and decrease in lung function. The study, which covered a period of 15 years, also demonstrated that females are more susceptible than males to smoking's adverse effects on the lung function (6).

Chronic lung diseases are chronic diseases of the airways and other parts of the lung,
they affect all ages: children, teens, adults and elderly. Most of these diseases are chronic in nature and all have a major impact not only on the individual with the disease, but on the family, the community, and the health care system (7; 8; 9).

According to pulmonary function tests, chronic lung diseases can be divided in obstructive and restrictive that appear clearly in results of pulmonary function tests. Some of the most common are asthma, chronic obstructive pulmonary disease (COPD), lung cancer, cystic fibrosis, sleep apnea and occupational lung diseases (10).

The two most important risk factors for chronic respiratory diseases are tobacco smoke and air pollution. Those who smoke cigarettes increase their risk of developing lung cancer, chronic obstructive pulmonary disease

(COPD) and asthma. However, the effects are more severe in those with lung disease. The amount and duration of cigarette smoking is assessed by pack years (11).

Pack years

Definition: It is a way to measure the amount a person has smoked over a long period of time. It is calculated by multiplying the number of packs of cigarettes smoked per day by the number of years the person has smoked. For example, 1 pack year is equal to smoking 20 cigarettes (1 pack) per day for 1 year, or 40 cigarettes per day for half a year, and so on. One pack year equals 365 packs of cigarettes (12).

A pack year is smoking 20 cigarettes a day for one year. Quantification of pack years smoked is important in clinical care where degree of tobacco exposure is closely correlated to risk of disease (13).

Pulmonary function tests (PFTs) :

The pulmonary function tests are used for detecting the nature and severity of pulmonary disorders and to measure the response to therapy. These functions are usually based on measurements of lung volumes and maximal flow. However, the pulmonary function tests are compared to normal values that are estimated on the basis of the height, age, sex, and race of the patient (14; 15;16).

Measurement of airflow limitation by spirometry :

Spirometry is a simple important test that can be carried out at the hospital or the doctor's clinic. It is useful in the initial evaluation of patients suffering from shortness of breath, who may have one of respiratory or cardiac disorders (17).It is performed by a device called a spirometer. It measures forced expiratory volume in first second (FEV1) and forced vital capacity (FVC) and this is given in terms of percentage, FEV1/FVC,which can be compared against charts that give the normal reading for a person´s age, sex, race and height. In normal subjects, the percentage is more than 70 (14).

Spirometry measure forced vital capacity (FVC) which is the maximal volume of air forcibly exhaled from the point of maximal inspiration and forced expiratory volume in one second (FEV1) which is the volume of air exhaled during the first second of this maneuver. The ratio of these two measurements should be calculated. Spirometry
measurements are evaluated by comparison with reference values based on age, height, sex, and race (16).

The presence of FEV1 < 80% of the predicted value, in combination with an FEV1 / FVC < 70% confirms the presence of air flow limitation (9) .

This study aimed to illustrate the effects of smoking on pulmonary function tests readings in both obstructive and restrictive chronic lung diseases.

Patients and methods

Patients:

The study was conducted in Merjan teaching hospital in Babylon Province in the period from December 2010 to March 2012. The study consisted of 182 patients with chronic lung diseases who were classified into two groups (obstructive and restrictive groups) according to results of pulmonary function tests. The obstructive group included 114 patients while the restrictive group included 68 patients. The study was carried out on patients with chronic lung diseases (regardless of the individual diagnosis) with abnormal pulmonary function tests and history of the symptoms more than six months.

The patients involved in this study were taken randomly and they were either admitted in the wards or outpatients. Patients with other systemic diseases were excluded from the study. All patients were subjected to: verbal agreement, full history, complete clinical examination, and pulmonary function tests (PFT) as measured by spirometer.

Assessment of dyspnea (breathlessness):

Dyspnea was assessed according to the scale of Medical Research Council (MRC) (18) which reflects the functional state of the patients. It is divided into 5 grades as follows:

Table (1): MRC dyspnea scale

Grade	Degree of breathlessness related to activities
1	Not troubled by breathlessness except on strenuous exercise
2	Short of breath when hurrying or walking up a slight hill
3	Walks slower than most people on the level because of breathlessness, stops for a mile or so or stops after 15 minutes when walking at own pace
4	Stops for breath after about 100 m or after a few minutes on the level
5	Too breathless to leave the house, or breathless when dressing or undressing

Pulmonary function tests (PFTs):

In this study, pulmonary function tests were carried out in all patients with the help of Mir spirometer connected to computer using Spirobank software. It measures many parameters but we took the special parameters that are useful in differentiating obstructive from restrictive pulmonary diseases as shown in the figure below.

Before doing the test, weight and height of each patient were measured then some needed informations like age ,gender, race and smoking status in addition to weight and height for each patient were fed into the spirometer programme which automatically calculates the PFTs parameters that appear as predicted values according to the age, gender and race, weight and height. Three trials of the test were done for each patient until we get the result that is acceptable and reproducible. Type and severity of chronic respiratory diseases were also determined by the apparatus.

Cases that were involved in the study included patients with obstructive lung diseases that had FEV1/FVC < 70% and FEV1 % ≤ 80 % of predicted and patients with restrictive lung diseases in which both FEV1 and FVC were reduced but the FEV1/FVC ratio was normal.

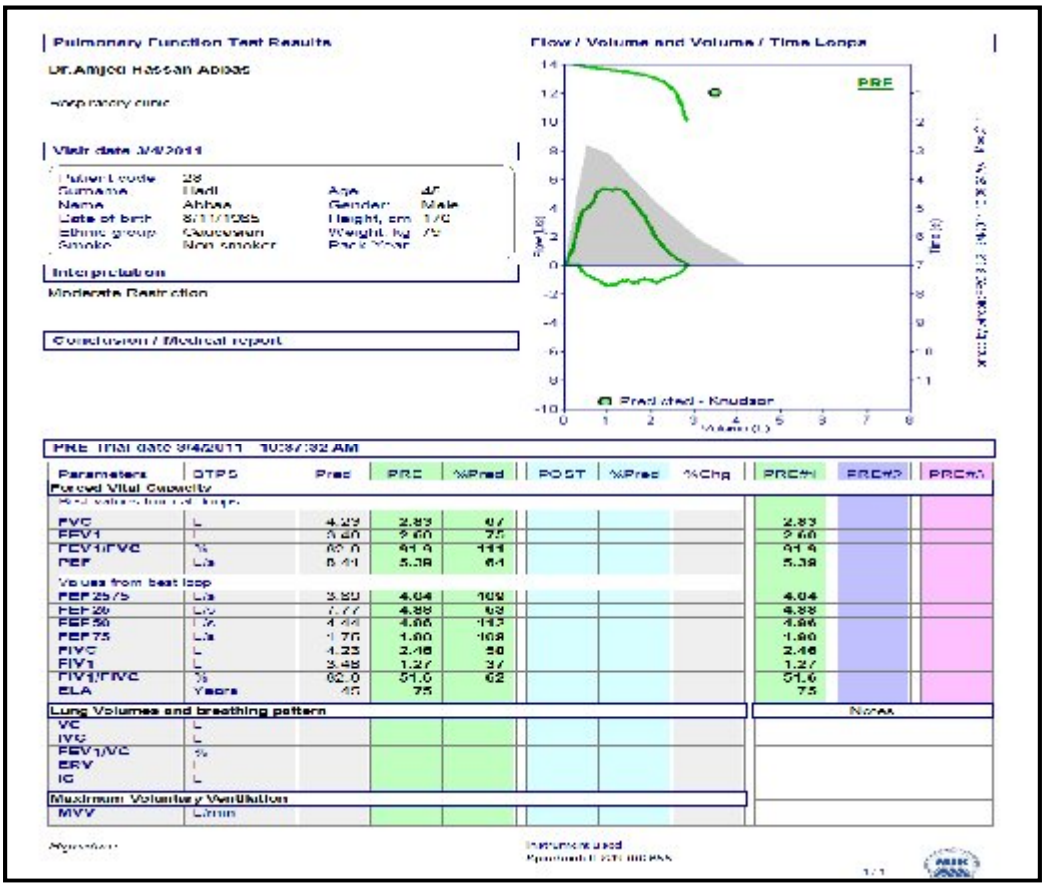

Figure (1) shows results of spirometry

In this study, severity of obstructive diseases was graded according to FEV1% predicted while that of restrictive diseases was graded according to FVC% predicted according to the following table:

Table (1) : Severity Distribution in obstructive and restrictive groups

Grade	Obstructive group (according to FEV1% predicted)	Restrictive group (according to FVC% predicted)
60-80	mild	mild
40-59	moderate	moderate
<40	severe	severe

Statistical Analysis :

Statistical analysis was performed using the SPSS programme version 18. T test was used for comparison between means of ages and pack years of obstructive and restrictive groups. Cross-tabulation and chi square was used for comparison between distribution of gender in both groups. Regression analysis was used for correlation between parameters in both groups. P values of less than or equal to 0.05 were considered to indicate statistical significance.

Results

Age distribution

Table (1) showed the mean ages of the patients´ groups. There was no significant difference in ages between the studied groups (p >0.05).

Table 1 :Mean ages of all groups

Mean age (years)	obstructive group (no.114)	restrictive group (no.68)	P value
mean± SD*	56.41±11.859	53.58±12.580	0.3

SD*= standard deviation

Table (2) showed the distribution of all patients (146 patients) in both groups according to age group. The ages of patients ranged from 31-70 years. Age group 61-70 years old was the dominant which included highest number of patients with (56) out of (114) in obstructive group and (26) out of (68) in restrictive group.

Table 2 : Age Distribution

Age group (years)	Obstructive group (no. 114) No.	%	Restrictive group (no.68) No.	%	P value
31-40	15	13	14	20	
41-50	13	11	12	18	
51-60	30	27	16	24	
61-70	56	49	26	38	
Total	114	100	68	100	0.4

Gender Distribution:

In this study, males were more predominant than females in both group (65% in obstructive group and 58% in restrictive group) but there was non-significant difference between them as shown in table (3).

Table 3 : Gender Distribution

Gender	Obstructive group (no.114) No.	%	Restrictive group (no.68) No.	%	P value
Male	80	65	46	58	
Female	34	35	22	42	
Total	114	100	68	100	0.4

Duration of diseases:

The duration of symptoms in obstructive group was 8.55 years (±10.91) while in restrictive group, it was 6.42 years (±5.97) and there was no significant difference in both groups as clarified in the table below

Table 4 :Duration of symptoms

Duration	Obstructive group(no. 114)	Restrictive group (no.68)	P value
mean± SD*	8.55±10.91	6.42±5.97	0.3

*SD= standard deviation

As shown in table (5), the study revealed no significant difference in both groups in the mean of pack years.

Table (5) : Duration of tobacco use (pack years)

Duration (pack years)	Obstructive group (no. 114)	Restrictive group (no.68)	P value
mean± SD*	57.85±41.826	55.16±37.265	0.3

*SD= standard deviation

The study revealed significant positive linear correlation between age and pack years in both groups as shown in figures (2) and (3).

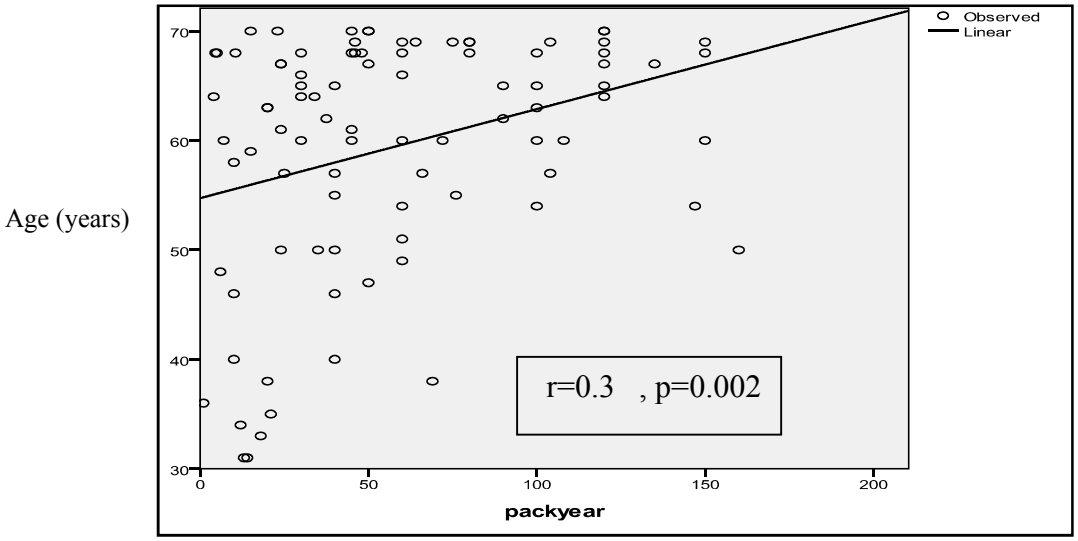

Figure (2): Correlation between pack years and age in obstructive group

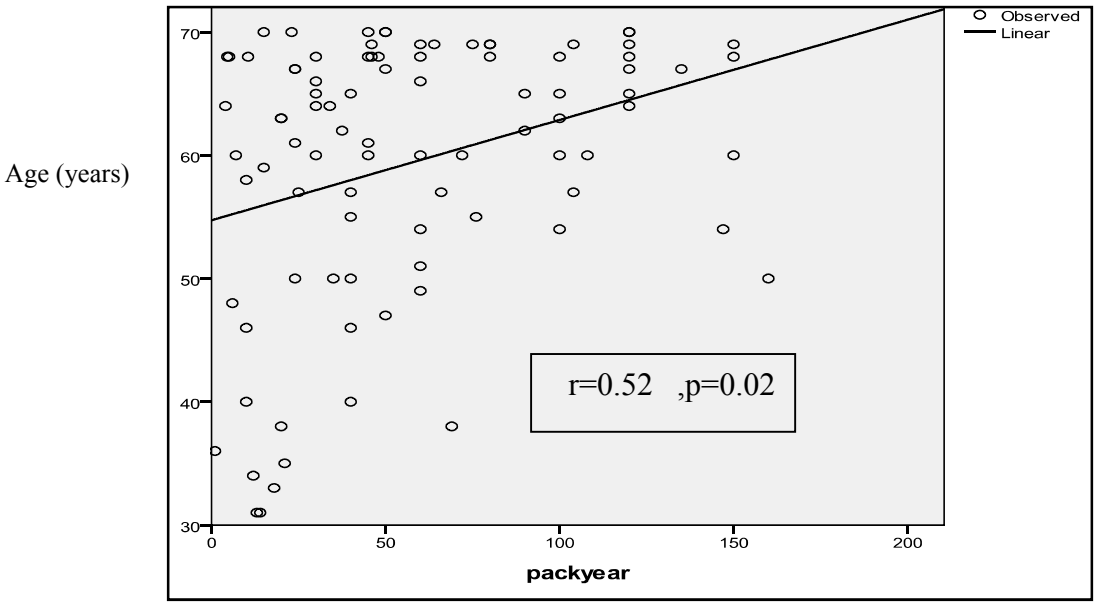

Figure (3): Correlation between pack years and age in restrictive group

The study also showed significant differences in the mean of pack years according to gender in both groups (p= 0.04 in obstructive group and p=0.000 in restrictive group)

Table (6) :Mean of pack years in obstructive group according to gender

Pack years	Obstructive group(no.114)		P value
	Male (80)	Female (34)	
mean± SD*	40.84±41.939	26.01±44.405	0.04

SD*= standard deviation

Table (7) :Mean of pack years in restrictive group according to gender

Pack years	restrictive group (no.68)		P value
	Male (46)	Female (22)	
mean± SD*	35.33±39.31	20.40±37.24	0.000

*SD= standard deviation

Figures (4) and (5) illustrated the relation between pack years and degree of dyspnea (functional state). There was significant correlation between pack year and functional state in both groups (r=0.37, p= 0.000 in obstructive group and r=0.42, p=0.05 in restrictive group)

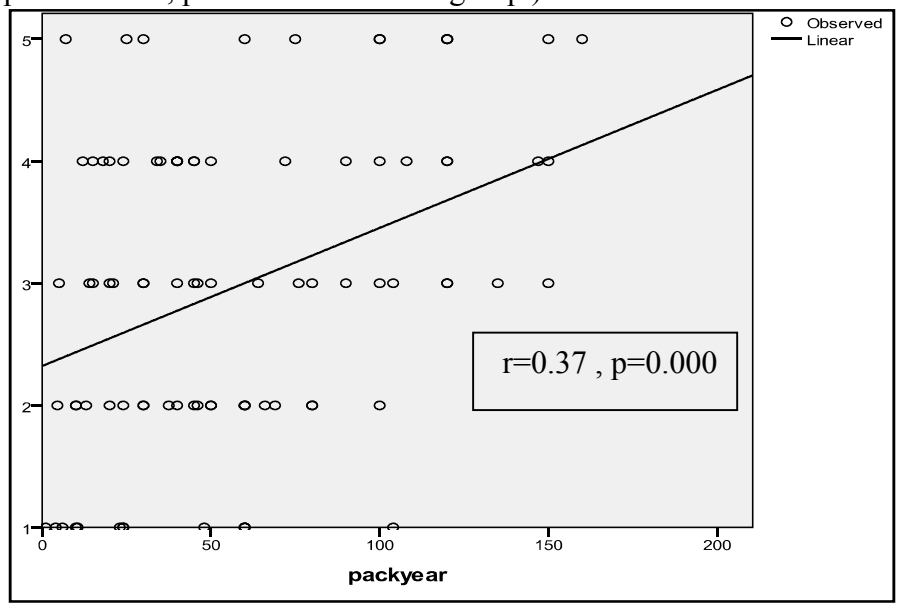

Figure (4): Correlation between pack years and degree of dyspnea (functional state) in obstructive group

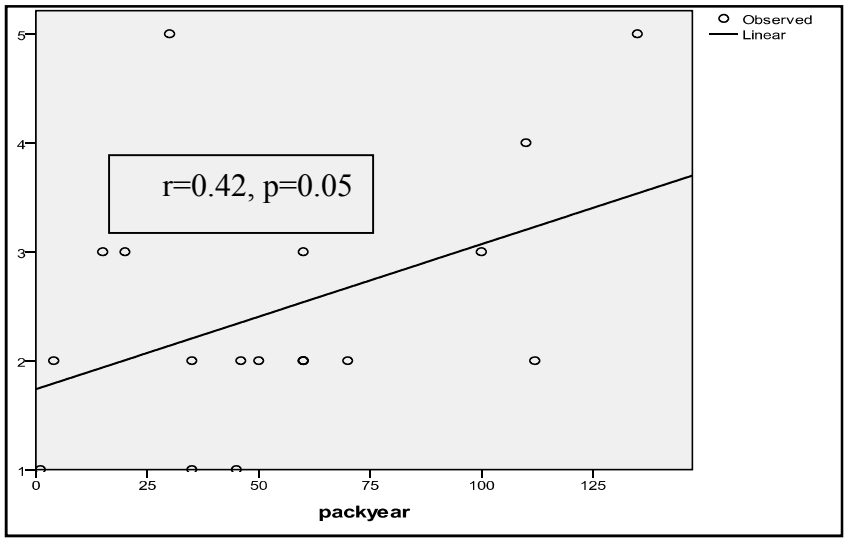

Figure (5): Correlation of pack year with functional state in restrictive group

There was highly significant correlation between pack years and severity of disease in obstructive group which is assessed according to FEV1% predicted and restrictive group according to FVC% predicted (r=0.41, p= 0.000 in obstructive group and r=0.2, p=0.03 in restrictive group) as shown in figures (6) and (7).

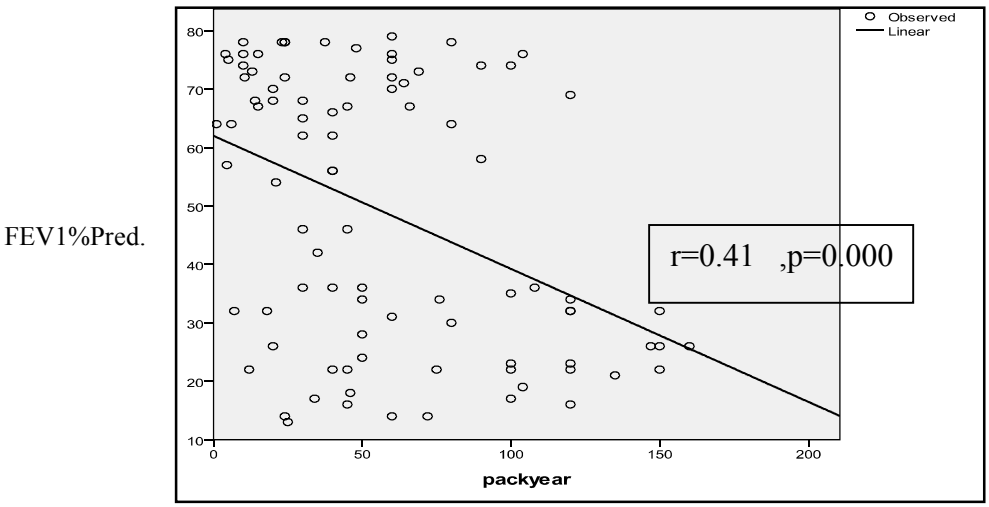

Figure (6): Correlation between pack years and severity of disease in obstructive group

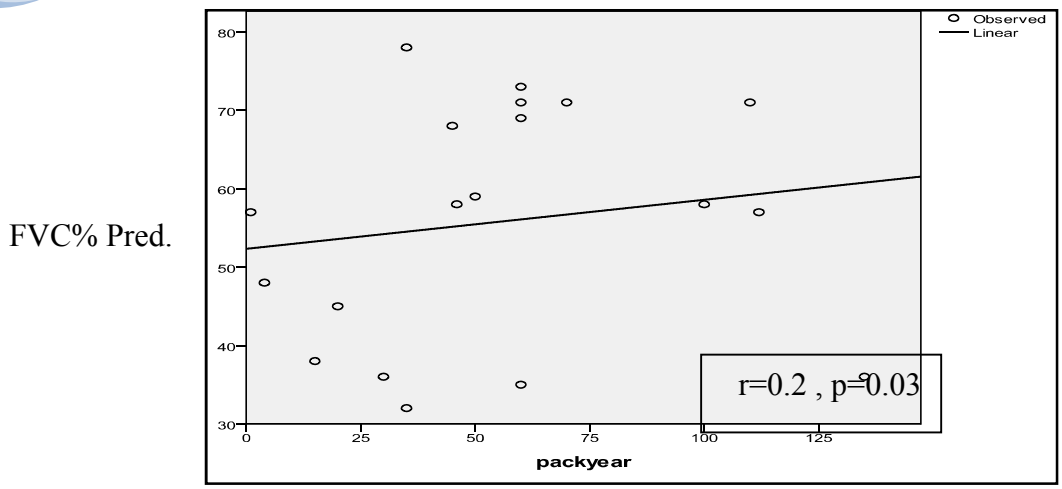

Figure (7): Correlation of pack year with severity of disease in restrictive group

Discussion

In this study, we aimed to assess the difference and correlation between severity of smoking as assessed by pack years and severity of chronic lung diseases whether obstructive or restrictive type. The results of this work showed the influence of smoking on pulmonary function tests results. In general, smoking of tobacco reduced all the mean values of lung function tests in both groups.

Age distribution:

There was no significant difference in mean ages and distribution in both groups. The age of patients in both groups ranged from 31-70 years old. The maximum number of obstructive group patients in this study were in the age group of 61-70 years. The maximum number of patients admitted in this age group occurs mainly because of the longer duration of tobacco exposure and repeated respiratory tract infections, which would have compromised their quality of life.

Most cases of patients appeared dramatically after the age of 45 years, and peaking at the age group 61-70 years because most of patients were smokers and these lung disease whether obstructive or restrictive are chronic illnesses taking more than 10 packs year of smoking to develop symptoms. In this study, most of the patients start smoking in adolescence.

In addition, the study showed increase in the amount and duration of smoking with the increase of age in both groups and this may be due to delayed symptomatic effects of smoking on patients so patients continue to smoke with increasing amount in addition to increased addiction on tobacco with age and also increasing social pressure and daily burden with age in our country.

Gender distribution

Predisposition to airway narrowing and decreased lung recoil may vary between men and women giving sex differences in lung characteristics. In this study the percentage of male in obstructive group was 65% (80 out from 114) while in restrictive group it was 58% (46 from 68). The predominant male distribution was consistent with most studies but differ in some studies like Shrestha (19) and another study by (20) that found female predominance. This higher percentage of males can be attributed to smoking and it means that males need longer duration of exposure to smoking to get the same effects as females. In this study, findings suggested a gender difference in susceptibility to the lung-damaging effects of cigarette smoking. Reduced flow rates are due to a combination of airway narrowing and decreased lung recoil (21).

Since airway caliber is smaller in women, we could hypothesise that the same reduction in airway diameter would result in a relatively greater impact on the reduction in flow rates in women compared to men in addition to that many females were second –hand smokers (22).

Correlation between pack years and degree of dyspnea (functional state):

The study revealed significant positive correlation between pack years and functional states of patients in both groups, and this finding was expected because we found increased severity of diseases with the increase in pack years and this means increased degree of dyspnea.

Correlation between pack years and gender

Females were less smoker than males but they had a more severe reduction of FEV_1 and FVC for lower levels of exposure. These findings suggest that female smokers may have higher susceptibility to smoking-related lung damage at lower levels of exposure, and that the dose–response relationship may vary by gender. An alternative explanation is that the increased susceptibility in female smokers is unrelated to the number of pack years, and that another factor is causing lower lung function in female smokers like exposure to second-hand smoke (23;5).

Correlation between Severity of the disease and duration of tobacco use (pack years)

In this study, majority of the patients in both groups had a history of tobacco use of more than 40 pack years, with a mean of 57.85 years (±41.826) in obstructive group and 55.16 (±37.265) in restrictive group . There was no significant difference between groups.

Most of patients in both groups were present in severe state . This might be explained that the high percentage found in severe disease due to late presentation in addition to severe amount and duration of cigarette smoking as assessed by pack years.

The study revealed highly significant correlation between pack years and severity of obstruction and restriction in both groups. The study demonstrated a linear association between pack years and reduced level of FEV1 and FVC. Smoking a cigarette can cause acute bronchoconstriction, although tobacco smoke does not act as an acute irritant in all patients (13; 12).

Conclusion: From this study we conclude that the effects of smoking progress linearly with increasing age, males were more smokers than females but females were more sensitive to smoking (less pack years but more severe disease).In addition, smoking affects both respiratory diseases (obstructive and restrictive) and the severity of the diseases related directly to the number of pack years.

Recommendations: From the results expressed above, we recommend to use more sophisticated method like high-resolution computed tomography (HRCT) to find the histological lung changes in smokers patients in both obstructive and restrictive groups. All efforts should be made to motivate people with chronic respiratory diseases to quit smoking.

References

1. Altayeh A, Alkhankan F, Triest W, Badin S. Concurrent smoking-related interstitial lung diseases in a single patient. South Med J. 2009 Feb;102(2):180-183.
2. Anthonisen N.R., Connett J.E., Murray RP: Smoking and lung function of Lung Health Study participants after 11 years. Am J Respir Crit Care Med 2002, 166:675-679.
3. Kanne J.P., Bilawich A.M., Lee C.H., Im J.G., Müller N.L. Smoking-related emphysema and interstitial lung diseases. J. Thorac. Imaging.2007 Aug;22(3):286-291.
4. Hidalgo A, Franquet T, Giménez A, Bordes R, Pineda R, Madrid M.Smoking-related interstitial lung diseases: radiologic-pathologic correlation. Eur Radiol. 2006 Nov;16(11):2463-70.
5. James A.L., Palmer L.J., Kicic E, Maxwell PS, Lagan S.E., Ryan G.F., Musk A.W.: Decline in lung function in the Busselton Health Study The Effects of Asthma and Cigarette Smoking. Am J Respir Crit Care Med 2005, 171:109-114.Pulmonary Medicine Volume 2011 (2011), Article ID 461439, 4 pages
6. Sreekumar G. Pillai, , Wayne Anderson, Jørgen Vestbo, Susan M. Kennedy, , Edwin K. Silverman, and Peter D. Paré,. Sex Differences in Emphysema and Airway Disease in Smokers. CHEST December 2009 **vol. 136** no. 6 1480-1488.

7. Chen Y., Horne S.L., Dosman J.A.: Increased susceptibility to lung dysfunction in female smokers. Am. Rev. Respir. Dis. 1991, 143:1224-1230.
8. Inga-Cecilie Sørheim,Ane Johannessen, Amund Gulsvik, Per S Bakke ,Edwin K Silverman, Dawn L DeMeo. Gender differences in COPD: are women more susceptible to smoking effects than men? Thorax 2010;65:480-485.
9. Siatkowska H, Jastrzebski D, Kozielski J.Smoking and clinical manifestation, lung function impairment, resulting comorbidities. Pol Merkur Lekarski. 2010 Jul;29(169):8-13.
10. Katerina D. Samara,1 George Margaritopoulos,2 Athol U. Wells,2 Nikolaos M. Siafakas,1 and Katerina M. Antoniou1,2 Smoking and Pulmonary Fibrosis Pulmonary Medicine. Volume 2011 (2011), Article ID 461439, 4 pages.
11. Rodriguez J, Jiang R, Johnson WC, MacKenzie BA, Smith LJ, Barr RG. The association of pipe and cigar use with nicotine levels, lung function, and airflow obstruction: a cross-sectional study. Ann. Intern. Med. 2010 Feb 16;152(4):201-10.
12. Jensen EJ, Dahl R, Steffensen F. Bronchial reactivity to cigarette smoke; relation to lung function, respiratory symptoms, serum-immunoglobulin E and blood eosinophil and leukocyte counts. Respir Med. 2000;94:119–127.
13. Suma K. R. Study Of electrocardiographic and echocardiographic profile of COPD patients" – A cross sectional study. Dissertation. 2006.pp:92
14. Marion, M.S.; Leonardson, G.R.; Rhades, E.R.; Welty, T.K.; Paul, L. and Enright, P.L.(2001). Spirometry Reference values for American Indian Adults.Chest.,120:489-495.
15. Fulambarker, A.; Coper, A.S.; Javeri, A.; Jeres, S. and Cohen, M.E.(2004). Reference values for pulmonary function in Asian Indians living in the United States.Chest.,126:1225-1233.
16. Effros, R.M. (2006). Anatomy, development, and physiology of the lungs.Nature Publishing Group.
17. Fuhlbrigge, A.L.(2001).FEV1 a useful measure of asthma risk in children. J. Allergy Clin.Immunol.,107:61-67.
18. Chris S. 2008.The MRC breathlessness scale. Oxford Journals .Medicine. Occupational Medicine. Volume58, Issue3. Pp. 226-227.
19. Shrestha B., Dhungel S. and Chokhani R. Echocardiography based cardiac evaluation in the patients suffering from chronic obstructive pulmonary disease. Nepal Med Coll. J. 2009; 11(1): 14-18

20. Sayami A, Shrestha B. Critical Care (Manual of ICU and CCU of TU Teaching Hospital). 1st ed. Kathmandu: JICA Medical Education Project 1995: 5-11.

21.Brusasco V, Pellegrino R**:** Functional classification of COPD.
Eur Respir Rev 2002, 12:284-286.

22. Kim CS, Hu SC: Regional deposition of inhaled particles in human lungs: comparison between men and women. J. Appl. Physiol. 1998, 84:1834-1844.

23. Camp PG, Coxson HO, Levy RD, Pillai SG, Anderson W, Vestbo J, Kennedy SM, Silverman EK, Lomas DA, Paré PD. Sex differences in emphysema and airway disease in smokers. Chest.2009 Dec;136(6):1480-8.