Prevalence Rates of Chronic Non-Specific Respiratory Disease in Fire Fighters[1-3]

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SUMMARY

A cross-sectional study measured the prevalence of chronic non-specific respiratory disease in 1,768 Boston fire fighters. Simple pulmonary function tests, forced vital capacity and 1-second forced expiratory volume, and a standardized respiratory symptom questionnaire classified fire fighters into one of several categories of chronic non-specific respiratory disease. Relevant exposure information was also obtained.

Experienced fire fighters had a higher chronic non-specific respiratory disease rate than new fire fighters of the same age group, although cigarette smoking partially obscured the occupational effect. Several indicators of occupational exposure and their resulting symptoms were associated with higher chronic non-specific respiratory disease rates. Significantly higher disease rates were found in fire fighters who smoked or had smoked cigarettes in the past.

Although selection factors may result in a population of fire fighters who have less chronic non-specific respiratory disease than the general population, excess respiratory disease is associated with the occupation of fire fighting. It appears that the fire fighter incurs increased risk of disease due to his occupation and cigarette smoking.

Introduction

There is a paucity of information on the effects of fire fighting on the respiratory system of fire fighters. To examine this problem a cross-sectional study was conducted to determine the prevalence of chronic non-specific respiratory disease (CNSRD) in Boston fire fighters. The prevalence rates of chronic non-specific respiratory disease and their association with fire fighting experiences are reported in this paper.

Since fire fighters are frequently exposed to high concentrations of smoke and other combustion products, it seems reasonable to expect a high risk of respiratory disease. The fire fighters believe this to be true, and a number of states have supported this with legislation (1). However, there is little information available that either supports or refutes this notion. Mastromatteo in his examination of mortality data on Toronto fire fighters found a decreased risk of lung disease (2, 3); however, he also discovered a slightly increased prevalence of heart disease which can be confused with lung disease

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in mortality data. The medical literature contains case presentations of acute smoke inhalation and its treatment, and respiratory complications of burns (4). There is little information on groups; however, Thomas found a slight temporary decrease in pulmonary function after exposure to smoke, and a greater decrease after exposure to specific chemical agents in Louisville fire fighters (4).

Materials and Methods

Population: The study population consisted of 1,970 uniformed employees of the Boston Fire Department (BFD) who were on Department rolls any time during the study period of August 24, 1970 to February 10, 1971. During this study, approximately 1,720 members of the BFD were actively fighting fires. The rest were in support functions such as maintenance, fire prevention, or administration. Contact was made with 92.3 per cent of the population, of whom 1.6 per cent refused to participate (table 1). Loss of 23 participants because of unsuitable pulmonary function tests resulted in a final group of 1,768.

Data collection: Interviews and pulmonary function measurements were conducted by visiting the fire houses on a schedule set up to match shift assignments. Three circuits of all the fire houses were required.

Questionnaire: Each participant completed a questionnaire which included age, marital status, national extraction, birthplace, occupational history, and medical history relating to the cardiopulmonary system. Interviewers collected fire and smoke exposure history with related adverse effects, tobacco smoking history, and standardized questions of respiratiory symptoms modified from the British Medical Research Council (5).

Evaluation of occupational exposure: Duration of exposure was identified by determining years with the BFD, years of fire fighting duty, years in support functions, and years of exposure to pulmonary irritants from other employment.

The severity of the fire fighter's past exposure was gauged by questions regarding the frequency of requiring oxygen at fires; number of times the individual was overcome; number of times hospitalized for smoke inhalation; length of stay in the hospital and time off the job; and the number of "pastings" or "shellackings" taken at fires. These latter slang terms refer to the nonspecific malaise resulting from "bad" fire exposures.

Interviewers determined: (*1*) the frequency of "black lungers" (black sputum coughed up after exposure to smoke), (*2*) the time required for this clearance of black mucus to cease, and (*3*) hemoptysis.

Pulmonary function: Forced vital capacity (FVC) and 1-second forced expiratory volume (FEV_1) were measured with a Stead-Wells spirometer. Three satisfactory tracings were acquired on each fire fighter; the mean of these was used as the "true" value. The measurements were corrected to body temperature and pressure, saturated with water (BTPS).

Heights were measured to the nearest centimeter with the participant in stocking feet; weights were obtained by inquiry.

Chronic non-specific respiratory disease: The respiratory symptoms and pulmonary function data were used to categorize each participant as having either no disease or CNSRD. The latter included those with chronic non-productive cough, chronic bronchitis, asthma, and chronic obstructive lung disease. Each fire fighter could fit into one or more of the latter 3 disease categories. The criteria for chronic bronchitis, asthma, and chronic obstructive lung disease were derived

TABLE 1

NUMBER OF MEN IN THE BOSTON FIRE DEPARTMENT, ACCORDING TO CATEGORY AND PARTICIPATION STATUS

Group	No.	Participated* (%)	Refused (%)	Missed (%)
Fire fighting companies	1,719	93.1	1.1	5.8
New recruits	65	98.5	0	1.5
Headquarters staff*	83	67.1	2.4	30.5
Fire prevention	79	77.2	8.9	13.9
Maintenance	24	50.0	0	50.0
Total no.	1,970	1,791 (90.8%)	28 (1.5%)	151 (7.7%)

*Includes 23 who were not included in the study because of insufficient pulmonary function data.

TABLE 2

CRITERIA FOR CHRONIC NON-SPECIFIC RESPIRATORY DISEASES

Disease Category	Symptom
No symptoms – no disease	None
Chronic non-productive cough only	Cough for 3 months of the year for 3 years
Chronic bronchitis	Cough and phlegm for 3 months of the year for 3 years
Asthma	Diagnosed by physician
Chronic obstructive lung disease	Cough and phlegm for 3 months of year for 3 years or more and $FEV_1/FVC < 60\%$, and/or dyspnea grade $\geqslant$ 3 and/or wheezing of the chest most days/nights

from the Ciba Guest Symposium and are summarized in table 2 (6).

To examine the influence of smoking, several CNSRD categories were combined. The "no symptom–no disease" category described above was retained. Those with chronic non-productive cough, chronic bronchitis, asthma, and asthma in combination with chronic bronchitis were categorized as having "bronchitis." All those with chronic obstructive pulmonary disease, alone or in combination with chronic bronchitis, were grouped as "chronic obstructive pulmonary disease" (COPD).

Data presentation: Standardized rates were adjusted by the direct method. The adjustments were based on that characteristic in the total study population.

Results

Demographic characteristics: The mean age of fire fighters in the study was 44.0 years, with the age distribution being skewed toward the young, reflecting the large number of fire fighters who joined the force after World War II. Average years on the force were 16.8, of which 16.2 years had been served fighting fires. Most of the fire fighters were born in Boston (80.2 per cent) or its environs (13.6 per cent); 65.5 per cent were of Irish ancestry and 11.8 per cent were of Italian extraction. All participants were assumed to come from the same social class because all had to meet uniform minimum educational standards and were engaged in the same work at the same salary (except officers).

Prevalence rates of chronic non-specific respiratory disease: The age-specific CNSRD rates found among the Boston fire fighters are shown in table 3. The highest prevalence category was chronic bronchitis with a crude rate of almost 12 per cent; the second was chronic obstructive lung disease at 5.0 per cent, followed by those with both chronic

TABLE 3

PREVALENCE RATES OF CHRONIC NON-SPECIFIC RESPIRATORY DISEASES BY AGE GROUPS IN THE BOSTON FIRE DEPARTMENT, 1970

	Age Groups, *years*					Crude	
Disease classification	21–24 *(%)*	25–34 *(%)*	35–44 *(%)*	45–54 *(%)*	55+ *(%)*	Rate *(%)*	No.
No disease	81.5	82.1	74.2	74.6	77.2	76.5	1,352
Chronic non-productive cough	3.7	1.8	2.5	2.6	2.9	2.5	44
Chronic bronchitis (CB)	11.1	10.9	15.0	12.5	7.1	11.9	211
Chronic obstructive pulmonary disease (COPD)	0.0	3.0	3.9	5.6	8.4	5.0	88
CB and COPD	3.7	1.8	4.4	3.7	3.8	3.5	62
Other*	0.0	3.0	0.0	1.1	0.0	0.6	11
Total	54	329	361	783	341		1,768

*Includes those with asthma, and asthma in combination with other CNSRD classifications.

bronchitis and obstructive lung disease (3.5 per cent).

Age-specific chronic bronchitis rates were 11 per cent in those 21 to 24 years old, 15 per cent in the group 35 to 44 years of age, and 7 per cent in men 55 years or older. The bronchitis rate for fire fighters showed a downward trend in the older age groups. The prevalence rates of COPD increased steadily with age, from none in men less than 35 years of age to 8.5 per cent in men 55 years or older. The fire fighters' prevalence rate for both chronic bronchitis and COPD was relatively constant with age.

Cigarette smoking and prevalence rate of CNSRD: A strong association was found between cigarette smoking and CNSRD prevalence (table 4). Fire fighters who smoked cigarettes had 3 times more bronchitis (22.3 per cent versus 6.7 per cent) and 6 times more COPD (14.4 versus 2.3 per cent) than never-smokers. The bronchitis rate of ex-cigarette smokers was almost the same as never-smokers, but their prevalence rate of COPD (5.1 per cent) was more than twice that of never-smokers.

Pipe and or cigar smoking had little effect on CNSRD rates. Those who smoked pipes and cigars mixed with cigarettes had disease rates similar to those of cigarette smokers.

TABLE 4

AGE ADJUSTED PREVALENCE RATES OF CHRONIC NON-SPECIFIC RESPIRATORY DISEASE IN BOSTON FIRE FIGHTERS, BY SMOKING CATEGORY*

	Chronic Non-Specific Respiratory Disease	
Smoking Category	Bronchitis (%)	COPD (%)
Never smoker	6.7	2.3
Ex-cigarette	9.6	5.1
Ex-pipe/cigar	10.2	8.6
Ex-mixed	9.8	4.0
Current cigarette	22.3	14.4
Current pipe/cigar	6.0	3.4
Current mixed	17.1	13.8
Ex-cigarette, current pipe/cigar	8.6	4.8

*Adjusted to age distribution to total Boston Fire Department study population.

The rates for those who had switched from cigarettes to pipes and cigars were only slightly higher than those of pipe and cigar smokers.

Rates of CNSRD were found to be independent of age for never-smokers, somewhat related to age in ex-smokers, and highly age-dependent for current smokers (table 5). For COPD, there was an age-related increase in prevalence for ex-smokers, but not for never-smokers. For current smokers, the rates increased with age from 4.0 per cent in those less than 25 years of age to 22.4 per cent in those 55 years or older.

Effect of time on the job: Because of the low labor turnover in the Fire Department, there was a high correlation between age and years on the job ($r = 0.92$) and also between age and years spent on fire duty ($r = 0.88$). This relationship made the separation of the effects of aging and exposure difficult.

CNSRD in support groups: Fire fighters who were not actively fighting fires had a 42.4 per cent age-standardized rate of CNSRD. This compares to 25.0 per cent for those assigned to fire fighting ($P < 0.05$ by Mantel-Haenszel chi-square) (7).

CNSRD in young fire fighters: Of the 413 men 35 years of age or younger, 114 of them had less than 6 months service, 299 had 0.5 to 14 years of service. In dividing the groups it was found that the recently hired fire fighters had a lower rate of CNSRD than experienced men of the same age range. The age distribution of the 2 groups was similar. Experienced fire fighters had a significantly higher CNSRD rate (20.7 per cent) compared with the new men (12.3 per cent) (table 6). This relative risk of 1.68 was statistically significant ($P < 0.05$ by test of normal deviate).

Rates of CNSRD in young fire fighters increased with amount smoked; however, new fire fighters had lower rates for all smoking categories than experienced fire fighters (table 6). The experienced fire fighter who was a light or non-smoker had more than a 3-fold higher rate of CNSRD than the new fire fighter in the same smoking category; but the experienced fire fighter smoking more than 1 pack per day had a rate only 1.14 times that of the more-than-a-pack-a-day new fire fight-

TABLE 5

AGE SPECIFIC PREVALENCE OF CHRONIC NON-SPECIFIC RESPIRATORY DISEASE IN BOSTON FIRE FIGHTERS AND POLICEMEN, BY CIGARETTE SMOKING HISTORY

Age (years)	Cigarette Smoking History*	% in BFD† with CNSRD**		No. in Smoking Group	% in BPD with CNSRD		No. in Smoking Group
		Bronchitis	COPD		Bronchitis	COPD	
21–24	Never	5.6	5.6	18	—	—	0
	Ex	27.3	0.0	11	—	—	0
	Current	10.0	4.0	25	0.0	0.0	1
25–34	Never	8.5	0.0	71	0.0	0.0	4
	Ex	6.4	1.3	78	0.0	0.0	2
	Current	17.8	8.3	180	26.7	13.3	15
35–44	Never	5.8	0.0	52	0.0	0.0	15
	Ex	15.0	3.5	113	12.5	9.4	32
	Current	21.9	13.3	196	21.8	14.5	55
45–54	Never	5.9	4.8	187	10.5	5.3	19
	Ex	8.3	5.4	242	9.1	12.1	33
	Current	25.1	16.1	354	23.4	21.3	47
55+	Never	8.3	1.2	84	12.5	12.5	8
	Ex	6.2	13.6	81	0.0	16.7	18
	Current	18.4	22.4	76	10.5	36.8	19
Total no.		156	260	1,768	39	39	268

*Ignores pipe and/or cigar smoking.
†Boston Fire Department.
**Chronic non-specific respiratory disease.

er. The effect of fire fighting was partly obscured by heavy smoking.

Fire exposure indicators: Of the fire exposure indicators mentioned earlier, the use of oxygen at fires, lifetime number of "pastings," and lifetime number of times overcome bore a significant association with CNSRD. However, analysis by step-up multiple regression identified age as a covariable for each of these associations.

The 513 fire fighters who had required oxygen at a fire had an age-adjusted CNSRD rate of 27.6 per cent, compared to 21.1 per cent in those who did not ($P < 0.01$ by Mantel-Haenszel chi square). The CNSRD rate was 19.8 per cent for 862 men who had fewer than 10 pastings and 27.3 per cent for 906 men who had more than 10 pastings ($P < 0.01$ by Mantel-Haenszel chi square extension) (8). The age-adjusted prevalence rate for the 988 fire fighters who had never been overcome at a fire was 18.9 per cent and in-

TABLE 6

RATES OF CHRONIC NON-SPECIFIC RESPIRATORY DISEASE IN NEW AND EXPERIENCED FIRE FIGHTERS, BY CURRENT CIGARETTE CONSUMPTION

Current Cigarette Consumption	CNSRD Rate, % % Years on BFD		No.	Relative Risk of CNSRD of Experienced Compared to New Fire Fighter
	<0.5	0.5–14		
0–15	3.6 (2)*	11.6 (16)	193	3.22
15–24	15.0 (6)	21.3 (17)	120	1.42
25+	31.5 (6)	35.9 (29)	100	1.14
Total	12.3 (14)	20.7 (62)	413	1.68

*Numbers in parentheses represent number of cases.

creased to 33.8 per cent in those overcome 5 or more times while fighting fires ($P < 0.025$).

Manifestations of adverse exposure: The production of black mucus or "lungers" after exposure to fire and smoke, the delayed clearance of such mucus, and hemoptypsis were found to be associated with CNSRD. Each of these indicators was also associated with tobacco smoking.

The CNSRD rate, standardized for current cigarette consumption, when broken down by frequency of "lungers" in the previous year, increased from 19.2 per cent for the 536 men who had none to a maximum rate of 36.9 per cent for the 51 fire fighters who had coughed up "lungers" 50 or more times ($P < 0.01$). The 117 participants who produced black mucus even 12 hours after a fire had a CNSRD rate of 45.5 per cent (standardized for lifetime packs smoked). This contrasted to a rate of 24.8 per cent for 1,209 men who produced "lungers" for no more than 12 hours after a fire and a 15.0 per cent rate for the 441 who never coughed up "lungers" during their BFD career ($P < 0.01$).

The 30 participants with a history of hemoptysis had a 42.9 per cent CNSRD rate adjusted for lifetime packs smoked, as compared to a 24.8 per cent rate for those who did not ($P < 0.01$). However, hemoptysis was not related to fire fighting episodes.

Discussion

Since the study did not include all members of the BFD, it was of interest to examine the available data on the non-participants. Of the 179 Boston fire fighters not included in this study, 52 per cent could not be contacted, 28 per cent were not available because of injury or sickness, 16 per cent refused participation, and the remaining 4 per cent had left the Department. Although the participation was equal throughout the grades, those not included tended to cluster in the support functions. Non-participants were also older, with a mean age of 48.3 years. Therefore, it is believed that the prevalence rates reported in this study underestimate the true problem.

The strongest evidence for an association between the occupation of fire fighting and CNSRD was found in the analysis of the disease rates in the age group 35 years or younger. The higher prevalence rates in experienced fire fighters in this age group were most likely attributable to the occupation. Even in the heavy smoker, the occupational exposure adds to his risk of CNSRD. Occupational exposure for the light or non-smoker appeared to be sufficient to cause CNSRD.

Of the occupational exposure indicators that might be related to severe exposures, i.e., requiring oxygen, times overcome, and lifetime number of pastings, all showed an association with CNSRD. Indicators of severe exposure during the previous year, such as number of pastings or times overcome, were not associated with disease. Exposures thought to represent the most severe pulmonary insult, such as number of smoke inhalation episodes, hospitalizations, and lengths of hospitalizations, did not account for excess CNSRD.

The manifestations of exposure, such as production of "lungers" in the previous year, increased clearance time of smoke from the lung, and hemoptysis were more strongly associated with disease than with indicators of exposure. Certainly, mucus production and excessive lung clearance time are indicators of CNSRD. It is therefore possible that pre-existing disease accounted for "lungers" and slowed smoke clearance.

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