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P1134

## ORIGINAL ARTICLES

### Race-Specific Cancer Mortality in US Firefighters: 1984-1993

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*A mortality odds ratio (MOR) study of race-specific cancer risk among firefighters was conducted using 1984- 1993 death certificate data from 24 states. The Bureau of the Census Index of Industries and Occupations was used to code occupation on death certificates. The overall cancer mortality was slightly elevated among white firefighters (MOR = 1.1; 95% confidence interval [CI] = 1.1- 1.2), but the increase in overall cancer mortality among black firefighters was not significant (MOR = 1.2; 95% CI = 0.9- 1.5). Only prostate cancer risk was elevated in both groups (whites: MOR = 1.2; 95% CI = 1.0- 1.3; blacks: MOR = 1.9; 95% CI = 1.2- 3.2). Among white firefighters, elevated site-specific cancer mortality risks were found for the following cancer sites: lip (MOR = 5.9; 95% CI = 1.9- 18.3), pancreas (MOR = 1.2; 95% CI = 1.0- 1.5), soft tissue sarcoma (MOR = 1.6; 95% CI = 1.0- 2.7), melanoma (MOR = 1.4; 95% CI = 1.0- 1.9), kidney and renal pelvis (MOR = 1.3; 95% CI = 1.0- 1.7), non-Hodgkin's lymphoma (MOR = 1.4; 95% CI = 1.1- 1.7), and Hodgkin's disease (MOR = 2.4; 95% CI = 1.4- 4.1). We also observed a slightly elevated risk for bronchus and lung cancer (MOR = 1.1; 95% CI = 1.0- 1.2). Among black firefighters, excess risks were found for cancers of the brain and central nervous system (MOR = 6.9; 95% CI = 3.0- 16.0), colon (MOR = 2.1; 95% CI = 1.1- 4.0), and nasopharynx (MOR = 7.6; 95% CI = 1.3- 46.4). Future studies are needed to confirm the existence of*

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***differential cancer mortality risks among firefighters of different race/ethnic subpopulations.***

Firefighters are routinely exposed to a variety of carcinogenic substances such as benzene, polycyclic aromatic hydrocarbons (eg, benzo(a)pyrene), formaldehyde, asbestos, and metals (eg, chromium and cadmium) that are contained in fire smoke or building debris. [1] [2] These substances have been associated with increased risks for some site-specific neoplasms, such as lung and bladder cancer, in other populations. [3] Given these occupational exposures, excesses for lung and bladder cancer would be expected among firefighters. There is considerable evidence showing that the risks of lung and bladder cancer are slightly elevated in firefighters, although most studies did not achieve statistical significance. [4] In one study, Guidotti reported that the standardized mortality ratio (SMR) for lung cancer in firefighters with more than 35 years of exposure to fire fighting (weighted) was 408 ( $P < 0.05$ ). [5] Elevated risks for brain, renal, and lymphohematopoietic cancers in firefighters have also been reported in numerous studies. [6] [7]

In the United States, the firefighter profession has historically been composed of non-Hispanic white males. An increasing proportion of men (and women) from other race/ethnic groups, however, have joined this profession over the past 30 years. To date, race/ethnic specific cancer mortality among firefighters has not been examined. This study compared mortality odds ratios (MORs) between white male firefighters and their black counterparts, using death certificates from a 24-state occupational mortality database for the years 1984 through 1993.

P1135

**TABLE 1 -- Race-Specific Mortality Odds Ratios (MOR),<sup>a</sup> by Selected Cancer Sites, for Male White and Black US Firefighters: 1984-1993** †

Cancer Site	White Firefighters			Black Firefighters		
	Number	MOR	95% CI	Number	MOR	95% CI
All cancers	1817	1.1	1.1 -1.2	66	1.2	0.9 -1.5
Lip	3	5.9	1.9 -18.3	0		
Salivary glands	3	1.3		0		
Nasopharynx	0			1	7.6	1.3 -46.4
Esophagus	37	0.9	0.7 -1.3	4	1.4	
Stomach	52	1.2	0.9 -1.6	3	1.2	
Colon	149	1.0	0.9 -1.2	9	2.1	1.1 -4.0
Rectum	27	1.1	0.8 -1.6	0		
Liver	31	1.2	0.9 -1.7	0		
Biliary tract	10	1.1	0.6 -2.1	0		
Pancreas	88	1.2	1.0 -1.5	5	2.0	0.9 -4.6
Nasal cavity	2	1.2		0		
Larynx	13	0.8	0.4 -1.3	0		
Bronchus and lung	633	1.1	1.0 -1.2	15	0.8	0.5 -1.3

Pleura	4	1.8		0		
Bones and joints	3	1.0		0		
Soft tissue sarcoma	14	1.6	1.0 -2.7	0		
Melanoma of skin	35	1.4	1.0 -1.9	0		
Other skin	9	1.0	0.5 -1.9	0		
Prostate	189	1.2	1.0 -1.3	16	1.9	1.2 -3.2
Testis	1	0.6		0		
Bladder	48	1.2	0.9 -1.6	1	1.3	
Kidney and renal pelvis	49	1.3	1.0 -1.7	0		
Ureter	1	1.0		0		
Brain and central nervous system	41	1.0	0.8 -1.4	5	6.9	3.0 -16.0
Thyroid gland	3	1.3		0		
Non-Hodgkin's lymphoma	76	1.4	1.1 -1.7	1	0.8	
Hodgkin's disease	13	2.4	1.4 -4.1	0		
Multiple myeloma	28	1.1	0.8 -1.6	1	0.8	
Leukemia	60	1.1	0.8 -1.4	0		

\* Adjusted for age and time of death.

† 95% CI, 95% confidence interval.

## Materials and Methods

Since 1984, the National Cancer Institute, the National Institute for Occupational Safety and Health, and the National Center for Health Statistics have supported the coding of industry and occupational titles on death certificates in 24 states (Colorado, Georgia, Idaho, Indiana, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin).<sup>[8]</sup> The Bureau of the Census Index of Industries and Occupations was used to code occupation on death certificates.<sup>[9]</sup> From 1984 to 1993, among a total of 6607 reported male firefighter deaths, 1883 (28.5%) cancer deaths were identified, among which 1817 (96.5%) occurred in whites and 66 (3.5%) in blacks. Analyses were limited to males since the number of female firefighter deaths obtained during this period was small ( $n = 28$ ).

MORs<sup>[10]</sup> for white and black firefighters were calculated using a statistical program developed by the National Cancer Institute.<sup>[11]</sup> In calculating expected numbers, all causes of deaths except cancers were used as the reference from the same occupational mortality database where firefighters' cancer deaths were obtained. All MORs were adjusted by year and age at event.

## Results

MOR results are presented in Table 1. For white firefighters ( $n = 1817$ ), significant excess risks were found for the cancer of all sites combined (MOR = 1.1; 95% confidence interval [CI] = 1.1-1.2), lip (MOR = 5.9; 95% CI = 1.9-18.3), pancreas (MOR = 1.2; 95% CI = 1.0-1.5), bronchus and lung (MOR = 1.1; 95% CI = 1.0-1.2), soft tissue sarcoma (MOR = 1.6; 95% CI = 1.0-2.7), melanoma (MOR = 1.4; 95% CI = 1.0-1.9), prostate (MOR = 1.2; 95% CI = 1.0-1.3), kidney and renal pelvis (MOR = 1.3; 95% CI = 1.0-1.7), non-Hodgkin's lymphoma (MOR = 1.4; 95% CI = 1.1-1.7), and Hodgkin's disease (MOR = 2.4;

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P1136

95% CI = 1.4-4.1). For black firefighters ( $n = 66$ ), the excess risks were found for the cancer of brain and central nervous system (MOR = 6.9; 95% CI = 3.0-16.0), colon (MOR = 2.1; 95% CI = 1.1-4.0), prostate (MOR = 1.9; 95% CI = 1.2-3.2), and nasopharynx (MOR = 7.6; 95% CI = 1.3-46.4). Except for prostate cancer risk, which was elevated in both groups, white and black firefighters exhibited different risk patterns for most site-specific cancers.

## Discussion

Elevated mortality was observed among white male firefighters for the cancer of all sites combined and for cancers of the lip, pancreas, bronchus and lung, prostate, kidney and renal pelvis, as well as for soft tissue sarcoma, melanoma, non-Hodgkin's lymphoma, and Hodgkin's disease. Although they were all statistically significant, the cancer of all sites combined and bronchus and lung cancer showed only a 10% increased risk. Among black firefighters, excess risks were seen for cancers of the nasopharynx, colon, prostate, and brain. With the exception of prostate cancer, white and black firefighters exhibited differing patterns for certain site-specific cancer mortality risks, particularly for brain cancer.

The association between firefighting occupations and cancer has been intensively explored because firefighters are frequently exposed to a variety of carcinogenic substances in the course of their work. The previous firefighters' cancer studies, however, were largely limited only to white firefighters. Many epidemiological studies have documented a slightly elevated overall cancer risk in firefighters,<sup>[5] [12] [13] [14]</sup> although none of them have achieved significance. The study presented here demonstrated a slight but significant increase in overall cancer risk among white firefighters. Such an increase in overall cancer risk was not significant among black firefighters. Increased risks for various sites of cancer, such as the brain, melanoma/skin, kidney, and non-Hodgkin's lymphoma, have been reported in numerous firefighter studies.<sup>[2] [5] [13] [14] [15] [16] [17]</sup> The results from the study presented here corroborate the elevated risks for these cancers among white firefighters, except for brain cancer, for which only black firefighters' risk was significantly increased. Data on other sites of cancer (such as colon, multiple myeloma, and bladder) have been inconsistent.<sup>[2] [5] [12] [18] [19]</sup> The present study suggests a slightly increased risk for lung cancer among white firefighters and a twofold risk for colon cancer among black firefighters but does not find any excess risks for bladder cancer and multiple myeloma in either race group. In addition, our data suggest increased mortality risks among white firefighters for cancers of the prostate, pancreas, and soft tissue sarcoma, which have only been sparsely documented in the literature.<sup>[5] [13]</sup> Further studies are needed to examine firefighters' risk for these cancers.

It has long been recognized that cancer rates show enormous variation in race and ethnicity. [20] [21] [22] [23] In the United States, the mortality rates in the general population for overall cancer and for specific sites of cancer in white males are significantly different from those in black males. Black men have higher mortality rates for overall cancer and for site-specific cancers such as those of the oral cavity and pharynx, stomach, pancreas, lung and bronchus, and prostate; whites have higher mortality rates for cancer sites such as melanoma of the skin, kidney and renal pelvis, brain and central nervous system, non-Hodgkin's lymphoma, and Hodgkin's disease. The mortality rates for the remaining cancer sites (such as the nasopharynx, colon and rectum) were similar in the two groups. [20] In the present study of black and white firefighters, however, these race/ethnic differences in site-specific cancer mortality risks were only seen for prostate cancer ( $MOR_{blacks} > MOR_{whites}$ ), melanoma ( $MOR_{blacks} < MOR_{whites}$ ), non-Hodgkin's lymphoma ( $MOR_{blacks} < MOR_{whites}$ ), and Hodgkin's disease ( $MOR_{blacks} < MOR_{whites}$ ). For other sites, including the brain, lip, lung, pancreas, nasopharynx, soft tissue sarcoma, and colon, the observed firefighters' racial mortality risk differences do not agree with those observed in the general US population. For example, black firefighters have excess mortality risks relative to white firefighters for cancers of the brain, nasopharynx, and colon, while in the general population, blacks have less risk than whites for these cancers. [20] The same is true for lung and pancreatic cancer in white firefighters. Many factors--such as differences in social, cultural, economic, and physical environments and genetic susceptibility--have been postulated to explain this race/ethnic variation in cancer rates in the general population. [23]

Although the present MOR study is the largest to date in this occupational group, several study limitations should be noted. **Dosemeci** and Blair have discussed these limitations in detail. [24] First, some excess risks may simply be due to chance because of the small number of cancer deaths. For example, a significantly increased risk of nasopharyngeal cancer was observed among black firefighters, but this result was based on only a single death; similarly, a sixfold excess of lip cancer in white firefighters was based on three deaths. These large point estimates should be interpreted with caution since they are based on very few cancer deaths (ie, <5) and therefore have wide confidence intervals. Second, because of the small number of deceased black firefighters included in the study (only 66, compared with 1817 white firefighters), interpretations regarding the racial cancer mortality patterns must await replication in studies with larger numbers of minority firefighters.

Since data were based on death certificates, without information on

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P1137

the population at risk, the MOR was used to approximate the SMR in the present study. Although the MOR is an important tool in examining mortality risks in occupational groups, [25] [26] [27] [28] [29] [30] it is considered bias-prone because of misclassification of both the cause of death and the exposure arising from the use of death certificates. Several studies have shown that the accuracy of cancer death certificates varies by cancer site, as does the percentage agreement in occupation by industry. [31] [32] [33] [34] In addition, the MOR is equivalent to the SMR only under the assumption that the exposure (ie, fighting fires) is not associated with the reference cause of death (ie, all causes other than cancer). [10] [25] This may not be the case in our analyses, as firefighters also have a marked excess mortality in accidental causes and a decreased risk in heart and respiratory diseases. [5] [18] Finally, the results of this study could also be affected by the lack of information on confounding factors, such as lifestyle--including smoking, alcohol, and diet--socioeconomic status, or other occupational and environmental exposures related to disease outcomes. Despite these limitations, death certificate data are useful for generating hypotheses in occupational epidemiology because they are readily available and are based on large numbers and thus are stable.

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In summary, this study evaluated cancer mortality risks by race among US firefighters in 24 states. Different cancer mortality patterns among male black and white firefighters were observed. Black firefighters have excess risks for cancers of the colon, brain, prostate, and nasopharynx, whereas whites have higher risks for cancers of the lip, bronchus and lung, pancreas, prostate, kidney and pelvis, melanoma, non-Hodgkin's lymphoma, and Hodgkin's disease. Future studies are necessary to confirm the existence of differential cancer mortality patterns among firefighters of different race/ethnic subpopulations.

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P1138

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