Risk of Death Among Honolulu Fire Fighters

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To examine possible health risks associated with fire fighting, a 20-year Proportionate Mortality Ratio (PMR) study was conducted involving all male fire fighters with at least one year of service in the City of Honolulu Fire Department. The observed cause of death, as determined by the death certificates, was compared statistically to the expected numbers of deaths for all males over age 20 in Hawaii's general population. Significant increases in risk of death were found for brain cancer (Risk Ratio = 3.78), prostate cancer (Risk Ratio = 2.61), and cirrhosis of the liver (Risk Ratio = 2.3). A significant decrease in mortality was found for lung disease with a risk ratio of 0.37. No deaths were attributed to suicide nor to a category which included allergic, endocrine and nutritional diseases. Since fire fighters are known to suffer exposure to carcinogens and toxins, additional studies would be helpful in order to clarify possible risks to health associated with fire fighting on a long-term exposure basis.

Introduction

Occupational mortality among fire fighters has not been the central focus in many epidemiologic studies. Fire fighters are exposed to a variety of potentially toxic materials such as benzene, acrolein, metal fumes, hydrogen chloride,and other irritant gases, albeit on an intermittent basis. The increased use of synthetic building materials has recently raised concerns as to possible health effects from exposure to the combustion of such products[1,2]. The consequences from these exposures may include both acute and chronic effects on health, such as respiratory disease, cardiovascular disease and certain types of cancer[3-6]. Unfortunately, little quantitative information is currently available on such exposures.

Our study evaluated the mortality of 205 male fire fighters of the City and County of Honolulu from 1969 to 1988. The accuracy of the mortality records enabled us to evaluate cause-specific mortality, both by duration of employment and ethnicity. Since Hawaiians and Caucasians account for nearly 90% of the study population, ethnic comparisons were limited to these two groups.

Methods

On the basis of death certificates, the distribution of deaths by cause was compared between that of fire fighters and that of other males older than 20-years-of-age in the State of Hawaii. The observed percentage of firemen deaths for each cause from 1969-1988 was compared to the expected. For example, 6.8% of all male deaths in Hawaii were due to cancer of the respiratory system. The expected number of deaths in the fireman population due to this cause, therefore, would be 0.068 x 205 = 14 deaths.

Risk ratios were calculated as the ratio of the percent of fireman deaths due to that cause divided by the percent of other male deaths in Hawaii due to that cause. Taylor's series 95% confidence intervals were computed automatically by a statistical software package[7]. If there were no deaths among the firemen ascribed to a certain cause, then confidence intervals were not calculated.

The significance of the ratios of firemen to other men was analyzed by the chi-square method. Comparisons of firemen to other men in Hawaii's general population must be approached with caution, since the ethnic composition of the firemen is different from that in the general population. The ethnic composition of the firemen population is predominantly either Caucasian or Hawaiian. Accordingly, specific comparisons on the basis of ethnicity were also made and the results are presented separately.

Results

The risk ratios in cause-specific mortality in fire fighters are shown in Table 1. Cardiovascular mortality showed a borderline elevation, with a risk ratio of 1.16 (95% CI = 1.10 - 1.32). Overall respiratory mortality, on the other hand, showed a significantly decreased RR of 0.37 (95% CI = 0.17 - 0.81). Cirrhosis of the liver showed a modest elevation at 2.30 (95% CI = 1.21 - 4.37). There were no reported deaths in either the suicide or the allergic, endocrine and nutritional disease categories as compared to the expected general population rates of 2.44 and 2.75, respectively. As for malignant neoplasms, cancer of the prostate showed an elevated risk ratio of 2.61 (95% CI = 1.38 - 4.97). Cancer of the brain had

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Table 1

Total Cause of death	ICD 9 Code	Observed (n=205) %	Expected %	Risk Ratio	95% CI	
All infective and parasitic diseases	001-139	0.00	1.34	*	0.03	1.71
All malignant neoplasms	140-209	28.29	23.70	1.19	0.96	1.49
Digestive system	150-159	8.78	8.71	1.01	0.65	1.57
Stomach	151	1.95	2.47	0.79	0.30	2.09
Colon	153	2.44	2.21	0.91	0.37	2.20
Respiratory system	160-163	8.78	6.85	1.28	0.82	2.00
Genito-urinary system	179-189	5.37	2.35	2.28	1.28	4.06
Prostate	185	4.39	1.68	2.61	1.38	4.97
Brain and other CNS	191-192	1.46	0.39	3.78	1.22	11.71
Lymphatic system	200-209	1.95	2.06	0.95	0.36	2.50
Allergic, endocrine, & nutritional diseases	240-279	0.00	2.75	*	0.00	2.84
All diseases of nervous system	320-389	0.98	1.17	0.83	0.21	3.31
All diseases of the circulatory system	390-459	52.20	45.15	1.16	1.10	1.32
Arteriosclerotic heart disease	410-414	29.76	27.24	1.09	0.89	1.35
All CNS vascular lesions	430-438	6.83	7.67	1.13	0.66	1.95
All respiratory diseases	460-519	2.93	7.92	0.37	0.17	0.81
All diseases of the digestive system	520-579	4.88	3.87	1.26	0.69	2.31
Cirrhosis of the Liver	571	4.39	1.91	2.30	1.21	4.37
All diseases of the genitourinary system	580-629	1.95	1.48	1.31	0.50	3.48
All external causes	800-998	6.83	10.11	0.68	0.41	1.12
All accidents	800-949	4.39	5.72	0.77	0.41	1.46
Suicide	950-959	0.00	2.44	*	0.00	3.20

Confidence intervals are calculated using Taylor series' approximation.
* = Risk ratio is indeterminate; in these cases, the CIs are estimated by Cornfield's method.

an elevated risk ratio of 3 . 78 (95% CI = 1.22 - 11.71). Overall cancer mortality was no different from that in the general population.

In both Caucasians and Hawaiians, the mortality increase in cardiovascular disease and hepatic cirrhosis, and the decrease in respiratory mortality seen in Table 1 in the group as a whole was reflected in the ethnic-specific analysis (Tables 2 and 3). However, because of the decreased sample sizes, only the risk ratio for mortality from cirrhosis of the liver in Hawaiians was statistically significant (RR = 2.99, 95% CI = 1.12 - 7.96). The risk ratio for brain cancer was significantly elevated only in Caucasians (RR = 4.15, 95% CI = 1.04 - 16.51). Although the Hawaiian cohort also had an increased risk ratio, it was based on only one observed death; this led to a very wide confidence interval (RR = 3.60, 95% CI = 0.49 - 26.46).

Selected cause-specific mortality based on the number of years employed as a fire fighter demonstrated no significant variation from the mortality in the general population.

Discussion

Our study presents several interesting findings. Mortality from respiratory disease was significantly lower in the fireman population as compared to that in the general population. Although this finding is consistent with data from the Ontario and Buffalo cohort studies[8,9], it is perhaps surprising in view of the increased likelihood of exposure to smoke and dust inhaled by firemen. One possible explanation for this finding might be an under-reporting of respiratory disease on death certificates (proposed by Musk and Mitchell[10,11]). Other possibilities include: 1) A general trend toward job transfers, to positions away from respiratory hazards for those fire fighters who were developing respiratory complaints; 2) the "healthy worker" factor[12-14].

As discussed below, the borderline risk ratio elevation for cardiovascular mortality was probably an aberration. The incidence of cirrhosis of the liver was elevated in both ethnic groups, but was statistically significant only in the Hawaiians. Compared with other ethnic groups in Hawaii, these two groups appear to be heavier consumers of alcohol[15], and this may be a cause.

The overall mortality from neoplasms was comparable to that in the general population; however there were statistically significant results in several cancer subgroups. Brain cancer deaths were significantly elevated in Caucasians, although not in Hawaiians. An excess of brain cancer mortality among fire fighters has also been found in several other studies. The Buffalo[9], Los Angeles[16], and the combined Oregon/Washington cohort study[17], all reported significant increases in brain cancer deaths. Milham's Washington State survey also showed an elevated PMR of brain cancer[18]. Thus, the findings in our study of this cancer are consistent with those in previous reports.

Prostate cancer was significantly elevated in both Hawaiians and Caucasians. An excess of prostate cancer was also found in the Los Angeles cohort study[16]. The results of other

(Continued) ▶

Table 2

Caucasian Cause of death	ICD 9 Code	Observed (n=72) %	Expected %	Risk Ratio	95% CI	
All infective and parasitic diseases	001-139	0.00	1.17	*		
All malignant neoplasms	140-209	26.39	23.83	1.11	0.75	1.63
Digestive system	150-159	4.17	5.93	0.70	0.23	2.13
Stomach	151	1.39	1.19	1.17	0.17	8.20
Colon	153	1.39	1.95	0.71	0.10	5.02
Respiratory system	160-163	8.33	7.62	1.09	0.51	2.36
Genito-urinary system	179-189	9.72	3.22	3.02	1.49	6.15
Prostate	185	8.33	2.25	3.70	1.71	8.02
Brain and other CNS	191-192	2.78	0.67	4.15	1.04	16.51
Lymphatic system	200-209	1.39	2.11	0.66	0.09	4.63
Allergic, endocrine, & nutritional diseases	240-279	0.00	1.98	*		
All diseases of nervous system	320-389	2.78	1.28	2.18	0.55	1.86
All diseases of the circulatory system	390-459	48.61	42.19	1.15	0.91	1.46
Arteriosclerotic heart disease	410-414	33.33	26.84	1.24	0.90	1.72
All CNS vascular lesions	430-438	6.94	5.25	1.32	0.57	3.09
All respiratory diseases	460-519	4.17	7.02	0.59	0.20	1.80
All diseases of the digestive system	520-579	6.94	4.83	1.44	0.62	3.36
Cirrhosis of the Liver	571	5.56	2.87	1.94	0.74	5.05
All diseases of the genitourinary system	580-629	0.00	0.98	*		
All external causes	800-998	6.94	13.77	0.50	0.22	1.18
All accidents	800-949	4.17	7.45	0.56	0.18	1.70
Suicide	950-959	0.00	3.23	*		

Confidence intervals are calculated using Taylor series' approximation.
* = Risk ratio is indeterminate.

studies have not shown this increased mortality due to prostate cancer.

There were no suicide cases among fire fighters in our study; other studies have shown low suicide rates as well. Because of their daily responsibility for saving lives, fire fighters may have higher self-esteem, greater job satisfaction, and good social support networks that together foster improved psychological coping mechanisms during times of increased stress or emotional depression. Perhaps because of the small size of the study population, we can offer no plausible explanation for the paucity of deaths in the allergic, endocrine and nutritional disease category.

Risk by trend analysis according to length of employment was considered. However, it was not possible to determine the significance of age and length of employment on mortality, given the small number in the fireman population, and because comparable data was not available in the general population. We looked at a comparison between age adjusted employment of less than 20 years, 20 to 27 years, and 28+ years, but found no significant differences. If, however, exposure-related disease occurred within the first 20 years of employment, then a significant difference in comparison with the other categories (ie, 20 to 27 years and 28+ years) might not have been detected.

Our study has a number of limitations. First, biases may occur from the use of death certificates as a source of data[19]. The cause of death may roughly lead to a misclassification and, therefore, may not be reflected in the correct number of cause-specific deaths. This might occur, for example, when a person dying from a myocardial infarction is not recognized as having terminal cancer as the underlying cause of death.

Second, PMR studies, in general, tend to overestimate some cause-specific deaths while at the same time underestimating others. This is because cause-specific PMRs must add up to 100; high PMRs in some categories will result in low PMRs in other areas. The marginal increase seen in total cardiovascular mortality for example, may be reflective of low risk ratios in other categories.

Third, it should be noted that the vast majority of fire fighters in our study are either of Caucasian or Hawaiian descent; this predominant ethnic make-up is not reflective of the general population here in Hawaii. Therefore, total mortality rates must be judged with this in mind. However, because of the consistency in the findings in both Caucasians and Hawaiians, the findings overall were comparable. This indeed may not be reflected in other ethnic groups.

Finally, risk of disease in any occupational group may be influenced in part by the characteristics of the individuals who select that profession, the so-called healthy-worker effect. This potential bias could be minimized in future studies by comparing mortality data in a more closely related group, such as city policemen.

Conclusion

An attempt has been made in our study to point out possible risk of death associated with fire fighting caused by exposure to known toxic chemicals and carcinogens present in incendiary smoke. We hope that this PMR study will lead to

Table 3

Hawaiian Cause of death	ICD 9 Code	Observed (n=101) %	Expected %	Risk Ratio	95% CI	
All infective and parasitic diseases	001-139	0.00	1.49	*		
All malignant neoplasms	140-209	28.71	23.40	1.23	0.90	1.67
Digestive system	150-159	8.91	7.60	1.17	0.63	2.20
Stomach	151	1.98	2.61	0.76	0.19	3.01
Colon	153	0.00	1.29	*		
Respiratory system	160-163	8.91	9.32	0.96	0.51	1.79
Genito-urinary system	179-189	3.96	1.13	3.52	1.32	9.36
Prostate	185	2.97	0.89	3.35	1.07	10.45
Brain and other CNS	191-192	0.99	0.27	3.60	0.49	26.46
Lymphatic system	200-209	1.98	2.05	0.97	0.24	3.84
Allergic, endocrine, & nutritional diseases	240-279	0.00	4.11	*		
All diseases of nervous system	320-389	0.00	1.01	*		
All diseases of the circulatory system	390-459	52.48	45.40	1.16	0.96	1.39
Arteriosclerotic heart disease	410-414	27.72	28.81	0.96	0.70	1.32
All CNS vascular lesions	430-438	2.97	5.56	0.53	0.18	1.63
All respiratory diseases	460-519	2.97	5.41	0.55	0.18	1.68
All diseases of the digestive system	520-579	3.96	3.32	1.19	0.45	3.14
Cirrhosis of the Liver	571	3.96	1.32	2.99	1.12	7.96
All diseases of the genitourinary system	580-629	2.97	1.22	2.43	0.78	7.52
All external causes	800-998	7.92	12.32	0.64	0.33	1.25
All accidents	800-949	4.95	7.13	0.69	0.29	1.64
Suicide	950-959	0.00	2.31	*		

Confidence intervals are calculated using Taylor series' approximation.
* = Risk ratio is indeterminate.

further investigation based on more detailed information.

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