Prevalence of respiratory symptoms in Nigerian firefighters

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Abstract

The purpose of our study was to determine the prevalence of symptoms indicative of respiratory disorder in a third world country like Nigeria, where the use of respirator devices is not being practised, and to compare the effect of cigarette smoking on respiratory symptoms in firefighters. The study was a cross-sectional comparison of Nigerian firefighters with at least 2 years of fire fighting experience. A respiratory symptoms questionnaire was used as the investigative tool. The study was conducted in Federal Fire Service stations in Lagos Nigeria between July and August 2002; 201 firefighters were examined and the results for 100 smokers (cases) and 101 non-smokers (controls) were analysed. The prevalence of symptoms indicative of respiratory disorder were similar in both cases and controls: 70 (70%) vs 64 (63 %). A high prevalence was observed in the age groups 30–39 years and 40–49 years ($p \leq 0.01$). These groups represent the bulk of the firefighters studied. The cases had predominant specific symptoms, chest tightness 51 (51%) of cases vs 32 (31.7%) of controls, cough 27 (27%) of cases vs 20 (19%) of controls. It was concluded that the high prevalence of respiratory symptoms in both groups of firefighters studied calls for the need to use respirator protective devices in the course of fire combat operations, as well as constant attention to and treatment of respiratory symptoms.

Introduction

Smoke inhalation is the breathing in of the harmful gases, vapours, and particulate matter contained in smoke. Smoke inhalation typically occurs in victims of fire caught in structural fires. People trapped in fire may suffer from inhalation independent of receiving skin burns. However, the incidence of smoke inhalation increases with the percentage of total body surface burned.[1] Inhalation of smoke causes 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.[1]

The duration of exposure to smoke and the occurrence of the exposure in a confined space determine the severity of the pulmonary consequences of smoke inhalation.[2] These latter factors have assumed particular significance in recent years with the increased use of synthetic and plastic material in homes and industries, particularly in a developing country like Nigeria.[2]

Firefighters are exposed to toxic and irritant gases (hydrochloric acid, aldehyde, phosphogene, and ammonia) from combustion and smouldering products such as plastics, wood, and petroleum products. Their combined effect may cause pulmonary injury, obstruction of the airways, and increase in morbidity and mortality of the firefighters.

There is paucity of data on the study of firefighters in Nigeria. A study of 52 firefighters in Lagos in 1981, revealed 52% had respiratory symptoms, with symptoms being more prevalent in smokers (90%) than non-smokers (39%). This finding was lower when compared with previous observations by other authors.[3,4] Tarskin et al in 1977, found mild to moderately severe hypoxia in 19 of 21 mostly asymptomatic Los Angeles firemen when exposed to dense smoke containing polyvinyl chloride and other pulmonary irritants. The hypoxemia was transient with nearly complete reversibility within 24 hours. No significant functional respiratory impairment was observed when followed up later.[3] Young et al,[5] in an Australian fire brigade, found the prevalence of chronic respiratory disease to be less compared with reports by other authors.[6,7] In firefighters exposed for a long period in structural fires containing the toxicants, the effect on the pulmonary function was significant.[8–10]

Macklem[11] and Genovesi et al[12] observed more involvement of the small airways in firefighterswho smoked, irrespective of duration of exposure.

Classification of fires

It is important to classify fires because when the fire blazes, the focus is on the degree of the damage it may cause. The hazards depend on the class of fires that fire fighters are frequently exposed to. The medical hazards often vary, because the heat created by fire varies with the amount, arrangement, and moisture content of flammable materials in it. As such, for better understanding of the effect on firefighters, fires can be classified according to

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Classification of fire	Details of classification
A	Fires involving solid materials of organic nature, in which combustion takes place with the formation of glow.
B	Fires, involving liquids or liquefiable solids, e.g. petrol and kerosene fires.
C in	Fires involving gasses or liquefied gasses the form of jet or spray, e.g. methane, pro pane, butane.
D	Fires involving metals, e.g. calcium, magnesium, zinc, and aluminium.
Note: Information was obtained from the Federal Fire Service, Lagos.	

Table 1 Details of classification of fire

the nature of combustible materials. It also serves as a guide to the class of fires that firefighters are exposed to in the line of duty.

Materials and methods

The research was a cross-sectional study and subjects were active male and female firefighters who were on the alert list of the Federal Fire Service stationed in Lagos. Subjects were selected based on the inclusion criteria and each subject participated in the study voluntarily. A total of 201 firefighters were examined.

The age range of the cases (smokers), was 26–58 years while that of the controls (non-smokers) was 22–58 years. The mean ages of cases and controls were comparable (42.44±8.20 vs 41.74±7.42 years) (p=0.53). Consent was obtained from the ethical committee of Lagos University Teaching Hospital and the Federal Fire Service, Lagos. Informed consent was also obtained from the subjects. Individuals included in the study were:

(a) male and female smokers who had been actively involved in firefighting for at least 2 years (cases);
(b) male and female non-smoking firefighters involved in firefighting for at least 2 years (controls)

Firefighters with heart disease, congestive heart failure, thoracic cage abnormality – such as scoliosis, kyphoscoliosis, pectus carinatum, or pectus excavatum – were excluded.

Data analysis

Each participant completed a questionnaire which contained information pertaining to their socio-demography, and occupational and medical history in relation to respiratory system; also time (in years) spent in firefighting. The severity of the firefighters' past exposure was gauged by questions regarding the classification of fire fought.

The Epi info (Version 6) statistical software was used for data entry, validation, and analysis. The measures of central tendency and dispersion were computed for all quantitative variables: number of years in fire fighting, classification of fires fought in the last 2 years and data on smoking. Frequency distribution was used for variables such as specific chronic respiratory symptoms. The unpaired Student's 't' test was employed to assess the difference between the means of the two groups. A p value of 0.01 was used as the criteria for a statistically significant difference.

The analysis of variance (ANOVA) test was chosen for the comparison of two variables. For the relationship of two quantitative variables, correlation and regression methods were used. Chi-square test was used, where appropriate, to compare proportions and evaluation of association between variables in the contingency table and a p value of <0.05 was used as the criteria for a statistically significant difference between variables.

Results

For the purpose of this study, symptoms of respiratory disorder were defined as the presence of cough, chest tightness, breathlessness, wheeze, and sneezing with red eyes. These symptoms when present were used to categorise the subjects as having symptoms of respiratory disorder and may be a manifestation of the effect of repeated exposure to smoke. The age-specific prevalence of symptoms indicative of respiratory disorders was significant in most age groups. The results are shown in Table 2.

The distribution of specific respiratory symptoms is shown in Figure 1. Chest tightness appeared to be the most predominant symptom, with 51 (51%) of cases compared with 32 (31.7%) of controls (p=0.001). More cases, 27 (27%) had cough compared with controls, 20 (19.8%) (p=0.25). The case prevalence of wheeze, however, was low in both groups 10 (10%) cases vs. 13 (13 (12.9%) controls (p=0.54). Breathlessness was the next most predominant symptom with a prevalence of 29 (28.7%) in the controls compared with 27 (27%) amongst the cases (p=0.25). Using the Chi square test, the relationship between respiratory symptoms and duration of firefighting experience and class of fires fought was found to be significant statistically (p<0.05). This is shown in Table 3.

Age group	Smokers (n)	Prevalence (%)	Non smokers (n)	Prevalence (%)	P value
20–29 years	2	2.9	3	4.7	0.9
30–39 years	20	28.6	32	50	0.001**
40–49 years	33	47.1	21	32.8	0.0002**
50–59 years	15	21.4	8	12.5	0.007**
Total	70	100.0	64	100.0	
** p≤0.05 is significant					

Table 1 Age-specific prevalence of symptoms indicative of respiratory disorder

Duration of fire fighting (years)	Smokers' respiratory symptoms?			Non-smokers' respiratory symptoms?		
	No	Yes	Total	No	Yes	Total
0–9	7	13	20	6	13	19
10–19	8	24	32	11	20	21
20–29	12	26	38	14	29	43
30–39	2	8	10	1	7	8
Total	29	71	100	32	69	101
Chi-square test						
	Value	df	p value	Value	df	p value
	1.12	3	0.05*	1.55	3	0.05*

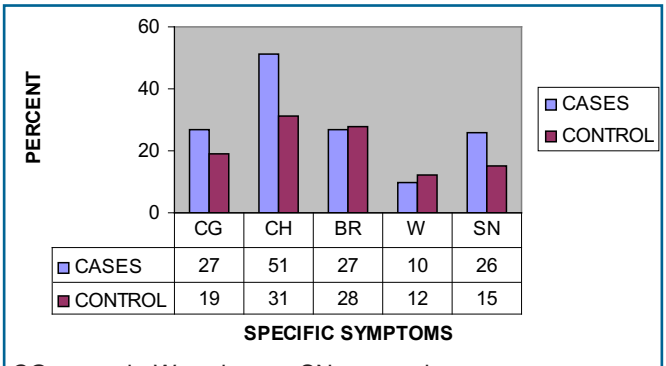
C^2 - Chi-square (* two tails test at p≤0.05 is significant).
df = degrees of freedom.
The test is significant, hence there is a relationship between respiratory symptoms and duration of fire fighting experience.

Table 3 Relationship between respiratory symptoms and duration of fire fighting experience

Classification of fires	Smokers' respiratory symptoms?			Non-smokers' respiratory symptoms?		
	No	Yes	Total	No	Yes	Total
A	6	3	9	1	17	18
B	5	15	20	4	16	20
C	1	0	1	0	1	1
All	17	53	70	1	7	8
Total	29	71	100	32	69	101
Chi-square test						
	Value	df	p value	Value	df	p value
	9.56	3	0.05*	11.44	3	0.05*

C^2 - Chi-square (* two tails test at p≤0.05 is significant).
df = degrees of freedom.
The data show significant relationship between respiratory symptoms and the different classifications of fires fought.

Table 4 Relationship between respiratory symptoms and classification of fires



CG = cough; W = wheeze; SN = sneezing;
CH = chest tightness; BR = breathlessness

Figure 1 Prevalence of specific symptoms in both case and control subjects

Discussion

In this study, the prevalence of symptoms indicative of respiratory disorder in both groups studied was similar. Overall prevalence was higher (67%) compared with (52%) in a previous study obtained two decades ago.[2] Fire fighting has been recognised as a hazardous occupation with a potential for exposure to a wide variety of toxic fumes, gases and smoke.[2–4] It would seem reasonable to expect that repeated exposure of this nature might be responsible for the induction of respiratory disease. The increase in prevalence of respiratory disease in both smoking and non-smoking categories may be associated with the introduction of man-made materials, particularly plastics, that has radically altered the composition of the gaseous fraction of smoke. The long duration of exposures to these significant toxic gaseous substances and high levels of carbon monoxide over the years in fire fighting might have contributed. The fact that none of the firefighters wore protective device during any firefighting activity, showed how much the firefighters were exposed to the harmful and toxic effect of smoke inhalation.

The age-specific prevalence of symptoms indicative of respiratory disorder, for both the smokers and non-smokers category, showed significant prevalence in the age groups of 30–39 years, and 40–49 years. These age groups actually represent the bulk of the firefighters studied. Amongst the smokers, the highest prevalence was in the 40-49 age group while the non-smokers category was the 30–39 age group. The younger firefighters had low prevalence of symptoms, when compared with the older ones. This was expected considering the longer period of exposure the older ones have had.

Sidor and Peter observed a similar trend for prevalence of respiratory symptoms.[4] The high prevalence rate in the 40–49 year age groups could be attributed to the experience they have had in the occupation, and in the older firefighters smoking was found to have an additive effect to the risk of having respiratory disorder. This however is in disagreement with earlier report in Nigeria. The reason for this observation may be connected with the short duration of firefighting experience the firefighters had, as most of them had not been long in the service at the time they were studied.

The results of the study in Australian firefighters by Young et al[5] confirmed the findings of this study. However, in Nigeria the prevalence of respiratory symptoms among the firefighters was also found to be a reflection of repeated unprotected exposure to toxic fumes and smoke over the years in the fire service. An analysis of specific symptoms showed chest tightness was predominant in both smoking and non-smoking firefighters. However, compared with the non-smokers, the smokers category showed statistically significant high prevalence for chest tightness. This may well be an early manifestation of the

effect of smoking long before the appearance of overt chronic obstructive pulmonary disease (COPD).[6–8]

The chest tightness could be attributed to obstruction in the smaller airways, causing restriction to the elastic recoil of the lungs and chest wall.[9,10] In COPD, the smaller airways are primarily, the first site to be affected. The effect of the smaller airways involvement could be sensed as a discomfort in the chest; this had been reported in the literature.[10,11] Before individuals seek medical attention, the disease must have passed through a stage of considerable peripheral obstruction; so it was not actually surprising in this study to find a high prevalence of chest tightness, with the evidence of smoking as an additional risk.[9–11] Breathlessness, cough, and wheeze appeared to have equal prevalence in both groups; these are some of the cardinal symptoms of obstructive lung disease. The prevalence suggests the presence of a certain degree of airflow obstruction in this group of firefighters. These symptoms were experienced commonly amongst the firefighters. This could be an indication of continual irritation of the airways from inhaled smoke and dust, with resultant bronchial-hyperreactivity. Sneezing with red eyes was more prevalent amongst the smokers compared with the non-smokers, which presumably suggests a higher level of hyper-responsiveness of upper airways in the smoking firefighters.

The relationship between respiratory symptoms and duration of firefighting experience, and classification of fires are significant. In contrast to the findings of Elegbeleye and Bandele,[2] the firefighters in this study had a mean of 18 years in the fire service in both groups while the prevalence of respiratory symptoms was found to be 70%. A similar trend of increase in prevalence of chronic obstructive airways disease was observed by Young et al[5] amongst firefighters with 20 years or more of firefighting experience. The majority of the fire fighters were exposed to all classes of fires and some that were exposed to A, B, or C classes equally had respiratory symptoms. This is in contrast to the previous study by Bandele et al when the firefighters found classes B and C to be the more frequently encountered classes.

The reason for this significant association could be due to the change in fire characteristics. In the early days the quality of the combustible materials compared with the present day has different man-made materials, particularly plastics, have radically altered the composition of the gaseous fraction of fire smoke.

Conclusion

This study showed a higher prevalence of symptoms indicative of respiratory disorder in both groups. However, the smokers had a higher prevalence for specific respiratory symptoms. The presence of these symptoms is related to duration of fire fighting experience, and the class of fire fought.

Fire fighting is associated with adverse respiratory hazards. The authorities in the Ministry of Works and Housing in charge of the Federal Fire Service should review the facilities available for fighting fires and provide uninterrupted effective breathing apparatus as a form of protective device. In this study none of the firefighters wore a protective device when fighting fires. This unprotected repeated exposure to smoke and noxious fumes could have been responsible for the observations in this study.

References

1. Lewis D. *Through the Smoke*. An article written for the Fire Museum Network's website, 1999 (available at www.firemuseumnetwork.org).
2. Elegbeleye OO, Bandele E.O. The chronic effect of fire fighting in Nigerian fire fighters. *African Annals Med* 1981; 1: 2–7.
3. Tarskin DP, Genovasi MG, Chopra S, Coulson A, Simon SM. Respiratory status of Los Angeles firemen: one-month follow up after inhalation of dense smoke. *Chest* 1977; 71: 445–9.
4. Sidor R, Peter JM. Prevalence rates of chronic non-specific respiratory disease in fire fighters. *Am Rev Respir Dis* 1974; 109: 255.
5. Young C, Jackson J, West S. Chronic respiratory disease and respiratory function in a group of fire fighters. *Med J Aust* 1980; 28: 654–8.
6. Brown RB. Smoking and lower respiratory tract infection. *Infections* 1987; 15 Suppl 3: S123-8-1.
7. Douglas DB, Douglas RB, Oakes D, Scott G. Pulmonary function in London firemen. *Brit J Ind Med* 1985; 42: 55–8.
8. Sidor R, Peters JM. Differece in ventilatory capacity of Irish and Italian fire fighters. *Am Rev Respir Dis* 1973; 108: 255–61.
9. Tager IB, Segal MR, Speizer FE, Weiss ST. The natural history of forced and expiratory volumes: effect of cigarette smoking and respiratory symptoms. *Amer Rev Respir Dis* 1988; 138: 837–49.
10. Dyer RF, Esh VH. Poly vinyl chloride toxicity in fires: hydrogen chloride toxicity in fire fighters. *JAMA* 1976; 235: 397.
11. Macklem PA. Obstruction in small airways: a challenge to medicine. *Amer J Med* 1972; 52: 721–4.
12. Genovesi MG, Taskin DP, Chopra S, Morgan M, MeElvoy. Transcient hypoxaemia in firemen following inhalation of smoke. *Chest* 1977; 71: 44..