

UNIFORMED PROFESSIONAL FIRE FIGHTERS ASSOCIATION OF CONNECTICUT

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Dear Senator Prague, Representative Ryan and members of the Labor and Public Employees Committee,

My name is Paul J. Rapanault. I am the Director of Legislative and Political Affairs for the Uniformed Professional Fire Fighters Association of Connecticut. Our 4,000 members serve in 50 fire departments throughout the state.

I am addressing you today in **SUPPORT** of **H.B. 6194 AAC ADDITIONAL WORKERS' COMPENSATION PRESUMPTIONS FOR FIREFIGHTERS, POLICE AND EMERGENCY RESCUE WORKERS.**

Fire fighters are exposed on a daily basis to stress, smoke, heat and various toxic substances. As a result, fire fighters are far more likely to contract cancer than other workers. And as fire fighters increasingly assume the role of the nation's leading providers of emergency medical services, they are also exposed to infectious diseases. Cancer and infectious disease are now among the leading causes of death and disability for fire fighters, and numerous studies have found that these illnesses are occupational hazards of fire fighting.

In recognition of this link, more than 40 states have enacted presumptive disability laws that presume that certain cancers and certain infectious diseases contracted by fire fighters are job-related for purposes of workers' compensation and disability retirement unless proven otherwise. No such law covers fire fighters in Connecticut.

Under H.B. 6194, fire fighters must be able to pinpoint the precise incident or exposure that caused a disease in order for it to be considered job-related. This burden of proof is extraordinarily difficult for fire fighters to meet because they respond to a wide variety of emergency calls, constantly working in different environments under different conditions. As a result, very few cases of occupational disease contracted by fire fighters have been deemed to be service-connected. This DIRECTLY CONTRADICTS what opponents of this legislation advance when they say that this bill will cause a multi-million dollar mandate that will break municipalities. THAT IS JUST NOT TRUE.

Please look at the information I have attached and vote to support this legislation. It is fair and contrary to what our opponents will tell you, the sky will not fall if you do.

Thank you for your consideration.

Paul J Rapanault
Legislative/Political Affairs

Study: Firefighters face higher cancer rates

By JAMES WALKER

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REGION — One of the most dangerous occupations in the world is becoming even more hazardous for its workers — but a new study suggests that the people we expect to protect us are not being adequately protected against the risks of their profession.

A study released by the University of Cincinnati has determined that firefighters are at a greater risk of developing four different types of cancer than the general population — and also suggests the protective equipment firefighters are using is insufficient in protecting them against cancer-causing agents.

What are you looking for?

In a report by the university's environmental health department, researchers found that firefighters are twice as likely to develop testicular cancer and have significantly higher rates of non-Hodgkin's lymphoma and prostate cancer than people in other professions — and overall found 10 cancers that were either possibly or probably related to firefighting.

The report also confirmed previous findings that firefighters are at greater risk for multiple myeloma, which is a cancer of the bone marrow for which there is currently no known cure.

The research is the largest comprehensive study to date investigating cancer risk associated with working as a firefighter and concludes that firefighters need better protection on the job.

The findings were published in the November issue of the Journal of Occupational and Environmental Medicine.

Dr. Andrea Ruskin, a hematologist and oncologist at the Whittingham Cancer Center at Norwalk Hospital, said while "it's nothing that has caught our eye, it's no surprise.

"They are exposed to so much," she said. Ruskin said firefighters' exposure to certain carcinogens can have a devastating effect on their health.

"They can get DNA damage," she said. However, Ruskin said not every firefighter on the job will get cancer, much the same as that not every smoker will develop lung cancer.

"It's a combination of exposure and genetic predisposition," she said.

Research shows that environment, including diet and lifestyle, causes up to 90 percent of all cancer.

The team of researchers at Cincinnati analyzed information on 110,000 firefighters from around the nation — most of them full-time, white male workers — from 32 previously published scientific studies.

Researchers believe there is a direct correlation between the chemical exposures firefighters experience on the job and their increased risk for cancer.

Fire Chief Denis McCarthy said there have been "dramatic changes" in the equipment that firefighters at the Norwalk Fire Department use for protection.

McCarthy said during the past 10 years, there have been significant upgrades in the breathing apparatus firefighters use, which went from "one-size-fits-all" to a custom fit. New regulations also have prevented recontamination by adopting standards to clean firefighters' "turn-out gear," which are the coats, pants and helmets firefighters wear; and all fire stations are equipped with diesel exhaust removal systems.

According to the study, firefighters are exposed to many compounds that the International Agency for Research on Cancer has designated carcinogens. These include benzene, diesel engine exhaust, chloroform, soot, styrene and formaldehyde.

The substances can be inhaled or absorbed through the skin and occur both at the scene of a fire and in the firehouse — where idling diesel fire trucks produce exhaust.

"Stations are not only living quarters, but it's a garage, too," McCarthy said. "We have the latest standard for protection against airborne agents."

Researchers at Cincinnati studied the risk for 20 different cancers.

The epidemiologists found that half the studied cancers — including testicular, prostate, skin, brain, rectum, stomach and colon cancer, non-Hodgkin's lymphoma, multiple myeloma and malignant melanoma — were associated at varying levels of increased risk with firefighting.

Researchers found firefighters have a 100-percent higher risk of developing testicular cancer, a 50-percent higher risk for multiple myeloma and non-Hodgkin's lymphoma, and for prostate cancer it's a 28-percent increased risk, compared with nonfirefighters.

"There's a critical and immediate need for additional protective equipment to help firefighters avoid inhalation and skin exposures to known and suspected occupational carcinogens," said Dr. James Lockey, a professor of environmental health and pulmonary medicine at Cincinnati, and the lead researcher of the study. "In addition, firefighters should meticulously wash their entire body to remove soot and other residues from fires to avoid skin exposure."

Lockey said that firefighters exposure to carcinogenic toxins "occur not when they are in the fire, but when they are in the vicinity of the fire."

According to information from the American Cancer Society, workplace exposure is often considerably higher than general environmental exposure. And while the society does not play a direct role in classifying or identifying carcinogens, it does provide information and guidance on environmental cancer risks.

The effect of environmental exposure was brought home in a recent report that found that nearly 70 percent of rescue personnel and workers who responded to the Sept. 11, 2001, terrorist attacks on the World Trade Center suffered from lung problems during and after the recovery efforts.

Mike Dubron, president and founder of the Los Angeles-based Firefighter Cancer Network, said his organization will establish regional directors throughout the nation this year.

Dubron said he established the network because firefighters are largely "alpha males that don't reach out to others" about private health issues.

"All (cancers) are alarmingly increasing for firefighters," he said.

Amanda Harper, a spokeswoman with the public relations department at the University of Cincinnati, said the situation with firefighters is very real.

"These people are public servants and need to be protected," she said.

For more information on the Firefighter Cancer Network, call 1-866-994-3276; or e-mail mdubron@lacofd.org; or visit the Web site at www.firefightercancernetwork.org.



Study: Firefighters More Prone to Cancer Risks

Nov 22, 2006 12:00 AM, By Katherine Torres

Researchers from the University of Cincinnati have discovered that firefighters may be more likely to develop certain types of cancer than workers in other professions.

Article Tools

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According to findings published in the November edition of the *Journal of Occupational and Environmental Medicine*, Grace LeMasters, Ph.D., Ash Genaidy, Ph.D., and James Lockey, M.D., found that firefighters are twice as likely to develop testicular cancer and have significantly higher rates of non-Hodgkin's lymphoma and prostate cancer than non-firefighters. The researchers also confirmed previous findings that firefighters are at greater risk for multiple myeloma.

The University of Cincinnati-led team looked at 32 previously published studies covering 110,000 firefighters – most of them full-time, white, male workers – to determine the comprehensive health effects and correlating cancer risks of their profession.

Firefighters Are Exposed to Many Carcinogens

LeMasters explained that firefighters are exposed to many compounds designated as carcinogens by the International Agency for Research on Cancer – including benzene, diesel engine exhaust, chloroform, soot, styrene and formaldehyde.

These substances can be inhaled or absorbed through the skin and occur both at the scene of a fire and in the firehouse, where idling diesel fire trucks produce diesel exhaust.

"We believe there's a direct correlation between the chemical exposures firefighters experience on the job and their increased risk for cancer," said LeMasters, who is a professor of epidemiology and biostatistics at the University of Cincinnati (UC) and was the lead author of the study.

UC epidemiologists found that half of the studied cancers – including testicular, prostate, skin, brain, rectum, stomach and colon cancer; non-Hodgkin's lymphoma; multiple myeloma; and

malignant melanoma – were associated with firefighting on varying levels of increased risk.

More Protective Measures Needed

According to the researchers, their findings suggest that the protective equipment firefighters have used in the past hasn't done a good job in protecting them against the cancer-causing agents they encounter in their profession.

"Firefighters work in an inherently dangerous occupation on a daily basis," LeMasters said. "As public servants, they need – and deserve – additional protective measures that will ensure they aren't at an increased cancer risk."

"There's a critical and immediate need for additional protective equipment to help firefighters avoid inhalation and skin exposures to known and suspected occupational carcinogens," said Lockey, who is a professor of environmental health and pulmonary medicine at UC. "In addition, firefighters should meticulously wash their entire body to remove soot and other residues from fires to avoid skin exposure."

Find this article at:

http://www.ehstoday.com/fire_emergencyresponse/ehs_imp_43228

Check the box to include the list of links referenced in the article.

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Breaking News Impact - The Oregonian - OregonLive.com

Oregon firefighters get cancer coverage in House vote

Posted by Harry Esteve, The Oregonian February 10, 2009 11:35AM

SALEM - While dozens of firefighters looked on, the House overwhelmingly voted to extend worker compensation claims to cover a variety of cancers thought to be caused by on-duty smoke inhalation and exposure to dangerous chemicals.

Everyone knows firefighting is a dangerous job, said Rep. Greg Matthews, D-Gresham, the lead supporter of the bill and a firefighter himself.

But "firefighter cancer should not be accepted or dismissed as being part of the job," he said.

House Bill 2420, which passed 55-1, expands the types of cancer covered under state worker compensation law. In addition to respiratory and cardiovascular diseases, the bill add 12 types of cancers to firefighter coverage, including brain, colon, stomach, testicular, prostate, throat, mouth, rectal, and breast cancer; multiple Myeloma, non-Hodgkin's lymphoma, and leukemia.

Firefighters wear protective gear, but it's sometimes not enough to ward off chemicals and particles that can cause disease, Matthews said. Entering a burning house can mean exposure to a toxic stew of carcinogens.

"They're into our skin, through our gloves. They're down our necks," he said. "You can't be 100 percent protected."

The main concern over the bill is how much it could end up costing the state. A staff summary says it's hard to know the financial impact. Each additional claim could end up costing as much as \$1 million in medical expenses, which could lead to higher worker compensation premiums.

But lawmakers said the extra cost, if there is one, would be worth it.

"It's time to take care of those who take care of us," said Rep. Jeff Barker, D-Aloha.

The bill now goes to the Senate, where it's expected to pass.

- *Harry Esteve*; harryestev@news.oregonian.com

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Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies

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Objective: The objective of this study was to review 32 studies on firefighters and to quantitatively and qualitatively determine the cancer risk using a meta-analysis. **Methods:** A comprehensive search of computerized databases and bibliographies from identified articles was performed. Three criteria used to assess the probable, possible, or unlikely risk for 21 cancers included pattern of meta-relative risks, study type, and heterogeneity testing. **Results:** The findings indicated that firefighters had a probable cancer risk for multiple myeloma with a summary risk estimate (SRE) of 1.53 and 95% confidence interval (CI) of 1.21–1.94, non-Hodgkin lymphoma (SRE = 1.51, 95% CI = 1.31–1.73), and prostate (SRE = 1.28; 95% CI = 1.15–1.43). Testicular cancer was upgraded to probable because it had the highest summary risk estimate (SRE = 2.02; 95% CI = 1.30–3.13). Eight additional cancers were listed as having a “possible” association with firefighting. **Conclusions:** Our results confirm previous findings of an elevated metarelative risk for multiple myeloma among firefighters. In addition, a probable association with non-Hodgkin lymphoma, prostate, and testicular cancer was demonstrated. (J Occup Environ Med. 2006;48:1189–1202)

During the course of their work, firefighters are exposed to harmful substances at the fire scene as well as at the firehouse. At the fire scene, firefighters are potentially exposed to various mixtures of particulates, gases, mists, fumes of an organic and/or inorganic nature, and the resultant pyrolysis products.^{1,2} Specific potential exposures include metals such as lead, antimony, cadmium, uranium, chemical substances, including acrolein, benzene, methylene chloride, polyaromatic hydrocarbons, perchlorethylene, toluene, trichloroethylene, trichlorophenol, xylene, formaldehydes, minerals such as asbestos, crystalline, and noncrystalline silica, silicates, and various gases that may have acute, toxic effects.^{1,2} In some situations, respiratory protection equipment may be inadequate or not felt to be needed resulting in unrecognized exposure.³ At the firehouse where firefighters spend long hours, exposures may occur to complex mixtures that comprise diesel exhaust, particularly if trucks are run in closed houses without adequate outside venting. In light of the World Trade Center disaster, concerns have reemerged and heightened related to building debris particle exposures from pulverized cement and glass, fiberglass, asbestos, silica, heavy metals, soot, and/or organic products of combustion.³

To date, only one meta-analysis conducted by Howe and Burch in 1990 examined the extent of cancer risk among firefighters in 11 mortality studies.⁴ They reported that there was an increased association with the occurrence of brain tumors, malignant melanoma, and multiple myeloma with the evidence in favor of

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This study was supported in part by a grant from the Ohio Bureau of Workers Compensation.

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Final Likelihood of Cancer Risk

Fig. 1. Likelihood of cancer risk.

first step, the strength of the meta-analysis by each study type (eg, SMR, PMR) was assigned a score. The score of “++” was assigned if the metarelativ risk was statistically significant and greater than 1.1. The score of “+” was assigned if the metarelativ risk was not statistically significant, but the point risk estimate was greater than 1.1. The score of “-” was assigned if the metarelativ risk was not statistically significant, and the point risk estimate was equal to or less than 1.1. At the second step, these scores were used to assign a probable, possible, or unlikely designation for the pattern of metarelativ risk association. A “probable” was assigned to the cancer-specific site if one metarelativ risk (ie, mSMR, mPMR, mSMR and PMR, mRR, mSIR, mOR) was statistically significant (score of ++) and at least another was greater than 1.1 (score of +). A “possible” assignment was given if only one metarelativ risk was available and was statistically significant (score of ++) or if at least two metarelativ risks were greater than 1.1 but were not statistically significant (score of +). “Not likely” was assigned if the cancer-specific site did not meet the probable or possible criteria.

The second criterion examined the “study type” used to generate metarelativ risks. If the metarelativ risk estimate reached statistical significance (score of ++), based primarily on PMR studies, the level was downgraded. PMR studies do not measure the risk of death or death rates but rather the relative frequency of that particular cause among all causes of death. Hence, the limitation of a PMR study is that the estimate may be abnormally low or high based on the overall increase or decrease in mortality and not due to the cause of interest.⁶ Also, if the mSMR point risk estimate was not significant and ≤ 1.1 (-), the level was downgraded. The third criterion used for generating the likelihood of cancer risk was an assessment of “inconsistency” among studies. Heterogeneity testing as described in statistical methods was used to evaluate

inconsistency. The level was downgraded if heterogeneity (inconsistency) testing among all combined studies had an $\alpha \leq 0.10$.

Statistical Methods

For all cancer outcomes having two or more studies, the observed and expected values from each study were summed and a metarelativ risk estimate (mRR) was calculated. An mRR was calculated for each cancer by each study type, eg, SMR studies and as a summary metarelativ risk across all study types. The mRR was defined as the ratio of the total number of observed deaths or incident cases to the total number of expected deaths or incident cases as follows:

$$mRR = \frac{\sum_{i=1}^n O_i}{\sum_{i=1}^n E_i}$$

where O_i denotes observed deaths (cases) in each individual study, E_i denotes expected deaths (cases), and n is the total number of studies.⁷ The 95% confidence interval (CI) of mRR may be computed using the Poisson probability distribution as described by Breslow and Day.⁸ The standard error (SE) for the metarelativ risk is calculated as $SE = \frac{1}{\sqrt{\sum W_i}}$ where W_i is the statistical weight for a given study defined as $1/SE_i^2$ and SE_i is the standard error for a given study.

In the absence of heterogeneity, the fixed-effect model was applied for deriving the metarelativ risk estimate; otherwise, the random-effects model was used. A test for heterogeneity for the fixed-effect approach is given by $Q = \sum_{i=1}^n W_i * \{\log(RR_i) - \log(mRR)\}^2$ where RR_i and mRR are the relative risk and the metarelativ risk, respectively. The hypothesis of homogeneity among studies would be rejected if Q exceeds $\chi^2_{n-1, \alpha}$. Then the random-effects model was used with a different study weight (W_i^*) that further accounts for the interstudy variation in

effect size.⁸ The weighing factor W_i^* in the DerSimonian and Laird random-effects model is

$$W_i^* = \frac{1}{\left[D + \left(\frac{1}{W_i} \right) \right]}$$

where W_i is the statistical weight for a given study for the fixed-effect model and is equal to $1/SE_i^2$ with SE_i being the standard error for a given study according to Chen and Seaton⁹

$$D = \frac{[Q - (n - 1)] * \sum_{i=1}^n W_i}{\left(\sum_{i=1}^n W_i \right)^2 - \sum_{i=1}^n W_i^2}$$

It should be noted that D is set to 0 if $Q < n - 1$. The random-effects model was validated against data provided in Petitti,¹⁰ which after application using our equations gave identical results. For this study, an $\alpha \leq 10\%$ or less for declaring heterogeneity was adopted.¹¹

The SAS software was used to perform the calculations and validated our program for the fixed-effect model using data from different studies compiled by Howe and Burch⁴ on standardized mortality ratios and proportional mortality ratios among firefighters. Where there were no observed deaths or incident cases, the lower confidence interval for an individual study was set at 0.1 as suggested in the method used by Collins and Acquavella.¹² This method was compared with the data excluding studies with a zero relative risk, and the results were similar.

Results

Identification and Characteristics of Studies

The computerized literature search identified 21 U.S. and 14 non-U.S. articles.¹³⁻⁴⁷ It was determined that three studies were not eligible for the meta-analysis because of either insufficient data,⁴¹ data were combined for firefighters and other personnel,⁴² or

the text was not published in English.⁴³ In addition, four studies⁴⁴⁻⁴⁷ were excluded because of overlapping populations with other reports.^{18,30} For example, in 1992, Demers et al¹⁸ reported more observed and expected cancers than in the 1994 article.⁴⁶ Four additional studies⁴⁸⁻⁵¹ were identified in the review by Howe and Burch⁴ and used in the meta-analysis. These latter four studies are not presented in Table 1. Hence, a total of 28 studies received a detailed review as shown in Table 1, which describes the study design characteristics, exposure, and outcome definitions. Sixteen were U.S. studies and 12 were non-U.S. investigations. Five studies had an internal comparison group with the remaining using regional or national comparison groups. Fourteen ascertained exposures from employment records and defined exposure as a dichotomous (yes/no) variable. The majority of the studies relied on death certificates for assessing a cancer diagnosis. Of a total of 32 articles, 26 are included in the meta-analysis as shown in Table 2. The six additional articles are case-control/mortality odds ratio studies and presented in Table 3 with one meta-analysis for non-Hodgkin's lymphoma.

Overview of Meta-analysis

Table 2 summarizes the meta-analysis results by study type. Studies were mostly mortality and were analyzed using SMRs and PMRs. All-cause mortality had an SMR 10% less than general population rates. Mortality from all cancers was similar to the general population using SMR and RR indices, but PMR studies showed a 10% significantly higher rate (Table 2). For individual cancers, there were statistically significant elevated meta-SMR estimates for colon cancer (1.34) and multiple myeloma (1.69). PMR studies demonstrated three significantly elevated meta-PMR values that included skin (1.69), malignant melanoma (2.25), and multiple myeloma (1.42). There was one significantly elevated metarelative risk for esoph-

ageal cancer (2.03). Incidence studies showed significant meta-SIR for cancers of the stomach (1.58), prostate (1.29), and testis (1.83).

As shown in Table 3, only one cancer type, non-Hodgkin lymphoma, had two mortality OR analyses, and both were significant. The estimated mOR was essentially based on Ma et al¹⁴ due to the much larger sample size of firefighters ($n = 4800$) compared with 23 for Figgs et al.¹⁵ Odds ratios were significantly higher for buccal cavity/pharynx (5.90) and Hodgkin's disease (2.4)¹⁴ as well as the single incidence study related to bladder cancer (2.11) and non-Hodgkin's lymphoma (3.27).²²

The next step was to determine the likelihood of cancer risk based on the three criteria assessment. Cancers receiving "probable" and "possible" designations are shown in Table 4. Based on evaluating the first criterion "pattern of metarelative risk" for the 20 cancer sites, eight were designated as "probable," four as "possible," and eight as an unlikely risk. Based on the second criteria "study type" stomach, rectum, skin cancer, and malignant melanoma risk were downgraded because of reliance on PMR studies for statistical significance or the mSMR point risk estimate was not significant and ≤ 1.1 .

For the third criterion, "inconsistency" among all studies caused a downgrading for only colon cancer to "possible." This inconsistency may have been related to several factors, including study type and a cohort effect. There were 14 SMR and PMR colon cancer studies with elevated meta-risk estimates of 1.34 and 1.25, respectively (Table 2). Of these 14 studies, there were 11 (78.6%) with firefighters employed on or before 1950. In contrast, there were six mRR and SIR studies with meta-risk estimates of 0.91 and 0.90, respectively, with half employed on or before 1950. It is possible that the older cohorts had higher exposures due to a lack of aware-

ness of the hazards or use of protective equipment.

A final check on the three criteria assessment presented in Table 4 was made by calculating an overall summary of cancer risk across all studies (ie, SMR, PMR, RR, SIR, OR). There was agreement that cancer was unlikely between the criteria assessment and the not significant summary risk estimates for esophagus, liver, pancreas, larynx, lung, bladder, kidney, and Hodgkin's disease and all cancers (Table 5). Differences between the two approaches were found for cancers of the buccal cavity/pharynx and leukemia because these were designated as possible by the criteria assessment but as not significant in the summary risk estimate. The remaining cancers were all rated as probable or possible and all had significant summary risk estimates. Of note, testicular cancer received the highest summary risk estimate (OR = 2.02; 95% CI = 1.30-3.13) related to the SIR studies compared with the "possible" designation by the three criteria assessment.

Discussion

The meta-analysis and criteria assessment designate the likelihood of cancer among firefighters as probable for multiple myeloma and prostate cancer. Thus, the findings related to multiple myeloma are in agreement with Howe and Burch.⁴ The Philadelphia firefighter study¹³ was the largest cohort study reported to date investigating exposure-response relationships. For Philadelphia firefighters, the SMR results for multiple myeloma demonstrated an increasing trend with duration of employment as a firefighter: 0.73 (95% CI = 0.10-5.17) for under 9 years, 1.50 (95% CI = 0.48-4.66) for 10 to 19 years, and 2.31 (95% CI = 1.04-5.16) with six observed deaths for greater than 20 years. Except for race, there are essentially no known risk factors for multiple myeloma other than occupational exposures (eg, paints, herbicides, insecticides,

T1

T2

T3

T5

T4

TABLE 1
Characteristics of Studies From Electronic Search

Reference	Company Location	Design/Analysis	Study Period	Number of Workers	Comparison Group	Exposure Variable	Exposure Source	Cancer Source	Cofactors
Baris, 2001 ¹³	Philadelphia	Cohort mortality (SMR)	1925-1986	7789	INT/NGP/NED	1, 3, 5	ER	DC	Age
Ma, 1998 ¹⁴	24 US states	Case-control (MOR)	1984-1993	6607	INT	4	DC	DC	Age/race
Figgs, 1995 ¹⁵	24 US states	Case-control (MOR)	1984-1989	23890 (cases) 119,450 (controls)	RGP	4	DC	DC	Age
Burnett, 1994 ¹⁶	27 US states	PMR	1984-1990	5744	INT	4	DC	DC	Age
Demers, 1993 ¹⁷	4 US states	Case-control (OR)	1977-1981	692 (cases) 1683 (controls)	LGP	4	TRV	TRV	Age
Demers, 1992a ¹⁸	Seattle, Tacoma (WA)	Cohort mortality (SMR)	1944-1979	4528	LGP	4	ER	DCN, TRV	Age
Demers, 1992b ¹⁹	Seattle, Tacoma, WA Portland	Incidence (SIR) Cohort mortality (SMR)	1944-1979	4546	INT/LW/NGP INT/LW/NGP	2, 3	ER	DCN	Age
Beaumont, 1991 ²⁰	San Francisco	Cohort mortality (RR)	1940-1970	3066	NGP	3, 6	ER	DCN	Age/yr
Grimes, 1991 ²¹	Honolulu	PMR, RR	1969-1988	205	RGP	3, 4	ER	DC	Race
Sama, 1990 ²²	Massachusetts	Case-control (MOR)	1982-1986	315	LW/RGP	4, 7	TRV	TR	Age/smoke
Vena, 1987 ²³	Buffalo	Cohort mortality (SMR)	1950-1979	1867	NGP	3	ER	DCN	Age/yr
Feuer, 1986 ²⁴	New Jersey	PMR	1974-1980	263	LW/RGP/NGP	3, 8	ER	DCN	Age
Morton, 1984 ²⁵	Portland, Vancouver	Incidence (SIR)	1963-1977	1678	RGP	4	TR	TRV	Age
Dubrow, 1983 ²⁶	British & USA	Cohort mortality (SMR)	1950-1977	—	—	4	AR	DC	None
Musk, 1978 ²⁷	US	Cohort mortality (SMR)	1915-1975	5655	RGP, NGP	4	ER	DC	Age
Berg 1975 ²⁸	US, Great Britain	Cohort mortality (SMR)	1949-1953 and 1959-1963	—	NGP	4	DC	DC	Age
Stang, 2003 ²⁹	Germany	PMR Case-control (OR)	1995-1997	269 (cases) 797 (controls)	RGP	4	ER	MR	Age
Bates, 2001 ³⁰	New Zealand	Cohort mortality (SMR)	1977-1995	4221	NGP	3	AR	DC, TR	Age/yr
Firth, 1996 ³¹	New Zealand	Incidence (SIR)	1972-1984	26207	NED	4	TR	TR	Age
Deschamps 1995 ³²	France	Cohort mortality (SMR)	1977-1991	830	NGP	2	ER	DGN	Age
Delahunt, 1995 ³³	New Zealand	Case-control (RR)	1978-1986	710 (cases) 12,756 (controls)	NGP	4	TR	TR	Age/smoke
Aronson, 1994 ³⁴	Canada	Cohort mortality (SMR)	1950-1989	5414	RGP	3, 6, 7	ER	DCN	Age/yr
Tornling, 1994 ³⁵	Sweden	Cohort mortality (SMR)	1931-1983	1153	LGP	1, 3, 7	ER	DC, TR	Age/yr
Giles, 1993 ³⁶	Australia	Incidence (SIR)	1960-1989	2865	RGP	3, 6, 7	TRV	TR	Age
Guidotti, 1993 ³⁷	Canada	Cohort mortality (SMR)	1927-1987	3328	RGP	2	ER	DCN	Age/yr
Hansen, 1990 ³⁸	Denmark	Cohort mortality (SMR)	1970-1980	886	NED	4	OTH	DC	Age (Continued)

TABLE 1
Continued

Reference	Company Location	Design/Analysis	Study Period	Number of Workers	Comparison Group	Exposure Variable	Exposure Source	Cancer Source	Cofactors
Eliopoulos, 1984 ³⁸	Australia	Cohort mortality (SMR) PMR	1989-1978	990	RGP	3	ER	DC	Age/yr
Mastromatteo, 1959 ⁴⁰	Canada	Cohort mortality (SMR)	1921-1953	1039	RGP	4	DC	DC	Age
<u>Exposure Variables</u>									
1. Number of firefighter runs	<u>Exposure or Cancer Source</u>								
2. Duration of "active" duty	ER, employment records								
3. Duration of employment overall as a firefighter	MR, medical records								
4. Occupation (based on death certificate or tumor registry)	AF, association records								
5. Company type engine, ladder	DC, death certificate								
6. Time since first employment	DCN, death certificate nosologist								
7. Age-specific	TR, tumor registry with no validation								
8. Employment status	TRV, tumor registry (occupation) with validation from external sources								
	OTH, other								
	<u>Design/Analysis</u>								
	RR, rate ratio								
	SMR, standardized mortality/morbidity ratio								
	MOR, mortality odds ratio								
	OR, odds ratio								
	PMR, proportional mortality ratio								
	SIR, standardized incidence mortality								
	<u>Comparison Group</u>								
	INT = internal								
	LW = local workers								
	LGP = local general population								
	RGP = regional general population								
	NGP = national general population								
	NED = national employment database								

engine exhausts, and organic solvents).⁵²⁻⁵⁷ Benjamin et al⁵⁸ reported that blacks compared with whites have at least double the risk of being diagnosed with multiple myeloma and twice the mortality rate. Race may be ruled out as a potential factor among firefighters, because cancer risk was investigated primarily for whites.

The analyses for non-Hodgkin's lymphoma were consistent across a diversity of study designs, including SMR, PMR, SIR, and OR incident/mortality studies. All showed elevated meta-risk or point estimates. The overall summary risk estimate was significantly elevated at 1.51 (95% CI = 1.31-1.73). Hence, non-Hodgkin's lymphoma is considered a probable cancer risk for firefighters. Non-Hodgkin's lymphoma is, however, several cancer types with five International Classification of Disease (ICD) codes (200, 202.0, 202.1, 202.8, 202.9). Of importance is how the definition of non-Hodgkin's lymphoma by ICD code may contribute to the variability in study findings. For example, in a study by Demers et al¹⁹ comparing firefighters with police, the mortality incidence density ratio for "lymphosarcoma and reticulosarcoma" (ICD 200) was not elevated (0.81)¹⁹ but was (1.40) for "other lymphatic/hematopoietic" (ICD 202, 203). Subsequent to the time period covered in this review, Ma et al⁵⁹ examined Florida firefighters but evaluated only one of two cancers for ICD code 200, ie, lymphosarcoma but not reticular sarcoma and found nonsignificance (SMR = 0.94). Hence, these studies demonstrate the importance of being cognizant that differences in cancer risk estimates and interpretation of risk may be influenced by outcome definition.

Results showing a probable association for prostate cancer is curious. Prostate cancer is the most common malignancy affecting men and is the second leading cause of cancer.⁶⁰ Risk of developing prostate cancer is associated with advancing age, black

TABLE 2
Metarelative Risk Estimates and Test for Inconsistency for Mortality and Incidence*

Disease	Number of Studies	Reference	Observed	Expected	Metarelative Risk	95% Confidence Interval	P Value Inconsistency
Mortality studies							
Standardized mortality ratio (SMR)							
All causes (001-999)	12	13, 19, 23, 27, 30, 32, 34	8384	9273.8	0.90	0.85-0.97	<0.00
All cancers (140-209)	13	13, 19, 23, 27, 30, 32, 34, 35, 37-40	1801	1799.9	1.00	0.93-1.08	0.02
Buccal cavity and pharynx (140-149)	5	13, 19, 32, 34, 37	34	29.8	1.14	0.79-1.60	0.84
Esophagus (150)	4	13, 19, 23, 34	17	25.1	0.68	0.39-1.08	0.62
Stomach (151)	7	13, 19, 23, 30, 34, 35, 37	75	81.3	0.92	0.73-1.16	0.72
Colon (153)	10	13, 19, 23, 26, 28, 30, 34, 35, 37, 51	252	188.3	1.34	1.01-1.79	<0.00
Rectum (154)	6	13, 19, 23, 30, 34, 35	54	40.7	1.33	1.00-1.73	0.43
Liver/gallbladder (155-156)	5	13, 19, 23, 34, 35	22	21.9	1.00	0.63-1.52	0.92
Pancreas (157)	6	13, 19, 23, 34, 35, 37	63	64.2	0.98	0.75-1.26	0.58
Larynx (161)	3	13, 19, 34	8	13.7	0.58	0.25-1.15	0.82
Lung (162)	8	13, 19, 30, 34, 35, 37, 38, 51	378	359.2	1.05	0.95-1.16	0.50
Skin (173)	3	13, 19, 37	16	15.7	1.02	0.58-1.66	0.68
Malignant melanoma (172)	2	30, 34	4	5.9	0.67	0.18-1.70	0.23
Prostate (185)	6	13, 19, 23, 34, 35, 37	104	91	1.14	0.93-1.39	0.67
Testis (186)	1	34	3	1.2	2.50	0.50-7.30	—
Bladder (188)	6	13, 19, 23, 30, 34, 37	41	33.0	1.24	0.68-2.26	0.03
Kidney (189)	6	13, 19, 23, 34, 35, 37	30	30.9	0.97	0.44-2.13	0.01
Brain and nervous system (191-192)	8	13, 19, 23, 27, 30, 34, 35, 37	64	46.1	1.39	0.94-2.06	0.07
Non-Hodgkin's lymphoma (200, 202)	3	13, 19, 34	30	20.6	1.46	0.98-2.08	0.92
Hodgkin's disease (201)	2	19, 34	4	5.1	0.78	0.21-2.01	0.59
Multiple myeloma (203)	4	13, 26, 34, 51	24	14.2	1.69	1.08-2.51	0.15
Leukemia (204-208)	2	13, 19	30	29.9	1.00	0.68-1.43	0.27
Proportional mortality ratio (PMR)							
All cancers (140-209)	6	16, 24, 39, 48, 49, 50	2443	2215.7	1.10	1.06-1.15	0.64
Buccal cavity and pharynx (140-149)	—	—	—	—	—	—	—
Esophagus (150)	—	—	—	—	—	—	—
Stomach (151)	—	—	—	—	—	—	—
Colon (153)	4	28, 48, 49, 50	99	79.2	1.25	0.90-1.74	0.08
Rectum (154)	1	16	37	25	1.48	1.05-2.05	—
Liver/gallbladder (155-156)	—	—	—	—	—	—	—
Pancreas (157)	—	—	—	—	—	—	—
Larynx (161)	—	—	—	—	—	—	—
Lung (162)	4	16, 48, 49, 50	773	742.1	1.04	0.88-1.23	0.04
Skin (172-173)	2	16, 24	42	24.8	1.69	1.22-2.29	0.41
Malignant melanoma (172)	2	48, 49	9	4	2.25	1.03-4.27	0.49
Prostate (185)	—	—	—	—	—	—	—

(Continued)

TABLE 2
Continued

Disease	Number of Studies	Reference	Observed	Expected	Metarerelative Risk	95% Confidence Interval	P Value Inconsistency
Testis (186)	—	—	—	—	—	—	—
Bladder (188)	1	16	37	37.4	0.99	0.70–1.37	—
Kidney (189)	1	16	53	36.8	1.44	1.08–1.89	—
Brain and nervous system (191–192)	4	16, 48, 49, 50	64	54.9	1.17	0.90–1.49	0.27
Non-Hodgkin's lymphoma (200, 202)	1	16	66	50	1.32	1.02–1.67	—
Hodgkin's disease (201)	—	—	—	—	—	—	—
Multiple myeloma (203)	4	16, 48, 49, 50	46	32.5	1.42	1.04–1.89	0.88
Leukemia (204–208)	2	16, 24	65	53.5	1.21	0.94–1.55	0.47
Relative risk (RR)							
All causes (001–999)	—	—	—	—	—	—	—
All cancers (140–209)	2	20, 21	291	295.6	0.98	0.87–1.10	0.17
Buccal cavity and Pharynx (140–149)	1	20	11	7.7	1.43	0.71–2.57	—
Esophagus (150)	1	20	12	5.9	2.03	1.05–3.57	—
Stomach (151)	2	20, 21	25	20.6	1.21	0.80–1.81	0.55
Colon (153)	2	20, 21	25	27.5	0.91	0.60–1.36	0.92
Rectum (154)	1	20	13	9	1.44	0.77–2.49	—
Liver (155–156)	—	—	—	—	—	—	—
Pancreas (157)	1	20	17	13.6	1.25	0.73–2.00	—
Larynx (161)	1	20	3	3.8	0.79	0.17–2.35	—
Lung (162)	1	20	60	71.4	0.84	0.64–1.08	—
Skin (172–173)	1	20	7	4.1	1.71	0.68–3.49	—
Malignant melanoma (172)	—	—	—	—	—	—	—
Prostate (185)	2	20, 21	19	24.3	0.78	0.13–4.82	<0.00
Testis (186)	—	—	—	—	—	—	—
Bladder (188)	—	—	—	—	—	—	—
Kidney (189)	1	20	4	5.9	0.68	0.19–1.74	—
Brain and nervous system (191–192)	2	20, 21	9	7.1	1.26	0.55–2.34	0.14
Non-Hodgkin's lymphoma (200, 202)	—	—	—	—	—	—	—
Hodgkin's disease (201)	—	—	—	—	—	—	—
Multiple myeloma (203)	—	—	—	—	—	—	—
Leukemia (204–208)	1	20	6	9.8	0.61	0.22–1.33	—
Incidence studies (SIR)							
All cancers (140–209)	3	30, 35, 36	367	366.6	1.00	0.90–1.11	0.61
Buccal cavity and pharynx (140–149)	2	18, 36	25	19.6	1.28	0.83–1.88	0.73
Esophagus (150)	2	18, 30	10	7.6	1.32	0.63–2.42	0.51
Stomach (151)	3	18, 30, 35	38	24.1	1.58	1.12–2.16	0.33
Colon (153)	4	18, 30, 35, 36†	59	65.3	0.9	0.69–1.17	0.37
Rectum (154)	3	18, 30, 35	41	36.1	1.14	0.81–1.54	0.4
Liver (155–156)	1	35	4	4.7	0.85	0.23–2.18	—
Pancreas (157)	4	18, 30, 35, 36	22	18.2	1.21	0.76–1.83	0.83
Larynx (161)	2	18, 31	13	8.3	1.57	0.17–14.51	<0.00
Lung (162)	4	18, 30, 35, 36	111	120.0	0.93	0.76–1.11	0.83
Skin (172–173)	1	35	5	3.3	1.52	0.49–3.54	—
Malignant melanoma (172)	4	18, 30, 35, 36	60	47.9	1.25	0.96–1.61	0.87
Prostate (185)	4	18, 30, 35, 36	147	114.1	1.29	1.09–1.51	0.56

(Continued)

TABLE 2
Continued

Disease	Number of Studies	Reference	Observed	Expected	Metarelative Risk	95% Confidence Interval	P Value Inconsistency
Testis (186)	2	30, 36	21	11.5	1.83	1.13–2.79	0.15
Bladder (188)	2	18, 30	31	29.9	1.04	0.70–1.47	0.67
Kidney (189)	3	18, 30, 35	11	18	0.61	0.30–1.09	0.69
Brain and nervous system (191–192)	3	18, 30, 35	19	15.4	1.23	0.74–1.93	0.84
Non-Hodgkin's lymphoma (200–202)	1	36	4	2.2	1.82	0.49–4.65	—
Hodgkin's disease (201)	—	—	—	—	—	—	—
Multiple myeloma (203)	—	—	—	—	—	—	—
Leukemia (204–208)	4	18, 25, 30, 36	18	12.9	1.4	0.82–2.21	0.36

Note. Codes of the International Classification of Causes of Death (9th Revision) in parentheses; published data for references 48–50 in Howe and Birch.⁴

*Meta analysis completed only for two or more studies.

†Reference 36 is a combination of colon and rectum cancers.

TABLE 3
Mortality and Incidence Studies for Case–Control/Mortality Odds Ratio Studies

	Outcome	References	Odds Ratio	95% Confidence Interval
All cancers (140–209)	Mortality	14	1.10	1.10–1.20
Buccal cavity and pharynx (140–149)	Mortality	14	5.90	1.90–18.30
Esophagus (150)	Mortality	14	0.90	0.70–1.30
Stomach (151)	Mortality	14	1.20	0.90–1.60
Colon (153)	Mortality	14	1.00	0.90–1.20
	Incidence	22*	1.04	0.59–1.82
Rectum (154)	Mortality	14	1.10	0.80–1.60
	Incidence	22*	0.97	0.50–1.88
Liver/gallbladder (155–156)	Mortality	14	1.20	0.90–1.70
Pancreas (157)	Mortality	14	1.20	1.00–1.50
	Incidence	22*	3.19	0.72–14.15
Larynx (161)	Mortality	14	0.80	0.40–1.30
Lung (162)	Mortality	14	1.10	1.00–1.20
	Incidence	22*	1.30	0.84–2.03
Skin (172–173)	Mortality	14	1.00	0.50–1.90
Malignant melanoma (172)	Mortality	14	1.40	1.00–1.90
	Incidence	22*	1.38	0.60–3.19
Prostate (185)	Mortality	14	1.20	1.00–1.30
Testis (186)	Incidence	29	4.00	0.70–27.40
Bladder (188)	Mortality	14	1.20	0.90–1.60
	Incidence	22*	2.11	1.07–4.14
Kidney (189)	Mortality	14	1.30	1.00–1.70
	Incidence	33	4.89	2.47–8.93
Brain and nervous system (191–192)	Mortality	14	1.00	0.80–1.40
	Incidence	22*	1.52	0.39–5.92
Non-Hodgkin's lymphoma (200, 202)	Mortality	14, 15†	1.41	1.10–1.70
	Incidence	22*	3.27	1.19–8.98
Hodgkin's disease (201)	Mortality	14	2.40	1.40–4.10
Multiple myeloma (203)	Mortality	14	1.10	0.80–1.60
	Incidence	17	1.90	0.50–9.40
Leukemia (204–208)	Mortality	14	1.10	0.80–1.40
	Incidence	22*	2.67	0.62–11.54

*Two control groups available; police rather than state employees selected as most comparable. Significance difference only for malignant melanoma when using state employees odds ratio and 95% confidence interval was 2.92 (1.70–5.03).

†Mortality odds ratio (mOR) calculated only for non-Hodgkin lymphoma as only case–control study with at least two studies. mOR estimated based primarily on larger sample in Ma et al.¹⁴

TABLE 4
Likelihood of Cancer Risk Among Firefighters After Employing Pattern of Metarelative Risk Association, Study Type, and Inconsistency Among Studies

Cancer Site	Pattern of Metarelative Risk Association										Criteria 2			Criteria 3				
	mSMR		mPMR		mSMR and PMR		mRR	mSIR	mOR	Likelihood of Cancer Risk		Study Type	Likelihood of Cancer Risk		Inconsistency	Likelihood of Cancer Risk		
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Buccal	+	-	NA	NC	NC	NC	NC	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible
Stomach	-	++	NA	NC	NC	NC	+	+	-	-	+	+	Possible	No change	No change	Possible	No change	Possible
Colon	+	+	+	+	+	+	-	-	-	-	+	+	Possible	No change	Down one	Possible	Down one	Possible
Rectum	+	+	NC	+	+	+	NC	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible
Skin	-	-	++	+	+	+	NC	NC	NC	-	+	+	Possible	No change	No change	Possible	No change	Possible
Malignant melanoma	-	-	++	-	-	-	NA	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible
Prostate	+	+	NA	NC	NC	NC	-	+	+	-	+	+	Possible	No change	No change	Possible	No change	Probable
Testis	NC	+	NA	NC	NC	NC	NA	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible
Brain	+	+	+	+	+	+	+	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible
Non-Hodgkin's lymphoma	+	+	NC	+	+	+	NA	NC	NC	++	+	+	Probable	No change	No change	Probable	No change	Probable
Multiple myeloma	++	+	++	+	+	+	NA	+	+	-	+	+	Probable	No change	No change	Probable	No change	Probable
Leukemia	-	-	+	+	+	+	NC	+	+	-	+	+	Possible	No change	No change	Possible	No change	Possible

Pattern of meta-relative risk: "+++" meta-relative risk is significant at the 5% level and >1.1; "+" meta-relative risk is not significant at the 5% level but <1.1; "-" meta-relative risk is ≤1.1 and not significant at the 5% level.

NA indicates no available studies; NC, not able to calculate because only one study of that type available.

Study type: down one level, the meta-relative risk (+/-) is based primarily on mPMR studies and/or negative (-) mSMR studies.

Inconsistency among studies: down one level heterogeneity significant among all combined studies at the 10% level.

ethnicity, a positive family history, and may be influenced by diet. Although the positive association with prostate cancer may be due to some of these factors, it is unlikely that these entirely explain the findings; most studies analyzed white men adjusting for age. The summary risk estimate was 1.28 (95% CI = 1.15–1.43). The mSIR was significantly elevated, and all individual studies showed excess SIR values. Parent and Siemiatycki,⁶¹ in a review article, concluded that there was suggestive epidemiologic evidence for prostate cancer associated with exposure to pesticides and herbicides, metallic dusts, metal working fluids, polycyclic aromatic hydrocarbon, and diesel engine emissions. Certainly firefighters are exposed to these latter two agents. Recently, exposure to complex mixture in the semiconductor industry also has been associated with an increase in prostate cancer.⁶² Thus, it is possible that some of the mixed exposures experienced by firefighters may be prostate carcinogens. Ross and Schottenfeld⁶³ have cautioned, however, against associating occupational exposures with prostate cancer.

Although there were only four studies evaluating testicular cancer, we propose upgrading the likelihood of cancer risk from possible to probable. This upgrade is suggested because testicular cancer had the largest summary point estimate (2.02, 95% CI = 1.30–3.13) as well as consistency among the one SMR study, two incidence studies, and one case-control study showing elevated risk estimates between 1.15 and 4.30. Testicular cancer is the most common malignancy between the ages of 20 and 34. Except for cryptorchism, no risk factor has been clearly demonstrated.⁶⁴ Because testicular cancer occurs among younger men with high survival, mortality studies are less germane. Bates et al³⁰ showed an increase in the incident cases of testicular cancer with firefighter exposure duration as follows: 10 years:

TABLE 5
Summary of Likelihood of Cancer Risk and Summary Risk Estimate (95% CI) Across All Types of Studies for All Cancers

Cancer Site	Likelihood of Cancer Risk by Criteria	Summary Risk Estimate (95% CI)	Comments
Multiple myeloma	Probable	1.53 (1.21–1.94)	Consistent with mSMR and PMR (1.50, 95% CI = 1.17–1.89) Based on 10 analyses Heterogeneity—not significant at the 10% level
Non-Hodgkin lymphoma	Probable	1.51 (1.31–1.73)	Only two SMR and another PMR studies Slightly higher than mSMR and PMR (1.36, 95% CI = 1.10–1.67) Based on eight analyses Heterogeneity—not significant at the 10% level
Prostate	Probable	1.28 (1.15–1.43)	Consistent with mSIR (1.29, 95% CI = 1.09–1.51) Based on 13 analyses Heterogeneity—not significant at the 10% level
Testis	Possible	2.02 (1.30–3.13)	Slightly higher than mSIR (1.83, 95% CI = 1.13–2.79) Based on four analyses Heterogeneity—not significant at the 10% level
Skin	Possible	1.39 (1.10–1.73)	Slightly lower than mSMR and PMR (1.44, 95% CI = 1.10–1.87) – derived on basis of PMR studies Based on eight analyses Heterogeneity—not significant at the 10% level
Malignant melanoma	Possible	1.32 (1.10–1.57)	Slightly higher than mSMR and PMR (1.29, 95% CI = 0.68–2.20) Based on 10 analyses Heterogeneity—not significant at the 10% level
Brain	Possible	1.32 (1.12–1.54)	Slightly higher than mSMR and PMR (1.27, 95% CI = 0.98–1.63) Based on 19 analyses Heterogeneity—not significant at the 10% level; there was heterogeneity among SMR studies
Rectum	Possible	1.29 (1.10–1.51)	Slightly lower than mSMR and PMR (1.39, 95% CI = 1.12–1.70) Based on 13 analyses Heterogeneity—not significant at the 10% level
Buccal cavity and pharynx	Possible	1.23 (0.96–1.55)	Slightly higher than mSMR (1.18, 95% CI = 0.81–1.66) Based on nine analyses Heterogeneity—not significant at the 10% level
Stomach	Possible	1.22 (1.04–1.44)	Lower than mSIR (1.58, 95% CI = 1.12–2.16); Based on 13 analyses Heterogeneity—not significant at the 10% level
Colon	Possible	1.21 (1.03–1.41)	Slightly lower than mSMR and PMR (1.31, 95% CI = 1.08–1.59) Based on 25 analyses Heterogeneity—significant at the 10% level; there were heterogeneity among SMR and PMR studies
Leukemia	Possible	1.14 (0.98–1.31)	Similar to mSMR and PMR (1.14, 95% CI = 0.92–1.39) Based on eight analyses Heterogeneity—not significant at the 10% level
Larynx	Unlikely	1.22 (0.87–1.70)	Higher than mSMR (0.58, 95% CI = 0.25–1.15) Based on seven analyses Heterogeneity—not significant at the 10% level
Bladder	Unlikely	1.20 (0.97–1.48)	Similar to mSMR and PMR (1.24, 95% CI = 0.83,1.49) Based on 11 analyses Heterogeneity—significant at the 10% level; there was heterogeneity among SMR studies
Esophagus	Unlikely	1.16 (0.86–1.57)	Higher than mSMR (0.68, 95% CI = 0.39–1.08) Based on eight analyses Heterogeneity—not significant at the 10% level
Pancreas	Unlikely	1.10 (0.91–1.34)	Slightly higher than mSMR (0.98, 95% CI = 0.75–1.26) Based on 13 analyses Heterogeneity—not significant at the 10% level
Kidney	Unlikely	1.07 (0.78–1.46)	Similar to mSMR and PMR (1.23, 95% CI = 0.94–1.59) Based on 12 analyses Heterogeneity—significant at the 10% level; there was heterogeneity among SMR studies

(Continued)

TABLE 5
Continued

Cancer Site	Likelihood of Cancer Risk by Criteria	Summary Risk Estimate (95% CI)	Comments
Hodgkin's disease	Unlikely	1.07 (0.59–1.92)	Higher than mSMR (0.78, 95% CI = 0.21–2.01) Based on three analyses Heterogeneity—not significant at the 10% level
Liver	Unlikely	1.04 (0.72–1.49)	Similar to mSMR (1.00, 95% CI = 0.63–1.52) Based on seven analyses Heterogeneity—not significant at the 10% level
Lung	Unlikely	1.03 (0.97–1.08)	Similar to mSMR and PMR (1.05, 95% CI = 0.96–1.14) Based on 19 analyses Heterogeneity—not significant at the 10% level; there was heterogeneity among PMR studies
All cancers	Unlikely	1.05 (1.00–1.09)	Similar to mSMR and PMR (1.06, 95% CI = 1.02–1.10) Based on 25 analyses Heterogeneity—significant at the 10% level; there was heterogeneity among SMR studies

CI indicates confidence interval; SMR, standardized mortality ratio; PMR, proportional mortality ratio; SIR, standardized incidence ratio.

SIR = 1.39, 95% CI = 0.2–5.0; 11 to 20 years: SIR = 4.03, 95% CI = 1.3–9.4. In those exposed greater than 20 years, the risk estimate remained elevated but declined (SIR = 2.65, 95% CI = 0.3–9.6), possibly because testicular cancer generally occurs at a younger age. Bates et al³⁰ argued that, although the reason for the excess risk of testicular cancer remained obscure, the possibility that this is a chance finding was low because incident studies are likely the most appropriate methodology for a cancer that can be successfully treated.

The 1990 findings of Howe and Burch⁴ showing a positive association with brain cancer and malignant melanoma are compatible with our results because both had significant summary risk estimates. Brain cancers were initially scored as probable but then downgraded to possible (Table 5). There was inconsistency among the SMR studies, which resulted in the use of the random-effects model, yielding confidence limits that were not significant (SMR = 1.39, 95% CI = 0.94–2.06) (Table 2). This inconsistency primarily resulted from the Baris et al study,¹³ a 61-year follow up of 7789 firefighters demonstrating a marked reduction in brain cancer (SMR = 0.61, 95% CI = 0.31–1.22). As

noted in Table 4, however, there were elevated, but not significant, risk estimates across all studies, ie, mSMR, mPMR, mRR, and mSIR. This consistency is all the more remarkable given the diversity of rare cancers included in the category "brain and nervous system." Furthermore, there was a 2003 study by Krishnan et al⁶⁵ published after our search that examined adult gliomas in the San Francisco Bay area of men in 35 occupational groups. This study showed that male firefighters (six cases and one control) had the highest risk with an odds ratio of 5.93, although the confidence intervals were wide and not significant. In addition, malignant melanoma was also initially scored as probable but was downgraded to "possible" due to study type. This study downgrade was related to the negative SMR (–) and reliance primarily on a PMR study. Thus, in conclusion, our study supports a probable risk for multiple myeloma, similar to Howe and Burch's⁴ findings, and a possible association with malignant melanoma and brain cancer.

Summary

We implemented a qualitative three-criteria assessment in addition to the quantitative meta-analyses. Based on the more traditional quan-

titative summary risk estimates shown in Table 5, 10 cancers, or half, were significantly associated with firefighting after the three cancers were designated as a probable risk based on the quantitative meta-risk estimates and our three criteria assessment. These cancers included multiple myeloma, non-Hodgkin's lymphoma, and prostate. A recommendation is also made, however, for upgrading testicular cancer to "probable" based on the twofold excess summary risk estimate and the consistency among the studies. Thus, firefighter risk for these four cancers may be related to the direct effect associated with exposures to complex mixtures, the routes of delivery to target organs, and the indirect effects associated with modulation of biochemical or physiologic pathways. In anecdotal conversations with firefighters, they report that their skin, including the groin area, is frequently covered with "black soot." It is noteworthy that testicular cancer had the highest summary risk estimate (2.02) and skin cancer had a summary risk estimate (1.39) higher than prostate (1.28). Certainly, Edelman et al³ at the World Trade Center, although under extreme conditions, revealed the hazards that firefighters may encounter only because air monitoring was performed.

As noted in Table 1, approximately half of the studies used local, regional, or national general population rates as the comparison group. These general population comparison groups raise concern that the actual risk of cancer may be underestimated due to the healthy worker effect related to the strict physical entry requirements, maintenance of better physical fitness, and good health benefits. The healthy worker bias may be less pronounced, however, for cancer than for conditions such as coronary heart disease. Furthermore, tobacco is unlikely a contributing factor because cancers known to be associated with smoking such as lung, bladder, and larynx were designated as unlikely and corresponding summary risk estimates were not statistically significant.

These findings of an association of firefighting with significant increased risk for specific types of cancer raise red flags and should encourage further development of innovative comfortable protective equipment allowing firefighters to do their jobs without compromising their health. Studies are especially needed that better characterize the type and extent of exposures to firefighters.

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CANCERS

Brain Cancer — Many studies have found between 2-3 times increased risk. One study found an almost four fold risk. A dose-response relationship has been shown (increasing risk of brain cancer with longer length of employment as a fire fighter and with a greater number of fires attended). Vinyl chloride is commonly found in fires and is known to cause brain cancer. Acrylonitrile and formaldehyde are considered to be probably carcinogenic to the human brain.

Digestive (Gastrointestinal) System Cancers — Once cleared from the airways, inhaled particles and the carcinogens that adhere to them are transferred to the GI tract by swallowing. Asbestos, soots and vinyl chloride are all known to cause cancer of the human GI system.



Colon Cancer — Several studies have found an increased risk, with one study finding a more than two times higher risk. Another study found an almost two times higher (1.83) risk for fire fighters, with almost five times the risk (4.71) for those with more than 40 years of experience, suggesting a dose-response trend. Two other studies showed increased risk with increased exposure (length of employment, number of runs). Asbestos is known to cause colon cancer in humans. PAHs present in diesel exhaust have been linked to colon cancer.

Rectal Cancer — Excess rectal cancer (up to two times higher risk) has been found consistently in many studies of fire fighters.

Pancreatic Cancer — Some studies have found an increased risk. One study found a two times higher risk. Another study found three times the rate in fire fighters as compared to police officers (a comparable group).

Liver Cancer — The largest study of liver cancer found a two times higher risk for fire fighters.

Stomach Cancer — Most studies have found an increased risk. One study found a two times higher risk. Another study found a 2-3 times higher risk for fire fighters with more than 30 years of employment or more than 1,000 fires fought.

Esophageal Cancer — Some studies have found an increased risk. One study found a two times higher risk. Soots are present in all fires and known to cause cancer of the esophagus.

Pharyngeal (Throat) and Oral Cancer — Some studies have found an increased risk.

Genitourinary Cancers

Bladder Cancer — Studies have found a 2-3 times increased risk. Two studies found a two times higher risk compared to police (2.11 and 1.7). Increasing risk with longer employment was demonstrated with risk for those with more than 40 years of experience increased by 5.71. Another study also supported a dose-response relationship. Diesel exhaust and formaldehyde probably cause bladder cancer in humans.

Kidney Cancer — Several studies have found increased risk for fire fighters. One study found a greater than four times increased risk. Another study found a greater than two times increased risk for those employed for more than 20 years. Other studies showed highest risk for those employed the longest as fire fighters. Diesel exhaust and formaldehyde probably cause kidney cancer in humans.

Prostate Cancer — Studies have consistently found an increased risk. Two studies found a greater than two times higher risk. Acrylonitrile and formaldehyde probably cause prostate cancer in humans.

Testicular Cancer — Several studies have shown a greater than 2 times increased risk. One study showed a four times higher rate. Fire fighters report that their groin area frequently becomes covered with "black soot." Soot is known to cause cancer of the scrotum.

Hematological (Blood) and Lymphatic Cancers

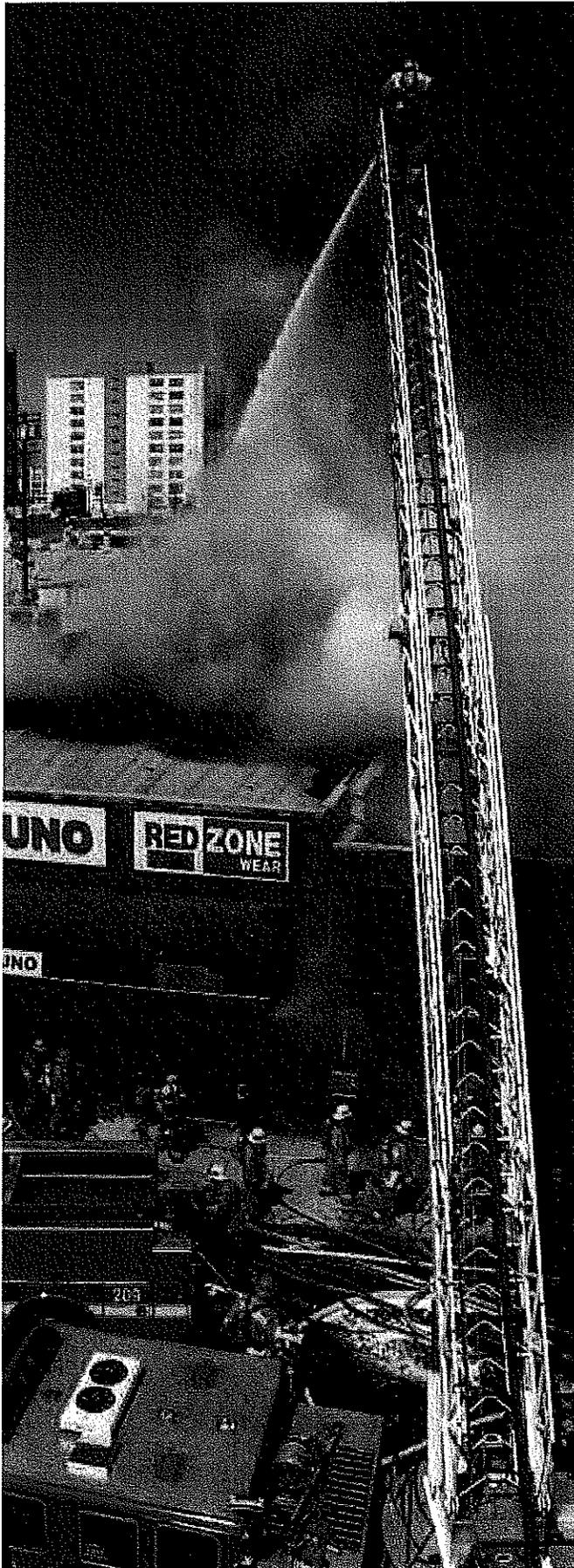
In general, fire fighters have more than two times the risk. Vinyl chloride is known to cause hematological and lymphatic cancers in humans. Acrylonitrile and formaldehyde are probably carcinogenic to the human blood and lymph systems.

Leukemias — One study found a 2.67 times higher risk compared to police. Another study found fire fighters with more than 30 years of experience are at 2-5 times increased risk. Benzene and soots are known to cause leukemia in humans.

Lymphomas — In one study, fire fighters had non-Hodgkin's lymphoma at more than three times the rate of police officers (a comparable group). Other studies have also found elevated rates.

Multiple Myeloma — Fire fighters are at increased risk.

Skin Cancer — Several studies have found an increased risk. Two studies found an almost three times increased risk of skin cancer. One showed increasing risk with increased length of employment. Another study found a greater than three times increased risk in a subgroup of fire fighters. Fire fighters often have direct skin contact with soot, which is known to cause skin cancer in humans.



Connecticut Fire Fighters and Infectious Diseases

Infectious diseases have become a hazard to fire fighters too big to ignore. Fire fighters and their employers must continue to take progressive steps toward reducing the risks of these hazards. Fire fighters and emergency medical responders are exposed during motor vehicle accidents in which blood and sharp surfaces often are present, by rescuing burn victims, and through the administration of emergency care. The victim may require extrication from a difficult-to-access accident scene, such as a motor vehicle accident or poorly accessible building. There may be broken glass or other sharp objects at the scene that are poorly visualized, and the lighting at the scene may be minimal. In addition, if the victim is bleeding profusely and needs to be extricated quickly to save his/her life, the emergency provider must act quickly, with disregard for his/her own safety. Fire fighters may also be involved in emergency medical treatment at the scene, including intravenous line insertion and blood drawing. The infectious disease status of the victim is almost never known to the fire fighter while he or she is rendering emergency services. All of these factors combine to place the fire fighter at increased risk of contracting a bloodborne contagious disease through a puncture wound, skin abrasion or laceration that becomes contaminated with infected blood or body fluids from the victim.

The CCM misrepresented the literature by rhetorically addressing its claim that research on the risks of infectious and contagious diseases is also not conclusive. This cannot be farther from the truth. In the MMWR article CCM cited, the authors stated, "This report summarizes the findings of five studies of HCV (Hepatitis C Virus) infection among first responders." This statement is untrue and grossly misleading. Only two of the five "studies" contain published data, and both of these efforts were developed and designed to assess issues related to Hepatitis B. The three remaining "studies" represent unpublished data collected during what were primarily Hepatitis C education and screening programs. Data collected in an uncontrolled and scientifically flawed manner can simply not be dubbed a "study" by these authors in order to confer validity. Furthermore, these "studies" were all cross sectional voluntary studies that had limited participation rates. The "studies" collected little to no information about the participants' occupational exposures, thus severely limiting the ability to assess any occupational risk factors.

Most importantly, four of the five "studies" failed to show an association between Hepatitis C and the most common risk factors in the general population (injection drug use, high-risk sexual behavior and transplant/transfusion prior to 1992). There was clearly an occupational risk factor.

These authors acknowledge that first responders, including fire fighters and emergency medical personnel, who are exposed to blood are at risk for infection by bloodborne pathogens. The exposure data from the "studies" cited indicates that emergency response employees have a high rate of exposure to blood and body fluids. In light of the biological and occupational plausibility of exposure, we believe that it is impossible to make any statements about the lack of association between work as an emergency response employee and Hepatitis C using the data from the five selected "studies."

The facts of fire fighter exposures to infectious diseases are clear. On October 16, 1998, the United States Centers for Disease Control and Prevention published its "Recommendations for Prevention and Control of Hepatitis C Virus (HCV) Infection and



Connecticut's professional fire chiefs and fire fighters strongly believe sufficient evidence is available that shows fire fighters suffer from cancer, heart and infectious diseases due to their exposures in performing the tasks involved in fire fighting and emergency medical care. We believe it is time for you to pass this legislation to clearly indicate that such diseases are occupationally related to fire fighting and provide those that suffer from these diseases a rebuttable presumption for compensation benefits.

HCV-Related Chronic Disease.” CDC, through this document, has determined that health care workers, which include fire fighters and emergency medical personnel, are at occupational risk for acquiring Hepatitis C infections. The CDC guidelines recommend that departments implement policies for follow-up of HCV infection in emergency workers after a documented exposure to blood.

In fact, and contrary to CCM's statements, fire fighters are exposed to blood on a frequent basis during their daily work activities. In a U.S. federal government study conducted during the development of the federal OSHA Bloodborne Pathogen Standard (29CFR1910.1030 OSHA Regulatory Impact and Flexibility Analysis) it was shown that 98 percent of EMTs and 80 percent of fire fighters are exposed to bloodborne diseases on the job.

Connecticut Fire Fighters and Cost of Legislation

CCM is also confused on the issue of paying for treatment of a fire fighter injured at work, in this case through an exposure to a carcinogen, toxic combustion products or an infectious agent that results in disease. The legislation only provides for a rebuttable presumption — that is, the employer can demonstrate that the

exposure did not occur in the line of duty—to compensate a fire fighter if an exposure leads to a disease. Just as a fire fighter would be compensated for injuries that occurred after falling through the roof of a burning structure, a fire fighter who has acquired a disease from a job exposure would be compensated. Based on actual experience, the cost per cancer claim for those states having presumptive occupational disease statutes is substantially less than the unsubstantiated figures asserted by the CCM. One reason for this, unlike benefits for other occupations, is the higher mortality rate and significantly shorter life expectancy associated with fire fighting. Fire fighters are dying too quickly from cancer and other occupational diseases, unfortunately producing a significant pension annuity saving for states and municipalities.

If, as CCM claims, the existing worker's compensation system is fair as well as the appropriate mechanism to address such claims, then such legislation may not be needed. However, as testimony and experience has demonstrated, municipalities throughout Connecticut categorically deny fire fighter claims when such individuals suffer from an occupationally acquired disease.

Thank you for your support.



The following states have presumptive disability laws that recognize that fire fighters are at increased risk for certain illnesses. The laws create a rebuttable presumption that the specified diseases are job related:

State	Heart Disease	Lung Disease	Cancer	Infectious Diseases
Alabama	P	P	P	P
Alaska	pending	pending	P	
Arizona			P	P
Arkansas				
California	P		P	P
Colorado	P	P	P	P
Connecticut	P post 1996 hires pending	pending	pending	pending
District of Columbia				
Delaware				
Florida	P		pending	P
Georgia	P	P		
Hawaii	P	P		
Idaho	P	P		P
Illinois	P	P	P	P
Indiana	P	P	P	P
Iowa	P	P		
Kansas	P	P	P	
Kentucky	P	P		
Louisiana	P	P	P	
Maine	P	P		P
Maryland	P	P	P	
Massachusetts	P	P	P	
Michigan	P	P		
Minnesota	P		P	P
Mississippi				
Missouri	P	P	pending	
Montana				
Nebraska			P	
Nevada	P	P	P	
New Hampshire	P	P	P	
New Jersey		P	P	
New Mexico				
New York	P		P	
North Carolina	pending	pending	pending	pending
North Dakota	P	P	P	P
Ohio	P	P		
Oklahoma	P	P	P	
Oregon	P	P	pending	pending
Pennsylvania	P	P		P
Rhode Island		P	P	P
South Carolina	P	P		
South Dakota	P	P	P	
Tennessee	P	P	P	
Texas	P	P	P	P
Utah	P	P		
Vermont	P		P	
Virginia	P	P	P	P
Washington	P	P	P	P
West Virginia				
Wisconsin	P	P	P	
Wyoming				