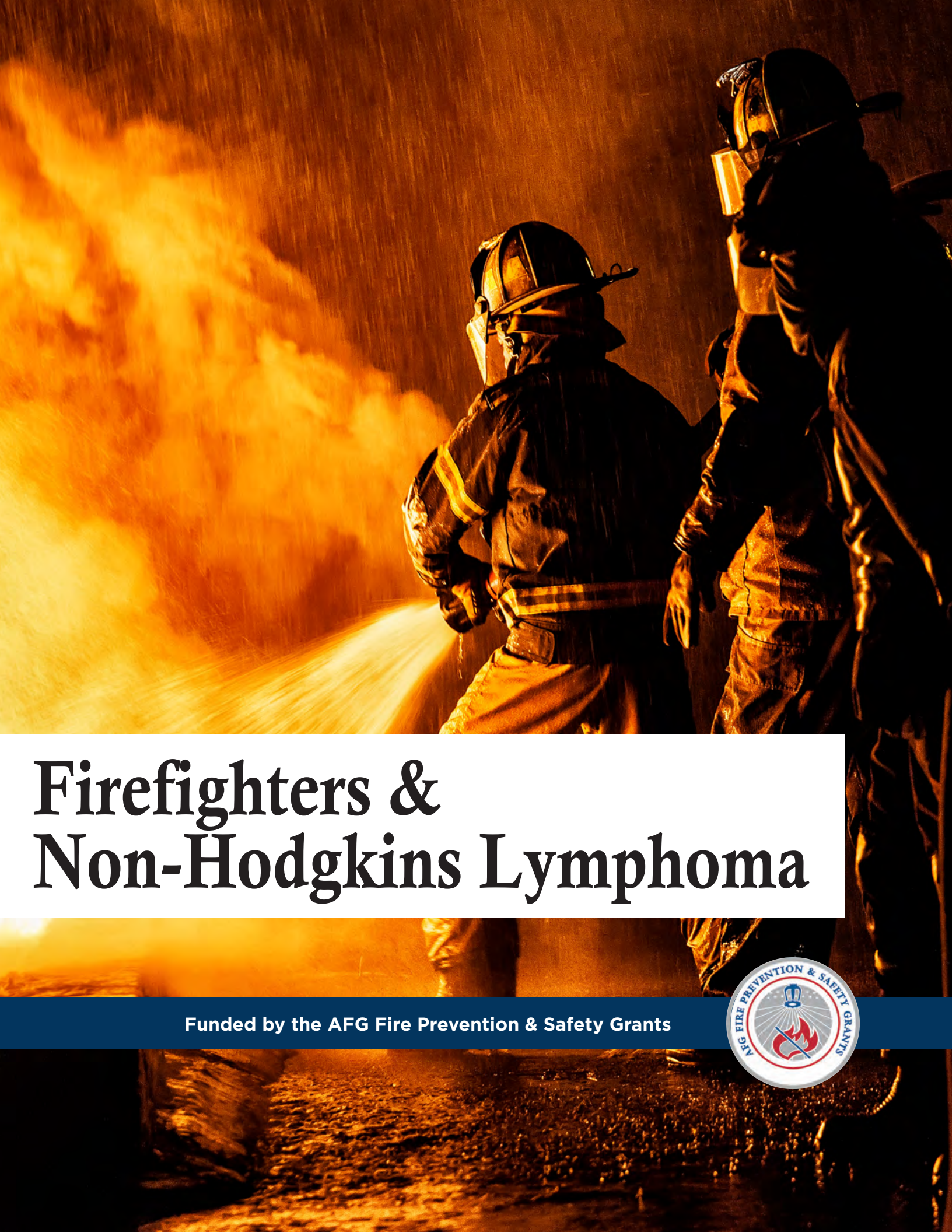

Firefighters & Non-Hodgkins Lymphoma

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Authors:
Walker S. Carlos Poston, Ph.D., M.P.H., FACE
Sara A. Jahnke, Ph.D., FACE
Maria DH Koeppel, Ph.D.
Christopher K. Haddock, Ph.D., PStat®

Center for Fire, Rescue & EMS
Health Research
NDRI-USA, Inc.
New York, NY

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GENERAL EPIDEMIOLOGY: NON-HODGKINS LYMPHOMA (NHL)

The American Cancer Society (ACS)[1] reports that NHL accounts for approximately 4% of all cancers and is one of the most common cancers in the United States. An estimated 81,560 people (≈56% men) will be diagnosed with NHL in 2021 and approximately 20,720 are expected to die within the year.

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".

Specific to melanoma, IARC ***noted "limited" evidence in humans for NHL 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"[3] ***which is often used in cases of workers compensation.***

RISK FACTORS FOR NHL

While research is ongoing about specific risk factors for NHL, a number have been identified that seem to increase risk of disease development.

- **Age**: Risk of developing NHL increases with age[1]. Approximately half of new NHL patients are over the age of 70[4].
- **Race/Ethnicity**: NHL is most common in caucasians[1-4].
- **Family history**: Development of NHL seems to cluster in families[4].
- **Gender**: Males are more likely to develop NHL than females[4].
- **Lifestyle factors**: Evidence is mixed for the relationship between lifestyle risk factors and NHL[4,5]. Smoking has been found to increase risk[5]. Data is mixed on the relationship between NHL and obesity[6] but the relationship has been found to be more consistent for women than men[7].
- **Infectious agents**: Several infections (e.g. Epstein Barr virus, human herpes virus 8, HIV, helicobacter pylori, hepatitis C) leads to increased risk of developing NHL[1].
- **Radiation exposure:** There is some evidence that survivors of significant radiation exposure, such as nuclear reactor accidents and atomic bombs, are at increased risk for developing NHL.[1]

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 presence of carcinogens that are typically 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 benzene, polychlorinated biphenyls (PCBs), styrene, trichloroethylene, and dioxins[8,9]. These same chemicals have recently been implicated as playing a central role in the development of NHL[10–12]. 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

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 combustion[13]. PCBs have been found in the fire environment as a product of combustion[13]. Data suggests that exposure to PCBs likely leads to development of NHL[11,12,14,15].

Benzene. Benzene is present as a product of combustion from several standard household materials (e.g. PVC pipe, PVC siding, Christmas trees)[8], from exposure to diesel exhaust, and has been found to off-gas from firefighters' personal protective equipment (PPE)[16] and is widely recognized as a fire ground risk. Benzene has been noted as an exposure resulting from firefighting as a product of combustion[17]. Benzene is also present 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. There is evidence that benzene exposure is related to development of NHL[18].

OCCUPATIONAL RISK FACTORS FOR NHL

Shift work and being exposed to light at night interrupts the typical circadian rhythms of the body. Given the nature of the job and emergency calls, it is not surprising that firefighters – who are faced with a career of 24 hours shifts and emergency calls during the night – struggle with the negative health implications of shift work. Evidence about the impact of these interruptions has led the IARC to classify shift work as probably carcinogenic to humans. Lahti[19] and colleagues studied employees who had to be awake at night and found that jobs that required being awake at night ***increased the risk of NHL between 10% (RR=1.10, 95% CI = 1.03-1.19) and 28% (RR=1.28, 95% CI = 1.03-1.59)***.

FIREFIGHTING AND NHL

A number of meta-analyses have estimated the risk of NHL among firefighters. To begin with, LeMaster et al.'s[20] analysis found ***firefighters had a substantial increased risk of NHL incidence*** (OR: 3.27, 95% CI=1.19-8.98) and ***a 41% increased odds of NHL mortality*** (OR: 1.41, 95%=1.10-1.70).

The International Agency for Research on Cancer (IARC) developed a monograph on carcinogenic risk of firefighting. In it, they summarized the existing literature on the relationship between firefighting and cancers, and ***concluded that firefighters had a 21% elevated risk estimate*** (95% CI: 1.08–1.36) using a fixed effects model[21]. Most recently, Jalilian and colleagues[22] concluded that there was an increased risk for NHL mortality among firefighters, with a calculated summary mortality risk estimate of 1.42 (95% CI=1.05-1.90). ***This indicates that firefighters were more than 40% more likely to die from NHL***.

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