

Summary

It is recognised that firefighters are exposed to a variety of harmful substances and physical agents, and there has been a growing body of research in the last decade in relation to cancer occurrence within this occupational group. In 2007 the International Agency for Research on Cancer (IARC) convened a working group to assess the carcinogenicity of a variety of occupations including firefighting. This working group identified increased risks for three types of cancer – testicular and prostate cancer and non-Hodgkin’s lymphoma. Exposure assessment for this group has been difficult, including the reliable quantification of exposure. The current report is of a three-phase study that (i) examined the research published since a 2010 review carried out by the IOM for the Industrial Injuries Advisory Council (IIAC), by carrying out a systematic review and meta-analyses of the epidemiological evidence for specific cancers in firefighters, (ii) examined the occupational exposures associated with the cancers identified in Phase 1 and whether these exposures occurred in firefighters and (iii) looked in more detail at the potential exposure of firefighters to polycyclic aromatic hydrocarbons (PAHs) as these were the most commonly identified potentially causal exposures in Phase 2.

Phase 1

The first stage of the research was the development of a search strategy and carrying out searches between April and May 2016. In total 304 publications were screened against the inclusion criteria and 261 publications were excluded. From the 43 full publications sourced, eighteen were excluded as not being relevant to the review and two duplicate papers were identified. The resulting 23 papers were included in the review.

Meta-analyses were carried out for 18 specific cancer sites. Cancers identified as having a positive association with firefighting were colon (meta-RR=1.21, 95% CI 1.11-1.31), rectal (1.15, 1.04-1.27), melanoma (1.39, 1.27-1.52), prostate (1.15, 1.05-1.26), bladder cancer (1.15, 1.02-1.30) and Non-Hodgkin’s lymphoma (1.13, 1.04-1.23).

Firefighters are exposed to a large number of hazards and the types of exposure depend on what is being combusted or which chemical has been spilled. While positive associations have been identified in one country, this has not necessarily been reflected internationally. There can be many explanations for this, including variations in risk amongst the comparator populations and differences in hazard exposures between firefighters in different countries reflecting different firefighting strategies. While exposure assessment has been difficult in this area of research, reliably quantifying exposure is also difficult. Data from other comparable groups were not of a high enough quality to allow a reasonable comparison.

The report identifies firefighters as having an elevated risk of a number of cancers compared to the general population. These comprise colon cancer, rectal cancer, melanoma, prostate, bladder and

Non-Hodgkin's lymphoma. However, the analysis of data for testicular cancer did not affirm the increased risk identified by some earlier analyses. No association was found between lung cancer and firefighting, however one study of Danish firefighters did report a significant association with lung adenocarcinoma.

Phase 2

The occupational risk factors associated with the six cancers identified in Phase 1 were examined and consideration given to whether these risk factors are present for firefighters, who are involved in firefighting in a range of situations, within buildings, woodland fires, vehicle extrications and in the USA, also take on the dual role of being a paramedic. The data also represents an international perspective and it should be borne in mind that there are different work practices, different levels of protection and different work processes between national borders. IARC (2010) suggest that the time spent by a firefighter actually involved in fires is between 0.75% and 2.7% of their working time over the course of a year.

The approach taken was to examine the factors that the research literature indicates are linked to the development of specific forms of cancer and to examine whether firefighters are exposed to these risk factors. The study takes into account evidence regarding the known hazards to which firefighters are exposed, drawn from the existing research literature and from other reputable data sources, including the International Agency for Research into Cancer, Cancer Research UK, the National Institutes for Cancer (USA) and Australian cancer data sources. The collective evidence from these various sources was used to assess the likelihood of occupation as a firefighter being a cause of the specific cancers examined.

Firefighters are potentially exposed to many different substances in the work that they do. However, it is clear that the nature and extent of such exposures varies tremendously between individuals and, as a result, it is difficult to identify particular exposures in respect of cancer causation. The causes of most cancers are multifactorial, often including both lifestyle factors (such as smoking and diet), as well as occupational factors not related to substance exposure such as shift work or having a second job, in addition to any arising from substance exposures during firefighting activities, chemical spillages, etc. Given the relatively modest nature of any elevated risk identified it is likely that the contribution of exposure to any particular chemical substance is likely to be even more modest.

Nonetheless, the study found that there are known associations between PAHs and melanoma, bladder and possibly prostate cancers. However, the sources of PAHs in any fire environment can be numerous and without specific environmental monitoring it is impossible to state the sources. Exposure to diesel fumes was also identified as being associated with prostate and bladder cancer and possibly associated with non-Hodgkin's lymphoma and lung adenocarcinoma.

Phase 3

For the third phase of the study, we looked in more detail at the potential exposure of firefighters to PAHs as these were the most commonly identified potentially causal exposures. It should be noted that it is likely that all burning substances that contain aromatic compounds (including, but not limited to, building materials, furnishings, trees and vehicles) will emit PAHs. In addition, the



sources of PAHs in any fire environment can be numerous and without specific environmental monitoring it would not be possible to identify these sources. The nature of fires in terms of the substances burning and consequential exposures to potentially toxic combustion products will have changed over time, with new building materials, building furnishings and contents and an increased use of plastics and other man-made materials.

The Phase 3 work aimed to examine the following research questions: (i) what sources of PAHs are firefighters exposed to, (ii) what is the route of exposure for firefighters and (iii) what assessments have been made in relation to materials and combustion? These questions were addressed through identification of the relevant literature, identification of exposure routes and measurements and identification of relevant research into materials and combustion.

The research reviewed confirmed that firefighters are exposed to a variety of PAHs in live firefighting, training exercises, wildfire firefighting, overhaul and within fire station engine bays. There also appears to be ingress into fire engines and office and dormitory areas in fire stations. However, the types of PAHs monitored in each of these settings varied and not all were grouping 1 in the IARC classification.

How often firefighters' kit is thoroughly cleaned also warrants discussion. It was reported that by carrying out decontamination on site, 85% of contaminants were removed and it was suggested that fire kit should be washed after every fire event. The results from the studies reviewed suggest that there is also a need to improve fire kit removal procedures. There is certainly experience in emergency service workers in the safe donning and doffing of PPE for chemical or nuclear exposure. Research should be carried out to examine the best means of removing fire kit and in which order to ensure contamination is kept to a minimum.

Structural design issues within fire stations were also highlighted as part of this review to reduce exposure to PAHs. A number of international studies identified building age and design as a factor. From these studies there needs to be a better separation of engine and equipment bays from office and domestic areas. Ventilation equipment is also available for use when engines are started, but this may not always be used effectively.