



Firefighters & Colorectal Cancer

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DetecTogether

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GENERAL EPIDEMIOLOGY: COLORECTAL CANCER

Excluding skin cancers, colorectal cancer is the third most common cancer in both men and women in the United States¹. In 2021, the American Cancer Society (ACS) estimated 104,270 new cases of colon and 45,230 new cases of rectal cancer will be diagnosed. The lifetime risk of development is 1 in 23 for men and 1 in 25 for women¹. Excluding skin cancers, colorectal cancer is the third most common cause of cancer death, and is expected to cause 52,980 deaths in 2021¹. Survival rates for colon cancer vary depending on the stage, although the combined 5 year relative survival rate is 63%, while the combined 5 year relative survival rate of rectal cancer is 67%². When caught in Stage 1, the survival rate for colon cancer is 91% and when diagnosed at Stage 4, survival rate drops to 14%.

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)

In June 2022, IARC convened an international meeting of scientists to re-evaluate firefighting as an exposure related to cancer. They determined the literature supports reclassifying **firefighting to a Group 1 carcinogen (carcinogenic to humans) based on “sufficient” evidence**³. This is the **highest** classification of exposure only assigned when there is scientific certainty.

Their statement indicated:

There was also “strong” mechanistic evidence that occupational exposure as a firefighter shows the following key characteristics of carcinogens in exposed humans: “is genotoxic”, “induces epigenetic alterations”, “induces oxidative stress”, “induces chronic inflammation”, and “modulates receptor-mediated effects”.

Specific to colon cancer, IARC **noted “limited” evidence in humans for colon cancer as related to firefighting**. While typical use of the word “limited” implies a lack of evidence or support, IARC’s classification with the word limited “means that a positive association has been observed between exposure to the agent and cancer but that other explanations for the observations (technically termed “chance”, “bias”, or “confounding”) could not be ruled out with reasonable confidence.” ***It should be noted that IARC criteria and classifications are focused on scientific levels of certainty which are more stringent than those focused on the “weight of the evidence”⁴ which is often used in cases of workers compensation.***

GENERAL RISK FACTORS FOR COLORECTAL CANCER

Modifiable or lifestyle-related risk factors for colorectal cancer include:

- **Physical health.** Being overweight or obese increases risk of developing and dying from colorectal cancer. While this is true for both men and women, the link between obesity and colorectal cancer is stronger for men. Additionally, individuals who are not physically active have a greater risk of developing colorectal cancer⁵.
- **Food consumption.** Certain types of dietary choices can increase the risk of colorectal cancer. Eating a lot of red and/or processed meats increases risk, as does frying, broiling, or grilling meats⁵.
- **Substance use.** Chronic tobacco use leads to a greater chance of developing and dying from colorectal cancer, as does moderate to heavy alcohol use⁵.

Nonmodifiable risk factors for colorectal cancer include:

- **Age.** There is a positive correlation between age and risk of colorectal cancer, specifically after the age of 50⁵.

- **Personal health history.** Having a history of adenomatous polyps, especially if the polyps are large in size and number, increases risk of colorectal cancer. As does previously having colorectal cancer. Even if it was completely removed, the chances of developing new cancers in other areas of the colon and rectum are greater. Finally, having inflammatory bowel disease is a risk for colorectal cancer⁵.
- **Family health history.** As many as 1 in 3 people who develop colorectal cancer have other family members who have been diagnosed. Individuals who have a first-degree relative (parent, sibling, or child) with colorectal cancer are at a higher risk, specifically if the relative was younger than 50 when they were diagnosed⁵.

RISK FACTORS RELEVANT TO FIREFIGHTERS

Firefighters are exposed to a broad range of chemicals, both in the firehouse and during emergency response. Recent research conducted with live burns has begun to identify and quantify the presence of carcinogens that typically are present on the fire ground. Most alarming are findings that, even when the air appears “clear” there are often ultra-fine respirable particles and gaseous chemicals of several known carcinogens present. Unfortunately, this time period when there is no visible smoke is typically when firefighters remove their personal protective equipment and self-contained breathing apparatus. Particularly noted in the research is the presence of carcinogens such as perfluorooctanoic and perfluorooctanesulfonic acids (PFOA and PFOS), asbestos, phthalates, dioxins, benzene, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), vinyl chloride, and heavy metals⁶⁻¹³.

Firefighters face several routes of exposure including inhalation, dermal absorption, secondary exposure through contaminated dust from particulates post incident, and potentially the semi-volatile off-gassing of gear. While firefighters do have protective equipment including bunker gear and self-contained breathing apparatus, these are typically designed to protect personnel from fire and steam burns but not from carcinogens. Many of the chemicals firefighter are exposed to through their work have been implicated in the development of colorectal cancer.

Asbestos. Asbestos is well recognized as dangerous and a known carcinogen present on the fireground^{3,14}. IARC also recognizes asbestos as having limited evidence for being related to the development of colon cancer¹⁵.

Benzene. Benzene is present as a product of combustion from several standard household materials (e.g. PVC pipe, PVC siding, Christmas trees)⁶, from exposure to diesel exhaust, and has been found to off-gas from firefighters’ PPE¹⁰ and is widely recognized as a fireground risk. Benzene is not only present on the fire ground as a product of combustion, but also at high rates in many fire stations as trucks and ambulances are housed in the bay areas. While efforts are being made to increase the use of exhaust mitigation devices in the firehouse, their introduction and use is relatively new to the fire service. Exposure to benzene has been found to increase colorectal cancer risk¹⁶.

Arsenic. Commonly found in treated wood used in home construction, arsenic is a common byproduct of combustion on the fire ground⁶. A growing body of evidence suggests that even low levels of arsenic, such as those found in drinking water and well water, lead to increased risk of colorectal cancer¹⁷.

Polychlorinated biphenyls (PCBs). PCBs are man-made organic chemicals commonly used as coolants, lubricants in transformers, capacitors, and other electrical equipment. While the chemicals have been banned since the late 1970s due to the evidence that they are a probable human carcinogen, they remain in products manufactured prior to the ban, and have been found in the fire environment as a product of combustion¹⁴. Exposure to PCBs has been linked to an elevated risk of colorectal cancer¹⁸.

Shift Work

In 2019, the International Agency for Research on Cancer classified alternative shift work (including evening, night, rotating, and other unspecified schedules) as a probable human carcinogen¹⁹. The relationship between shift work and cancer development occurs through several mechanisms, including circadian rhythm disruptions, impacted melatonin secretion and production, and affecting lifestyle choices²⁰. Given the nature of the job and emergency calls, it is not surprising that firefighters – who are faced with a career of 24–48-hour shifts and emergency calls during the night – struggle with the negative health implications of shift work. Long-term shift work, especially night shifts, has been linked to an increased risk of colorectal cancer^{19,21}.

RISK OF COLORECTAL CANCER AMONG FIREFIGHTERS

A number of methodologically sound studies have studied the relationship between melanoma and firefighting and have found increased risks.

Lee et al.²² examined over 100,000 career Florida firefighters over a 34-year period, identifying 3,760 male firefighter primary cancer incidence using the Florida State Fire Marshall's Office and Florida Cancer Data System. After adjusting for age and year of cancer diagnosis, the authors found **male firefighters had a significantly elevated risk of late-stage colon cancer** (aOR = 1.19, 95% CI = 1.00 – 1.41).

In one of the largest single studies of U.S. career firefighters, Daniels and colleagues²³ studied a pooled cohort of 29,993 firefighters from San Francisco, Philadelphia, and Chicago. They found that **firefighters were 45% more likely to die from rectal cancer** than the general population (SIR=1.45, 95% CI=1.16-1.78).

International work found Korean firefighters **were 27% more likely** to develop colon and rectum cancer than the general population (SIR=1.27, 95% CI=1.01-1.59)²⁴.

Meta-Analytic Findings. While individual studies provide a strong foundation for the likely relationship between colorectal cancer and firefighting, even more convincing are the meta-analytic findings. It is difficult to make decisions about whether firefighting increases the risk of any type of cancer based on a single report because results often vary from study to study and studies vary with respect to a number of important design factors including sample size which is a primary determinant of the power to detect group differences. Meta-analysis is a widely-accepted procedure for statistically combining data from multiple studies. By combining all relevant studies, a meta-analysis provides the maximum possible sample size (at the time the review is conducted) and thus provides the smallest possible confidence interval around an estimate. This is why meta-analysis is a particular important tool for identifying risks for rare

diseases. Meta-analytic findings for the relationship between colorectal cancer and firefighting provide strong evidence for the relationship

A meta-analysis by LeMasters and colleagues²⁵ found an **increased risk of colon cancer** (SRE=1.21, 95% CI=1.03-1.41), as well as an **increased risk of rectal cancer among firefighters** (SRE=1.29, 95% CI=1.10-1.51).

A more recent meta-analysis echoed those results as Jalilian and colleagues found a **significantly elevated risk of developing colon cancer** in firefighters (SIREs=1.14, 95% CI=1.06-1.21), a **significantly elevated risk of developing rectal cancer** (SIREs=1.09, 95% CI=1.00-1.20), and a **significantly elevated risk of rectal cancer mortality** (SMRE=1.36, 95% CI=1.18-1.57)²⁶.

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