

Firefighters & Lung Cancer

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DetecTogether

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GENERAL EPIDEMIOLOGY: LUNG CANCER

According to the American Cancer Society¹, there are approximately 228,820 new cases of lung cancer annually and close to 135,700 deaths each year. The incidence rate of lung cancer was 59.3/100,000 (age adjusted to the 2000 US population) between 2012 and 2016. The average annual death rate is 40.2/100,000 (age adjusted to the 2000 US population). The survival rate for lung cancer diagnosed early, at Stage 1, is 63%, and the survival rate drops to 7% when it is detected at Stage 4. Early detection improves chances of survival.

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**². 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”.

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”³ which is often used in cases of workers compensation.

GENERAL RISK FACTORS FOR LUNG CANCER

Based on the 3rd Edition of the American College of Chest Physicians, there are a number of things that increase the risk of lung cancer⁴. In their published review of the literature and practice guidelines, they state: “Despite the identification of this constellation of well-established causal risk factors, the global epidemic of lung cancer is primarily caused by a single factor: cigarette smoking.” (pg. e1S) Of the 25% of lung cancer cases among non-smokers, the pertinent identified risk factors are outlined below⁵:

- **Gender:** In general, men are more likely to develop lung cancer than women. However, among never smokers, women are more likely to develop lung cancer than men⁵. This has been posited to be due to hormonal factors.
- **Genetics:** Having a relative who has suffered from lung cancer appears to increase risk of developing lung cancer.
- **Age:** In general, the probability of developing or dying from lung cancer before the age of 49 is 0.1%, meaning it is very rare in younger populations¹. Among non-smokers, the median age of developing lung cancer that is an adenocarcinoma is 63.5 years⁵.
- **Occupational Factors:** Chemical exposures on the job have been found to increase risk of lung cancers among non-smokers⁵. Specific chemicals pertinent to the work of firefighters and found to have a *strong* relationship to lung cancer include asbestos, polycyclic aromatic hydrocarbons (PAHs e.g. benzo[a]pyrene, benzene, dioxins), arsenic, and heavy metals^{5,6}.

CHEMICAL EXPOSURES AMONG 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 carcinogens that typically are present on the fire ground. Most alarming are findings that, even when the air appears “clear”, there often are ultra-fine respirable particles and gaseous chemicals of several known and suspected carcinogens present. Unfortunately, this time period (when there is no visible smoke) is typically when firefighters remove their personal protective equipment (PPE) and self-contained breathing apparatus (SCBA). Particularly noted in the research is the presence of carcinogens such as benzo[a]pyrene, dioxins, arsenic, asbestos, and heavy metals⁷⁻¹⁴ all of which have been classified as Group 1 carcinogens by the International Agency for Research on Cancer¹⁵. Exposure to heavy metals have recently been implicated as playing a role in the development of lung cancer⁶. Firefighters face several routes of exposure to these carcinogens including inhalation, dermal absorption, secondary exposure through contaminated dust from particulates post incident, and potentially the semi-volatile off-gassing of gear.

Benzo[a]pyrene (BaP): BaP is produced by burning wood and is present in coal tar (such as that on rooftops that burn during a fire) and diesel exhaust. This chemical has been found on the fire ground and has been thought to be both a byproduct of combustion and as a result of diesel exhaust. In a meta-analysis of the relationship between diesel exhaust and lung cancer, Lipsett and Campelman¹⁶ found that occupational exposure to diesel exhaust resulted in a 43% (Pooled RR=1.43, 95% CI = 1.31-1.57) higher risk of developing lung cancer even after controlling for smoking status.

Benzene: Benzene is present as a product of combustion from several standard household materials (e.g. PVC pipe, PVC siding, Christmas trees)¹¹, from exposure to diesel exhaust, and has been found to off-gas from firefighters' PPE⁷ and is widely recognized as a fire ground 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. Occupational exposures to benzene have been found to increase lung cancer risk by 19% (SRR=1.19, 95% CI = 1.06 – 1.34) and death from lung cancer by 21% (SMR = 1.07 – 1.35)¹⁷.

Asbestos: Asbestos, which is present in several types of building material, has increasingly been recognized as a health risk nationally. The IARC recognizes asbestos as both a known human carcinogen and as a carcinogen present in the smoke of fires². Among men, occupational exposure to asbestos has been found to be related to a 24% (OR=1.24, 95% CI = 1.18-1.31) increased risk of developing lung cancer with data showing an exposure/response relationship¹⁸.

Arsenic: Commonly found in treated wood used in home construction, arsenic is a common byproduct of combustion on the fire ground¹¹. A growing body of evidence suggests that even low arsenic levels, such as those found in drinking water and well water, lead to increased risk of lung cancer¹⁹.

Soot. Soot is the black particulate matter that is present as a by-product of combustion and has been classified as a known human carcinogens²⁰. Originally, soot was most commonly studied as a risk factor for chimney sweeps but has more recently been identified as a risk for firefighters as well. This matter is the result of burning products such as wood, oil, coal, plastics

and household items and has been found to contain such carcinogens as arsenic, cadmium, nickel, and several polycyclic aromatic hydrocarbons (PAH). Soot has been identified as a risk for firefighters and has limited evidence for being related to lung cancer²¹.

FIREFIGHTING AND LUNG CANCER RISK

Fire service studies have found statistically significant relationships between firefighting and development and/or death from lung cancer. In the largest single study of U.S. career firefighters to date, Daniels and colleagues²² studied a pooled cohort of 29,993 firefighters from San Francisco, Philadelphia, and Chicago. They found that **firefighters were 12% more likely to be diagnosed with lung cancer** (SIR=1.12, 95% CI=1.04-1.21) and **10% more likely to die from lung cancer** (SMR=1.10, 95% CI = 1.04 – 1.17) than the general population. An update of mortality for the cohort found the increased risk persisted with firefighters evidencing an **8% increased risk of dying from lung cancer** (SMR = 1.08, 95% CI = 1.02 – 1.15) compared to the general population²³.

Examining the cancer incidence from 45 years of follow-up in five Nordic countries, Pukkala²⁴ examined outcomes for 16,442 male firefighters. They found that, while lung cancer risk was not statistically significant overall for firefighters (SIR=0.97, 95% CI = 0.87 – 1.09), when looking specifically at adenocarcinomas of the lung, **firefighters had a 29% increased risk of cancer** compared to the general population (SIR =1.29, 95% CI =1.02 – 1.60).

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