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Correlation of pack year of smoking and lung function variables in firefighters

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Research Paper

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Cigarette smoking is responsible for vast majority of cases of chronic obstructive pulmonary diseases. Inhalation of smoke is also known to cause a broad spectrum of adverse respiratory effects. The effect of the two is expected to cause significant pulmonary dysfunction. Reduced pulmonary function in fire fighters has been reported in other parts of the world. This study aimed to assess the pulmonary function in Nigerian firefighters who smoke for variable periods as measured by pack year of smoking and also to compare the pulmonary functions changes in smoking and non smoking firefighters. The study is a cross sectional comparison of Nigerian firefighters with at least two years of fire fighting experience. One hundred (100) smoking (cases) firefighters were matched to 101 non smokers (controls) .Information pertaining history and duration of smoking for calculating pack year of smoking was obtained from each smoker. clinical data of Peak expiratory flow rate (PEFR), forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC) and the ratio of the FEV_1 to the FVC as a percentage (FEV_1/ FVC%) were measured and analyzed for both groups. Wright's peak flow meter, Mechanical Spiro meter,non-stretchable metric tape rule. Normograph for predicted FEV_1, FVC were used as investigative tools. Setting: Federal Fire Service stations in Lagos, Nigeria between July and August 2002.Even thought, all the subjects studied had evidence of obstructive airway disease, the FEV_1/FVC test showed more difference of statistical significance in the age groups 30-39, and 40-49, respectively . FEV_1/FVC (%), {(77 ±6[%] vs (74±4 [%] (p= 0.009)}, and FVE1/FVC {(76 ± 6 [%] vs 71 ± 6 [%] (P= 0.001). Correlations of pack year of smoking to FEV_1/FVC and PEFR for each age group showed significant positive association.(P < 0.001). An incidental finding of restrictive air flow limitation was discovered amongst the cases 25(25%) compared to 0(0%) of controls (FEV_1/ FVC 80-100% ,p < *0.01*).Smoking firefighters must be educated and advise to quit smoking as it has additional lethal effect on the lungs apart from smoke inhalations respiratory. The use protective respiratory device is advised as non wore any device during any fire fighting operations. Quitting smoking offers immediate and long-term benefits, reduces the risk of developing smoking-related diseases and improves health in multiple ways.

Key words: Pack year of smoking, lung function, firefighters.

INTRODUCTION

Cigarette smoking is widely prevalent all over the world and it continues to rise in developing countries. By 2030, developing world is expected to have 7 million deaths the annually from tobacco use (Abdullah and Hustu, 2004).

Smoking has deleterious effects on respiratory function and is clearly implicated in the etiology of a number of respiratory diseases. More than 2000 potential noxious constituents have been identified in tobacco smoke, many of which are potential carcinogens (Nunn, 1993). Cigarette smoking is well known as the most important causative factor for COPD and bronchogenic carcinoma. Inhalation of smoke is known to cause a broad spectrum of adverse respiratory effects ranging from mild irritations of the upper airways to severe tracheobronchitis, bronchospasm, pulmonary oedema, and bronchopneumonia, often resulting in respiratory insufficiency or even death (Abdullah and Hustu, 2004). The respiratory dysfunction is a product of hazardous atmospheres to which the fire fighters are exposed; the atmospheres are a combination of reduced oxygen, elevated temperature and irritant toxic; gases (Peter et al., 1978; Arunkumar et al., 1994). The combustion process consumes oxygen while producing toxic gases that either physically displace oxygen or dilute its concentration The harmful materials given off by combustion injure the airways and lungs in three ways: heat damage, tissue irritation, and oxygen starvation of tissues (asphyxiation) (Jacole et al., 1980; Phoon et al., 1984). Signs of heat damage are singed nasal hairs, burns around and inside the nose and mouth, and internal swelling of the throat. Tissue irritation of the throat and lungs may appear as noisy breathing, coughing, hoarseness, black or gray spittle, and fluid in the lungs Asphyxiation is apparent from shortness of breath and blue-gray or cherry-red skin colour depending on the person's skin colour. In some cases, the person may not be conscious or breathing (Gu et al., 1996; Kale et al., 1997).

For effective therapeutic intervention, pulmonary function test helps in determining the presence/ absence of obstructive, restrictive or mixed airway diseases. In clinical practice, therefore early detection of airflow obstruction by spirometry test will lead to early diagnosis of asymptomatic smokers who are more prone for early treatment and motivation to stop the habit of smoking decreases the morbidity and mortality. So, our present study was designed to study the effect of cigarette smoking apart from smoke inhalation firefighters. As an additional risk factor with adverse effect on respiratory function.

METHODOLOGY

The study was a cross-sectional case-control study conducted at the federal fire service stations in Lagos. Population consisted of active 201 males and who were on the alert list of the federal fire service stations. Informed consent was also obtained from the subjects. Included in the study were One hundred (100) smoking firefighters were matched to 101 non smokers . Smoking as cases and non smoking irefighters as controls. All were actively involved in fire fighting for at least two years. Excluded were those with Heart disease, congestive heart failure and thoracic cage abnormality such as scoliosis, kyphoscoliosis, pectus carinatum, pectus excavatum, and those who refused to consent.

Information pertaining to time spent in fire fighting in years, history and duration of smoking in pack years were also obtained The severity of the fire fighters past exposure was gauged by questions regarding to number of times involved in the last two years, and time spent in the worst episode of fire fighting.

Height was measured to within 0.1 cm using a stadiometer. Each subject was self-classified as a non-smoker, ex-smoker or current smoker. Cumulative exposure to cigarette smoking was measured by pack-years, which was calculated by multiplying the number of packs of cigarette smoked per day and the number of years of smoking. Taking smoking 20 sticks of cigarette daily for a year as one pack year of smoking. Marijuana use was similarly measured as never, former and current use. Marijuana consumption was not consented by any of the subjects, hence not taken into consideration. Pulmonary functions as a measure of $FEV_1$and FVC were obtained using a mechanical spirometer attached to vilograph. PEFR was measured with a Wright's peakflow meter. All tests were performed with the subjects comfortably seated upright. Three spirometric readings and PEFR manoeuvres were made by each subject, and the highest value was recorded, since this parameter requires maximum effort. A minimum of three and maximum of eight maximal performances were recorded until the results were reproducible, Using the predicted equation by Patrick and Femi-Pearse for adult Nigerians aged 17–60 years ,(Patrick et al., 1976) predicted values for FEV_1 and FVC were calculated for each patient and used to assess normalcy of ventilatory function and the pattern of ventilatory defect. An obstructive ventilatory defect was described when the FEV_1 was markedly reduced compared to the FVC, such that the FEV_1/FVC% was reduced to less than 70%. Values of FEV_1/FVC ratio expressed as percentage were used to determine presence of airway obstruction. However, FEV_1/FVC ratio declines as a normal process of aging, a ratio under 70% was defined to suggest evident airways obstruction. The values for each subject were compared with the predicted normal for age and height (Shin et al., 2004).

Data analysis

The Epi info (Version 6) statistical software was used for data entry, validation and analysis. The measure of central tendency and dispersion were computed for all quantitative variables e.g. PEFR, FEV_1, FVC and data on smoking. Variability in these figures was expressed as standard deviation. Mean and standard deviation were computed for all continuous variables and comparison

Table 1A. Comparison of lung function between smoking and non smoking fire fighters.

AGE GROUP	SMOKERS(cases)	NON SMOKERS(controls)	P.Value
20---29	520± 28	502± 67	0.2
30---39	538± 74	535 ± 74	0.9
40---49	511± 90	496± 33	0.27
50---59	487± 109	480 ± 96	0.2

**P.Value ≤0.01is significant, Mean peak expiratory flow rate *(l/m)* ±STD.

Table 1B. Comparison of lung function between smoking and non smoking fire fighters.

AGE GROUP	SMOKERS(cases)	NON-SMOKERS(controls)	P. Value
20---29	81± 2	72 ± 8	0.1
30---39	77± 6	74 ± 4	0.009**
40---49	76 ± 6	71 ± 6	0.001**
50---59	71± 9	69± 4	0.2

**P.Value ≤0.01is significant, Mean observed fev_1/fvc test (%)±STD.

was done using Student's t-test. Frequencies were generated for categorical variables and compared with the chi square test. Multiple linear regression and correlation analysis was utilized for the determinants of pulmonary function; *p*<0.05 was accepted as significant.

RESULTS

Comparison of lung function between smoking and non smoking fighters is shown (Table 1A). The PEFR for the different age groups between the smokers and non smokers were similar and did not show statistically significant difference across the age groups. Even thought, all had evidence of obstructive airway disease, the FEV_1/FVC test showed more difference of statistical significance in the age groups 30-39, and 40-49, respectively. FEV_1/FVC (%), {(77 ± 6 [%] vs (74±4 [%] (p= 0.009)}, and FVE_1/FVC {(76 ± 6 [%] vs 71 ± 6 [%] (P= 0.001). The result is shown in (Table 1B). The fact that smoking apart from smoke inhalation has adverse effect on lung function is shown in (Table 2). Correlations of pack year of smoking to FEV_1/FVC and PEFR for each age group indicate a statically significant association.

The number of non smokers with air flow limitation more compared to smokers, however , overall more smoking firefighters have lower than normal lung function when compared to non smokers .An FEV_1/FVC 80-100%, was discovered amongst the cases 25(25%) compared to 0(0%) of controls (p < 0.01), which was an incidental finding of restrictive air flow limitation in the smoking group. The ability to expire maximally and forcefully from a total lung capacity measured as forced expiratory volume in one second FEV1 was found to be lower in smokers compared to non smokers. The frequency distribution is shown in (Figure 1). A greater number of the smokers were having lower values of FEV_1

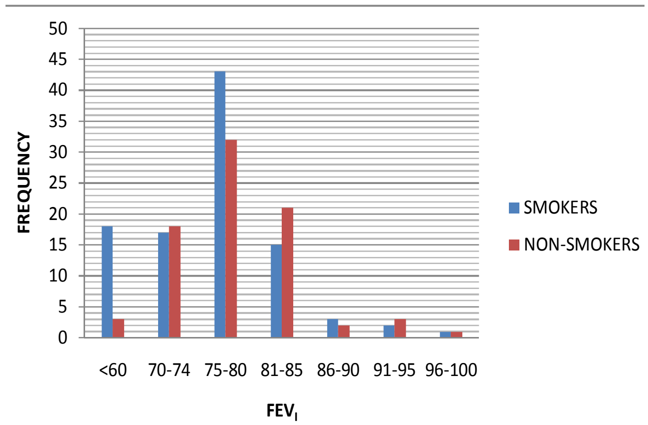

Figure 1. Frequency distribution of fve_1 in the study population.

when compared with the controls, which showed evidence of air way obstruction. The relationship between pack of smoking and FEV1 is shown in (Figure 2). Older firefighters seemed to have smoked more pack year and reverse was the case with the younger firefighters. there was inverse relationship between pack year of smoking and FEV1 levels.

DISCUSSION

The results reflect the effect of cigarette smoking as an additional effect to occupational smoke inhalation. Narrowing of the air ways reduces the ability to move air in and out of the lungs. The narrower the tubes, the lower will be the PEFR (Shin et al., 2004; Patrick and Femi-Pearse, 1976; Jaja, 1998). The present study showed an

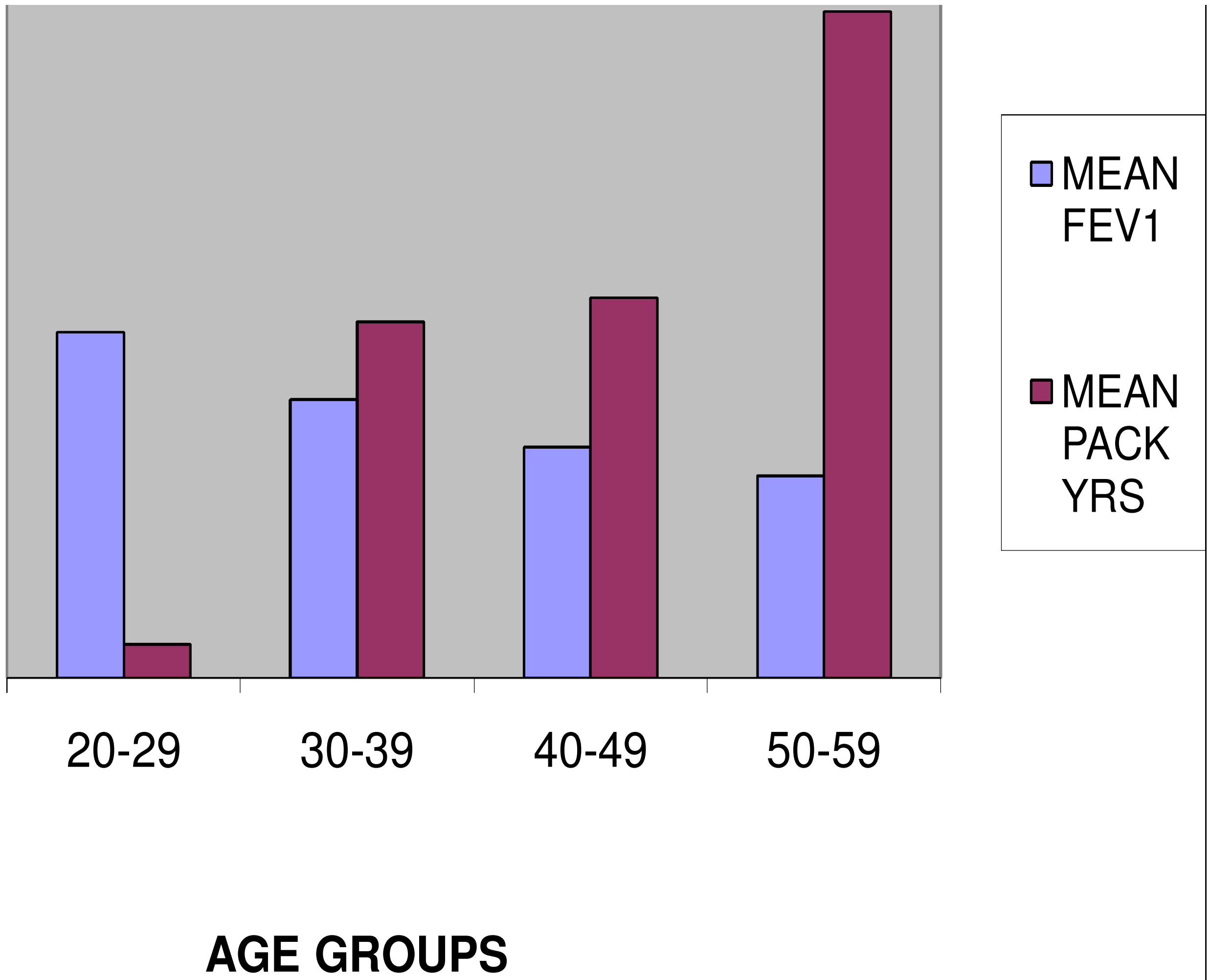

Figure 2. Graph showing the relationship of fev1 and pack year of smoking in the age groups.

increase in mean PEFR values up to 40 years and decrease in mean PEFR values with increasing age after 40 years in both smokers and nonsmokers. Evaluation of the peak exploratory flow rate showed similar mean for smoking and non-smoking firefighters within the different age groups. The highest mean value in both the groups was observed in the 30-39 years; and the lowest mean in the 50 – 59 years. Compared to the non-smoking group, the smokers had a higher value with an accelerated decline. But, the overall mean for both groups were similar.

Factors such as nutrition and environment could also contribute to the observed differences. The fact that PEFR *(l/m)* is effort dependent shows that this group of smoking fire fighters had increased effort. In agreement with earlier report by Jaja, 1998, values of PEFR *(l/m)* in this study-correlated positively within the age groups with those of FVC and FEV_1. The mean forced vital capacity in this study population was similar between the groups. However they were all reduced compared to the predicted normal for the subjects. This was not actually unexpected as smoke inhalation with additional affect of smoking tend to effect the smaller airways more and eventually results in obstruction to airflow before the normal residual volume is reached, thus giving an increased residual volume and hence the total lung capacity. The fall in FVC in this study was in relation to the FEV1, but the proportion of fall of FEV_1, is more than that of FVC. The overall mean of observed FEV/FVC for both groups was similar. The results when compared to the predicted mean for each group was however low. This suggests airflow obstruction and is in agreement with earlier report in Nigeria, (Patrick and Femi-Pearse, 1976; Jaja,1998). Nonetheless, there seem to be an increased loss of ventilatory functions in smokers as the favourably with that of non-smokers. However, it did not correspond to the findings of Douglas (Douglas et al.,1985) and (Das and Dhundasi, 2002; Ebomoyi and

Table 3. Distribution of airflow limitation in the study population.

FEV1/FVC test (%)	SMOKERS (n)	PERCENT (%)	NON-SMOKERS(n)	PERCENT (%)	P.Value
≤ 70	17	17	35	34.5	0.004**
70—74	27	27	33	32.7	0.38
75—80	31	31	33	32.7	0.8
80--100	25	25	0	0	0.000**
TOTAL	100	100	101	100	

**P.Value≤ 0.01 is significant.

Iyawe,2005)' where the average level of FEV_1/FVC ratio in London firefighters compared favorably with conventional predicted values. Reduced lung functions values of statistical significance were however observed in the age groups 30-39 and 40-49. This is actually in agreement with earlier report by (Tager et al.,1991 where decline in lung function was found to have begun from age of 35 years.

In this study, it was noted that there was a significant inverse dose-response relationship between FEV_1 and cigarette smoking measured as pack years. Longer the duration of pack years of smoking, the lower the FEV_1 in liters. The smokers with severe air flow limitation had mean pack years of 6.94±.7 years compared to those with minimal airflow limitation of 0.35±.21 years (Table 3). This finding is in agreement with findings of Musk et al,(1977a) and others (Musk et al,1977a;Douglas et al.,1985;Das and Dhundasi,2002; Mead et al., 1967;Ebomoyi and Iyawe,2005) who found that the duration of smoking when prolonged, measured by pack years was associated with proportionately, lower values of FEV_1. They also found that starting smoking at a younger age is associated with a lower value of FEV_1, and an accelerated decline that doubles that of normal aging process. The same applied to PEFR, where the elderly who had smoked for more pack year had a lowered value compared to younger firefighters who had barely started smoking. In this study, higher number of the non-smokers having evidence of severe airway obstruction compared to the smokers; this is in contrast to earlier findings by other authors (Tager et al.,1991; Musk et al.,1977b).This may not be unconnected with the part that smoking is known to affect the distal smaller airways in the pathological process of obstruction and before it results in evident airway obstruction that could be detected by a spirometer (Musk et al.,1977b;Douglas et al.,1985). Mild obstruction of airways was seen to be equally distributed in both groups, although, in other studies smoking fire fighters were found to have more severe obstruction (Douglas et al., 1985 ;Das and Dhundasi,2002; Mead et al., 1967). This study found 25(25%) of the smokers to have a very high FEV_1/FVC ratio of (85-100%), while none was observed amount the non-smokers. This finding is of statistical significant (P<0.01). The fire fighters with high ratio were found to have proportionally lower values of FVC in liters, interpretation of which, may suggest additional finding of restrictive airway disease(Mead et al., 1967;Musk et al.,1977b;Brandte et al.,1988).

Conclusions

Comparison of lung functions showed more airways obstruction in the smoking firefighters compared to the controls. There was also linear relationship between pack year of smoking and degree of air way limitation, indicating an additional effect of smoking on smoke inhalation. A restrictive feature of lung disease was observed amongst the smokers but none in the controls. Hence it is advised that firefighters should learn to quit smoking altogether because of its additive effect to smoke inhalation.

Competing interest

The authors declare that they have no competing interests.

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