ORIGINAL ARTICLE

Prevalence of Respiratory Symptoms and Lung Function Status of Firefighters in Benin City, Nigeria

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ABSTRACT

Background: To determine the prevalence of respiratory symptoms and lung function status of the firefighters in Benin City, Nigeria. **Methods:** A descriptive cross-sectional study carried out among firefighters in Benin City, Nigeria. Data was collected using relevant section of the Burden of Obstructive Lung Disease Initiative (BOLD) questionnaire. The lung function parameters were measured using the Koko Legend® spirometer. Data was analyzed using IBM SPSS Statistics version 20. **Results:** A total of 59 firefighters were studied. Their mean age (SD) was 42.1 (11.6) years. Males constituted 69.5%. The commonest respiratory symptoms were nasal congestion 11.9%, chest pain 10.2%, dyspnoea 8.5%, cough 6.8%, shortness of breath 5.1%, wheezing 3.4% and sputum production 3.4%. The mean FEV_1 (2.69 ± 0.98L vs 2.15 ± 0.74L), FVC (3.29 ± 1.15L vs 2.54 ± 0.90L) and PEF (7.84 ± 3.30L/s vs 6.19 ± 2.07L/s) values were significantly higher among firefighters actively involved in firefighting than those in the administrative department (p = 0.024, 0.010 and 0.038 respectively). The FEV_1/FVC ratio of the active firefighters was lower, 81.8% ± 8.0 vs 84.1% ± 7.4 (p = 0.262). Firefighters in the administrative department were four and five times more likely to have lower predicted FEV_1 (Adjusted OR = 4.02, 95% CI = 0.87, 18.57) and FVC (Adjusted OR = 5.16, 95% CI = 1.11, 23.89) respectively than those in the operations department.

Conclusion: The prevalence of respiratory symptoms was generally low in the firefighters studied. Most of those in operations showed obstructive abnormality while a higher proportion of those in administrative department showed restrictive abnormality. We recommend yearly lung function testing on all firefighters and long-term medical monitoring.

Keywords: Respiratory symptoms, lung function testing, firefighters.

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Introduction

There is a great concern over the health effects of smoke inhalation and exposure to combustion by-products of burning materials on firefighters.[1] Smoke is a combination of gases consisting of carbon monoxide and carbon dioxide, and also particulates such as silica, carbon, fluoride, aluminum, lead, hydrocarbons, acids, bases and phenols.[2] Smoke inhalation includes exposure to a wide variety of substances resulting from the complex chemistry of heat decomposition and pyrolysis.[3]

Firefighting is a physically demanding and hazardous occupation and firefighters are exposed to various irritants or pollutants.[4] Their combined effect may cause lung injury and obstruction of airways.[3] Schermer *et al* in

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their study looking at change in lung function over time in South Australian male metropolitan firefighters showed younger generations of firefighters to have an increase in lung functions relative to older colleagues.[5] Alkali and Bandele while looking at the effect of cigarette smoking on pulmonary function and respiratory symptoms among firefighters in Lagos, Nigeria, found a high prevalence of respiratory symptoms among the studied population.[6]

The purpose of this research was to determine the lung function status and to look into the respiratory symptoms of the firefighters in Benin City, Nigeria.

Materials and methods

Study design

This descriptive cross-sectional study was carried out among firefighters of Edo State Fire Service in Benin City, Nigeria, from 5th March to 21st April, 2015. Edo state is one of the 36 states of Nigeria and is located in the southern part of the country. The Edo State Fire Service has its headquarters in Benin City and three outstations located at Ekpoma, Ubiaja and Auchi. The permission to carry out the study was obtained from the State Ministry of Special Duties, Benin City where the Edo State Fire Service was domiciled. Each firefighter also gave written informed consent before the interviews and spirometry.

Study population

The study population comprised all firefighters in the employ of the Edo State Fire service as at the time of the study. Firefighters with contraindication to spirometry were excluded from the study. Such contraindications included recent abdominal or eye surgery, persons with chest deformity, unstable cardiovascular status (aneurysm, recent heart attack, raised blood pressure above 180/100 mmHg and pulse rate above 100 beats per minute), severe respiratory conditions like chronic obstructive pulmonary disease (COPD), pulmonary tuberculosis (PTB), asthma, lung cancers or evidence of significant exposure to other substance like silicon, tin, asbestos.

Data collection

The instruments for data collection were a questionnaire and the Koko Legend® Spirometer (Model 314000, Serial 2007LB0538).

Questionnaire: The interviewer administered questionnaire was adapted from relevant sections of the Burden of Obstructive Lung Diseases Initiative (BOLD) questionnaire that applies to this study. Information obtained was the socio-demographic characteristics and respiratory symptoms of the firefighters. The respiratory symptoms of interest included cough, sputum, wheezing, chest pain, dyspnoea, shortness of breath and nasal congestion.

Spirometry: The firefighters performed spirometry according to the American Thoracic Society (ATS) and European Respiratory Society (ERS) guidelines.[7] Appropriate quality control measures were ensured during the spirometry. A maximum of eight trials was conducted to obtain a minimum of three acceptable tests with reproducible FEV_1 and FVC values. The spirometer was calibrated for volume daily. The environment was monitored and ambient conditions were within accepted ranges. The best test from an acceptable curve that has the highest sum of forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) into the expiratory maneuver was used for interpretation. The pulmonary function parameters which included FEV_1, FVC, FEV_1/FVC ratio, peak expiratory flow (PEF) and the percentage predicted values for age, height and sex were recorded for each firefighter.

Data analysis

An initial univariate analysis was conducted for all variables to assess the distribution for each variable to establish whether they were within acceptable range. For the purpose of analysis and comparison, the firefighters were sub-classified according to their job category into those in operations and

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administrative departments. The staff in the operations department are those who are directly involved in the act of firefighting. On the hand the administrative staff worked in the offices.

The primary outcome variables FEV_1, FVC, FEV_1/FVC ratio, PEF and the respiratory symptoms were summarized using means and standard deviations. The socio-demographic characteristics and the respiratory symptoms were summarized using proportions. The independent t test was used to compare means while the chi square test was used to test for associations. A binary logistic regression was used to determine the predictors of the outcome variables in the two groups. For the respiratory symptoms, the presence of each symptom was the predicted outcome while for the lung function parameters, predicted values of 80% and above for FEV_1, FVC and PEF and 70% and above for FEV_1/FVC ratio were the predicted outcomes. Obstructive abnormality was defined as FEV_1/FVC ratio less than 70%, restrictive abnormality was defined as FEV_1/FVC ratio that is ≥70%, FVC and FEV_1, both < 80% of predicted.[8] All statistical analysis was done using IBM SPSS Statistics version 20 (IBM Corp., Armonk, NY, USA) and the level of significance was set at a p value of less than 0.05.

Results

Out of the 62 firefighters employed in the Edo State Fire Service as at the time of the study, 59 (95%) who were eligible for spirometry participated in the study. Table 1 shows the socio-demographic characteristics of the firefighters. The mean age (SD) of the firefighters was 42.1 (11.6) years but a higher proportion of them were aged 30 – 39 years. More than two third of them were males (69.5%) and married (76.3%). Most of them had secondary and tertiary level of education, 57.6% and 39.0% respectively. Thirty-six (61.0%) firefighters (31 males and 5 females) worked in the operations department and thus were actively involved in fire fighting while the remainder worked in the administrative department (10 males and 13 females). The duration of work in the Fire Service ranged from 1 – 35 years with majority of them having worked for 5 – 10 years. Eighteen (30.5%) firefighters were smokers.

The prevalence of respiratory symptoms reported by the firefighters was generally low. Nasal discharge (11.9%), chest pain (10.2%) dyspnoea (8.5%) and cough (6.8%) were the predominant symptoms experienced by the firefighters (Table 2). A stratification of the firefighters according to their job category showed that those in operations were older and significantly taller ($p = 0.013$) than those in administrative department. Both the systolic and diastolic blood pressures were also higher in among those in operations when compared with those in the administrative department, but these differences were not statistically significant. However, firefighters in administrative department had a significantly higher body mass index ($p = 0.014$) than those in operations (Table 3).

Table 4 shows both the total and subgroup spirometric parameters of the firefighters. The FEV_1, (2.15 ± 0.74 vs 2.69 ± 0.98), FVC (2.54 ± 0.90 vs 3.29 ± 1.15) and PEF (6.19 ± 2.07 vs 7.84 ± 3.30) were significantly lower in the firefighters in administrative department than those in operations with p values of 0.024, 0.010 and 0.038 respectively. The mean FEV_1, FVC and PEF values of the firefighters in operations was higher than the mean total values for all the firefighters. For the FEV_1/FVC ratio, firefighters in the administrative department had higher values (84.1% ± 7.4 vs 81.8% ± 8.0) compared to those in operations. But this difference was not statistically significant ($p = 0.262$).

A comparison of the outcomes (respiratory symptoms and percentage predicted lung functions) among the subgroups is shown in table 5. The respiratory symptoms did not differ significantly among the two groups in the bivariate analysis. After adjusting for age,

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height, duration of work, smoking status and indoor cooking in the multivariate analysis, firefighters in the operations department were more likely to have chest pain (Adjusted OR = 11.73, 95% CI = 0.38, 36.45) and dyspnoea on exertion (Adjusted OR = 2.08, 95% CI = 0.21, 20.58), although these finding were not statistically significant. Firefighters in the administrative department were four and five times more likely to have lower predicted FEV_1 (Adjusted OR = 4.02, 95% CI = 0.87, 18.57) and FVC (Adjusted OR = 5.16, 95% CI = 1.11, 23.89) respectively compared to those in operations.

The analysis of the correlation between the BMI and spirometric parameters of the firefighters showed that, in those in the operations department, there was a negative correlation between BMI and FEV_1 (r = -0.385, p = 0.020), FVC (r = -0.326, p = 0.053), FEV_1/FVC (r = -0.279, p = 0.100) and PEF (r = -0.356, p = 0.033). The negative correlation between FEV_1 and PEF was statistically significant. Similarly, a negative correlation which was not statistically significant existed between BMI and all the spirometric parameters among the firefighters in the administrative department; FEV_1 (r = -0.341, p = 0.111), FVC (r = -0.321, p = 0.136), FEV_1/FVC (r = -0.131, p = 0.888) and PEF (r = -0.141, p = 0.521).

In terms of respiratory abnormality, 5 (8.5%) firefighters (operations 80% and administrative 20%) had obstructive abnormality while 31 (52.5%) of them (operations 48.4% and administrative 51.6%) had restrictive abnormality.

Table 1: Socio-demographic characteristics of the firefighters

Variables	Frequency (n=59)	Percent
Age in years		
20 – 29	7	11.9
30 – 39	25	42.4
40 – 49	8	13.6
50 – 59	16	27.1
≥60	3	5.0
Mean age 42.1 ±11.6 years		
Sex		
Male	41	69.5
Female	18	30.5
Marital status		
Married	45	76.3
Single	12	20.3
Divorced/widowed	2	3.4
Educational status		
Primary	2	3.4
Secondary	34	57.6
Tertiary	23	39.0
Job category		
Operation	36	61.0
Administration	23	39.0
Job duration in years		
1 – 4	7	11.9
5 – 10	36	61.0
> 10	16	27.1
Median duration 7 years (Range 1 – 35 years)		
Smoking status		
Smokers	18	30.5
Non-smokers	41	69.5

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Table 2: Respiratory symptoms of the firefighters

Symptoms	Frequency (n = 59)	Percent
Nasal congestion	10	11.9
Chest pain	6	10.2
Dyspnoea	5	8.5
Cough	4	6.8
Shortness of breath	3	5.1
Wheeze	2	3.4
Sputum	2	3.4

Table 3: Comparison of mean values of some parameters among the firefighters

Parameter	Operation (n = 36)	Administrative (n = 23)	P value
Age (years)	43.6 ± 11.9	39.9 ± 11.2	0.239
Height (m)	173.4 ± 7.9	167.7 ± 8.9	0.013*
Weight (kg)	71.1 ± 13.4	74.7 ± 13.3	0.319
Body Mass Index (kg/m^2)	23.6 ± 3.8	26.8 ± 5.9	0.014*
Systolic blood pressure (mmHg)	130.6 ± 20.3	126.4 ± 18.9	0.435
Diastolic blood pressure (mmHg)	86.9 ± 15.1	82.6 ± 9.9	0.225

**Statistically significant*

Table 4: Total and subgroup mean spirometric parameters of the firefighters

Parameter	Total (n = 59)	Operation (n = 36)	Administrative (n = 23)	P value
FEV_1 (L)	2.48 ± 0.93	2.69 ± 0.98	2.16 ± 0.74	0.024*
FVC (L)	2.99 ± 1.11	3.29 ± 1.15	2.54 ± 0.90	0.010*
FEV_1/FVC (%)	82.7 ± 7.8	81.8 ± 8.0	84.1 ± 7.4	0.262
PEF (L/s)	7.19 ± 2.97	7.84 ± 3.30	6.19 ± 2.1	0.038*

**Statistically significant*

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Table 5: Comparison of outcomes among the firefighters

Parameter	Operation (n = 36)	Administrative (n = 23)	P value	Effect size*	
				Unadjusted	Adjusted [95% CI][a]
Nasal congestion	40%	60%	0.128	0.35	1.36 [0.24, 7.79]
Chest pain	33%	67%	0.153	3.56	11.73 [0.38, 36.45]
Dyspnoea	40%	60%	0.293	2.56	2.08 [0.21, 20.58]
Cough	67%	33%	0.665	0.77	0.68 [0.04, 10.40]
FEV_1[b]	72.7 ± 21.4	63.2 ± 24.0	0.119	2.57	4.03 [0.87, 18.57]
FVC[b]	73.6 ± 20.3	65.8 ± 19.7	0.152	4.02	5.16 [1.11, 23.89]
FEV_1/FVC[b]	102.9 ± 9.7	104.5 ± 8.7	0.536	0.36	1.40 [0.07, 30.04]
PEF[b]	87.4 ± 31.8	79.9 ± 25.5	0.345	0.69	0.49 [0.14, 1.73]

**Effect size expressed as mean differences for continuous variables and odds ratios for categorical data.*

[a]*Adjusted for age, height, duration of work, smoking status and indoor cooking.*

[b]*Percentage predicted lung function parameters expressed as means and standard deviations.*

Discussion

In this study, the prevalence of respiratory symptoms was generally low ranging from 3.4% (sputum/wheeze) to 11.9% (nasal congestion). This result contrasted with the result of an earlier study done in Lagos, Nigeria where the prevalence of respiratory symptoms was as high as 67.0%.[6] Possible reasons for our finding include the fact that the majority of the fire fighters had spent less than 10 years in the job and only 30.0% were smokers. A low prevalence of respiratory symptoms ranging from 0.7% (asthma attack) to 10.0% (wheeze) had also been reported in the Netherlands.[9]

Among the firefighters who had experienced cough, two thirds of them were in the operations group. This may not be unconnected with exposure to fumes and smoke from the fire during the course of their work. It has been documented in previous studies that prolonged and repeated exposures to smoke in the course of fire fighting is associated with a higher prevalence of respiratory symptoms among firefighters when compared to controls.[4,10,11] This finding underscores the need for regular and accurate use of personal protective equipment among firefighters. However, in Nigeria and in many developing countries of the world, the provision of personal protective equipment and their uses among worker is still rudimentary. Although, we did not explore the use of personal protective equipment by the firefighters in this study, Alkali *et al* in their study in Lagos in South West, Nigeria, reported that none of the 201 firefighters in the Federal Fire Service wore a protective device when fighting fires.[6]

We report that the spirometric indices (FEV_1, FVC and PEF) were lower among the firefighters in the administrative department (though within normal range), in this study. The reason for this could probably be from the fact that the firefighters in the operations department were significantly taller than their counterparts in administrative department (173.4m versus 167.7m) and of the 18 female workers in the establishment 13 (72.2%) worked in the administrative department. It is a known fact the height and sex of an individual would influence spirometric values. We also observed that the body mass index (BMI) was higher among firefighters in the administrative group. The reason for such could be the fact that this group had a lifestyle of inactivity. They could spend a long time sitting in one position when at work. Banerjee et al in a study in Kolkata

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India, reported a significant association between BMI and lung function parameters in non-asthmatic obese group. The spirometric parameters were affected with increasing BMI and it was more pronounced in females.[12] This study showed a negative correlation between BMI and the lung function parameters of the fighters.

Although, the FEV_1, FVC and PEF values of the firefighters in the operations department showed a statistically significant difference from those of their counterparts in the administrative department and after adjusting for the socio-demographic variables, this difference was no longer statistically significant. However, firefighters in operations department are 1.4 times more likely to have a lower FEV_1/FVC ratio than those in administrative department. These findings may be due to the small sample size utilized for the study. A larger sample size may have been more appropriate to determine the effect size.

Several studies have shown that there is a decline in lung function of firefighters from exposure to smoke and fumes over time and both restrictive and obstructive changes have been reported.[9,13-15] This could explain the reason why among the fire fighters with respiratory abnormalities, most of those in operations showed obstructive abnormality while a higher proportion of those in administrative department showed restrictive abnormality. These changes can even worsen if the firefighters smoked cigarette. In our study, 30.5% of the firefighters were reported to be smokers and this constitutes an additional burden to their lung health. In the Lagos study, the respiratory symptoms were more prevalent among smokers compared to the non-smoking firefighters.[6] Although, Jacquin *et al* did not find any statistical differences in respiratory impairments of smokers and non-smoking firefighters,[14] we however, suggest that a smoking cessation programme and health education on the cumulative effects of smoke inhalation from firefighting and cigarette smoking should be instituted for firefighters in Nigeria.

A limitation of this study is the small sample size utilized for the study even though it was a total population study. This is due to the fact that there has been a dearth of recruitment into the Edo State Fire Service for about seven years preceding the study. A multi-state study involving many states in southern Nigeria is being considered.

In conclusion, this study showed that the prevalence of respiratory symptoms was low in the firefighters studied. However, nasal discharge, chest pain, dyspnoea and cough were the mostly reported symptoms. The spirometric parameters were lower among firefighters in the administrative department when compared with those involved in active firefighting. We recommend yearly lung function testing on all firefighters and long-term medical monitoring.

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Conflict of interest

We the authors declare that we had no conflict of interest.

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