

Firefighter exposures

Risk Management for Task Based Exposures

OHSI Annual Meeting 2023 - Limerick

Stephan Koslitz

German Social Accident Insurance



German Social Accident Insurance Institutions cover

occupational accidents



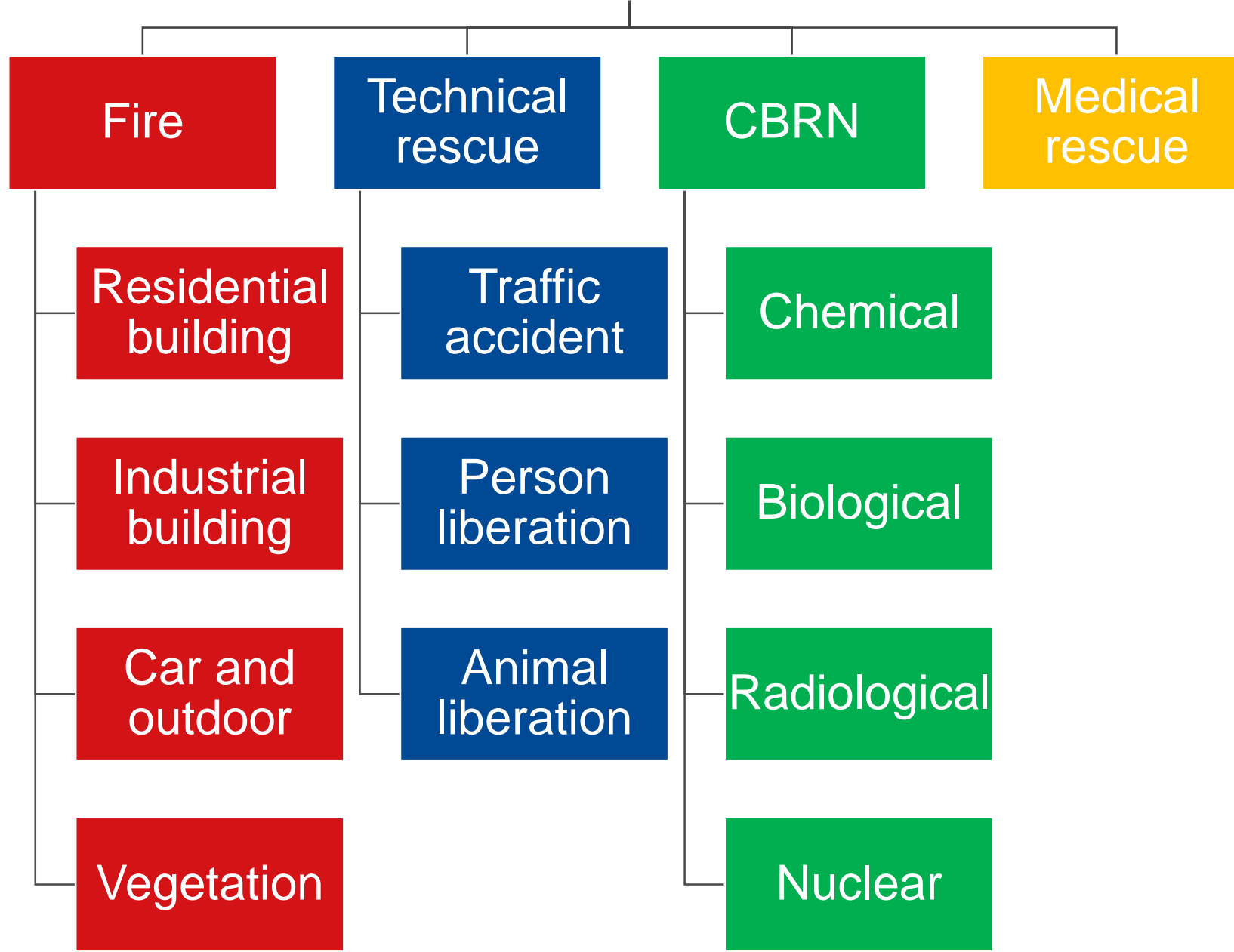
commuting accidents



occupational diseases



Firefighter missions



Functions in firefighting teams

- Fire captain
- Engineer
- Attack team with/without self-contained breathing apparatus (SCBA)
- Water squad

IARC classification of the HAZARD

International Agency for Research on Cancer (IARC) of the WHO

- 2022: Reclassification of occupational exposure as a firefighter as carcinogenic to humans (Group 1)
- 52 epidemiological studies were considered:
 - Sufficient evidence:
 - mesothelioma
 - bladder cancer
 - Limited evidence:
colon, prostate and testicular cancer, malignant melanoma, Non-Hodgkin's lymphoma

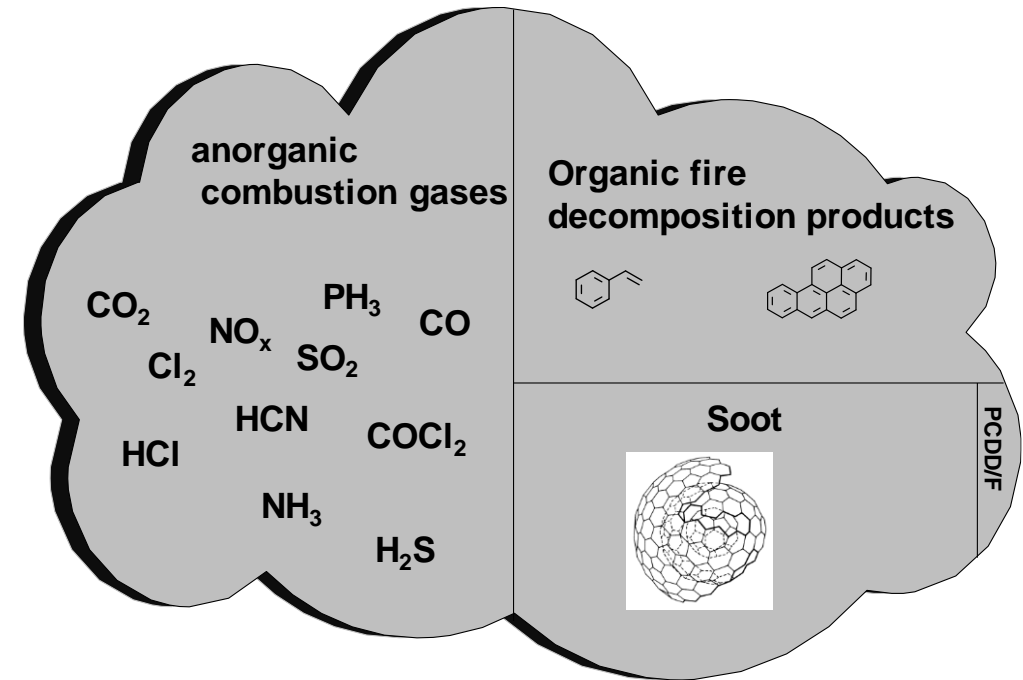
Source:

Demers PA et al. Carcinogenicity of occupational exposure as a firefighter. The Lancet Oncology 2022;23:985-986.

Fire smoke – what is it?

Possible release of

- Asbestos fibres
- Aluminium silicate from technical equipment
- fibres from old insulation wool in building insulation
- Carbon fibres from lightweight construction of road or air vehicles, etc
- Other dusts hazardous to health, e.g. silicogenic or metal-containing dusts



Definitions

- **Air-Monitoring:**
 - Pollutants/residues that could enter the body
- **Exposure-Biomonitoring:**
 - Pollutants, that have effectively entered the body
 - via all known and unknown routes of exposure (dermal, oral, inhalation)

Exposure pathways



✓ inhalative ✗
 ✓ oral ✗
 ✓ dermal ✓



© Michael Stifter – stock.adobe.com

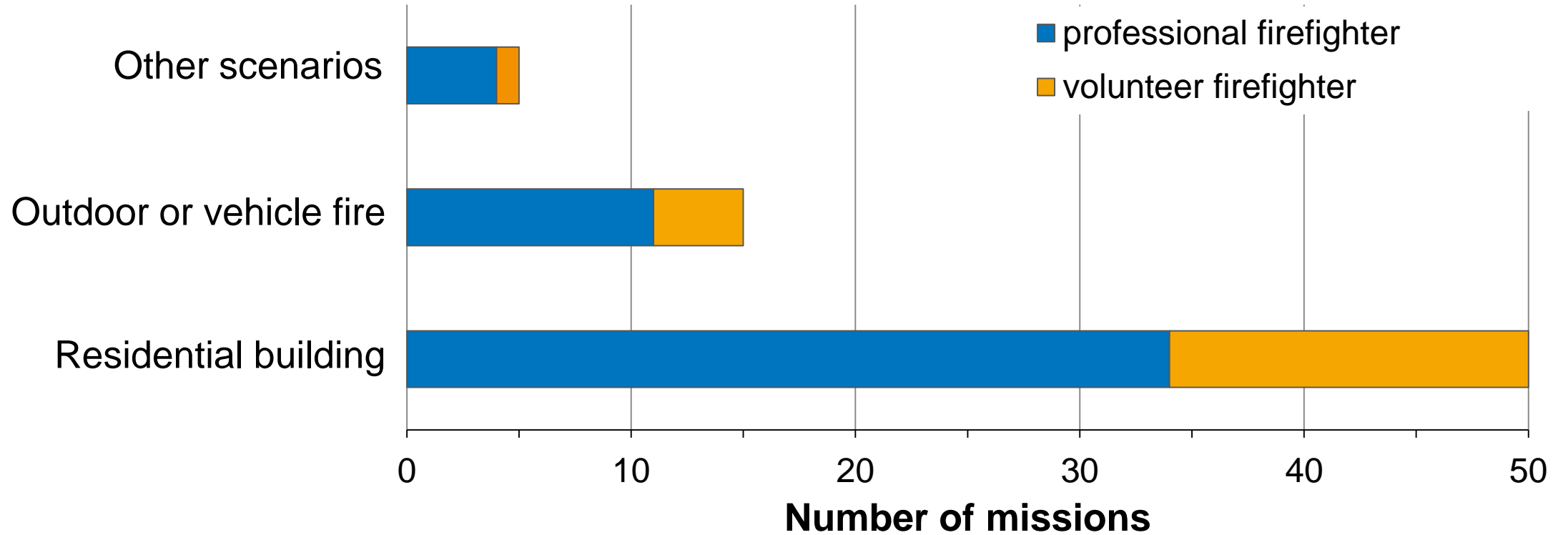
Self contained breathing apparatus (SCBA) reduces exposure mostly to dermal pathway

Biomonitoring study

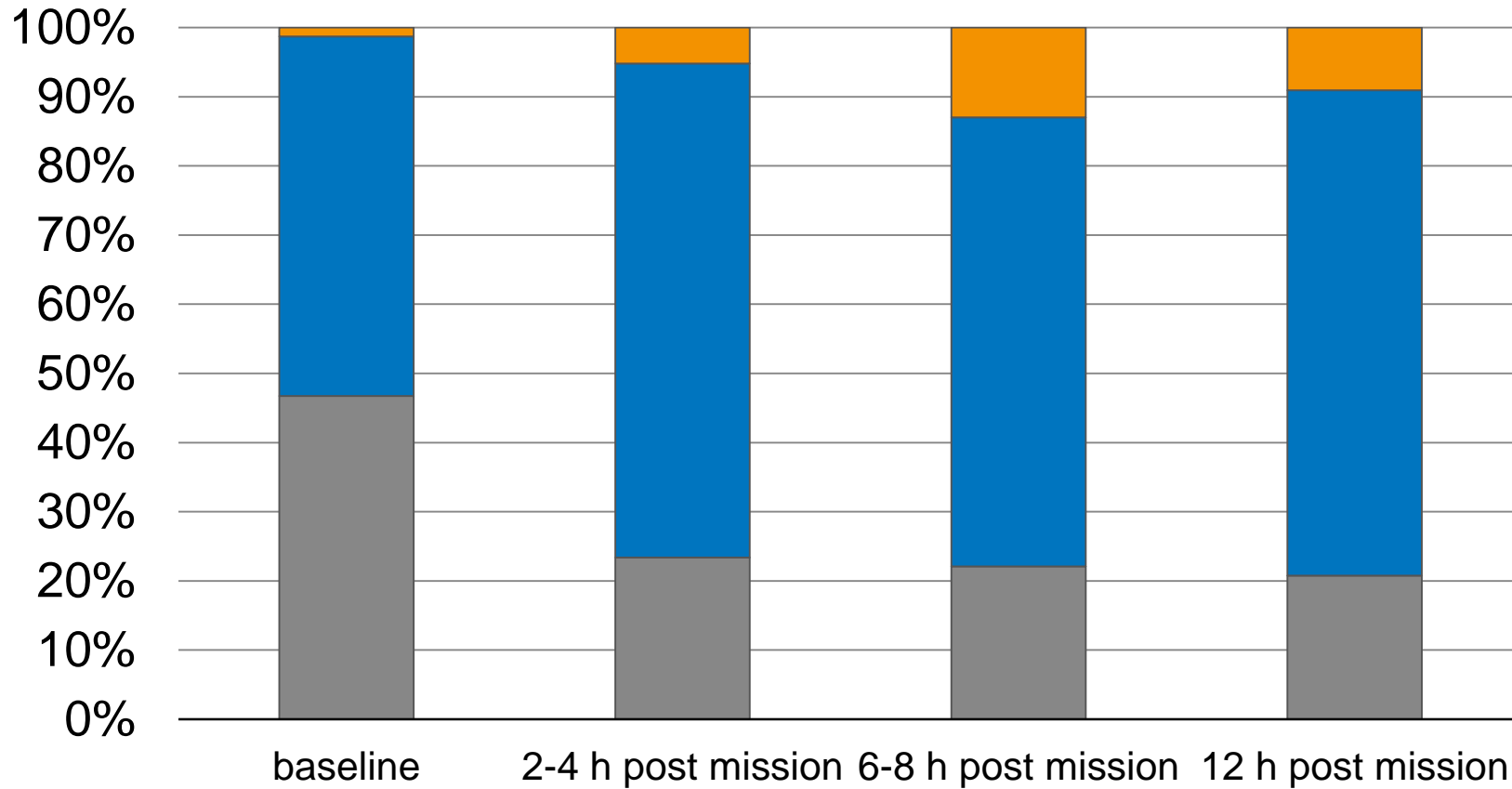
Study design / Experimental

- Biomonitoring of professional and voluntary firefighters in Berlin and Hamburg
- Participants
 - 217 baseline: urine sample & questionnaire
 - 70 missions (32%): urine sampling 2-4 h, 6-8 h, 12 h & questionnaire
- Collection of **274 urine samples**
- Determination of 1-hydroxypyrene (1-OHP): LOQ 0.05 µg/L (0.02 µg/g crea)
- Creatinine adjusted evaluation within in the range: 0.3 – 4.0 g/L creatinine

Missions / Exposure scenarios (N=70)



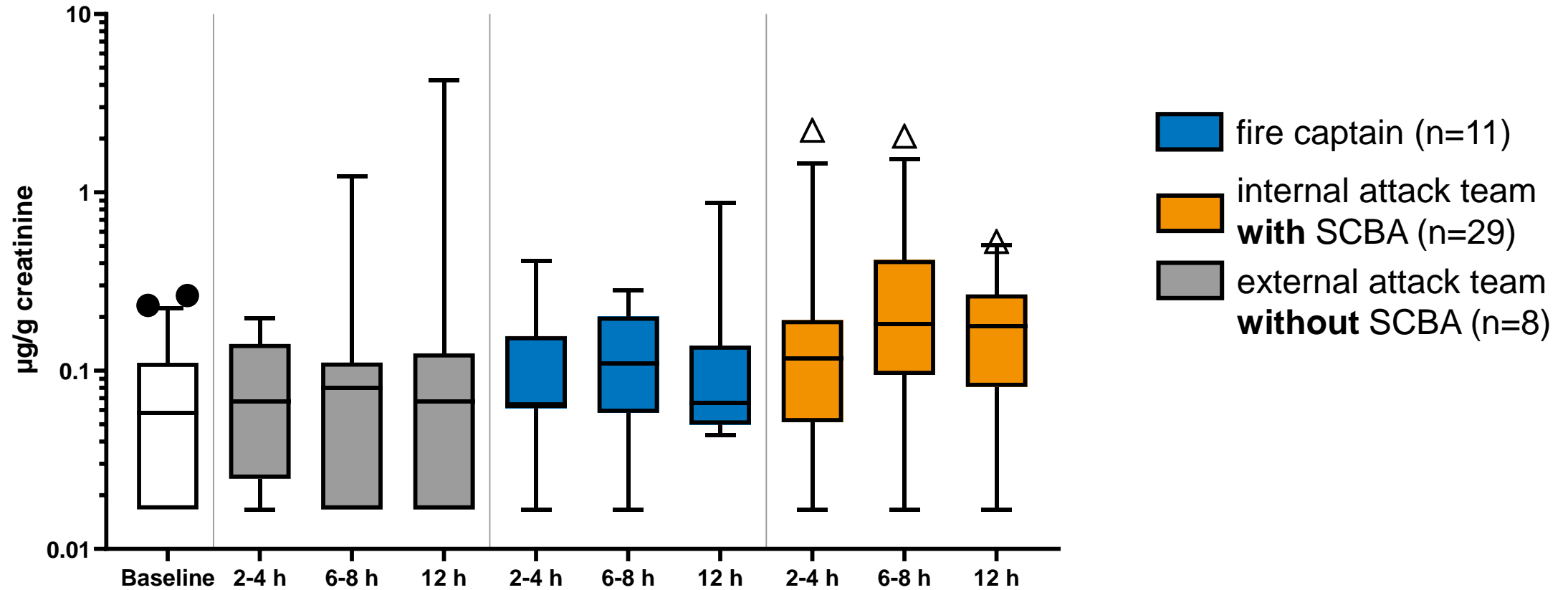
Distributions of 1-OHP concentrations (N=70)



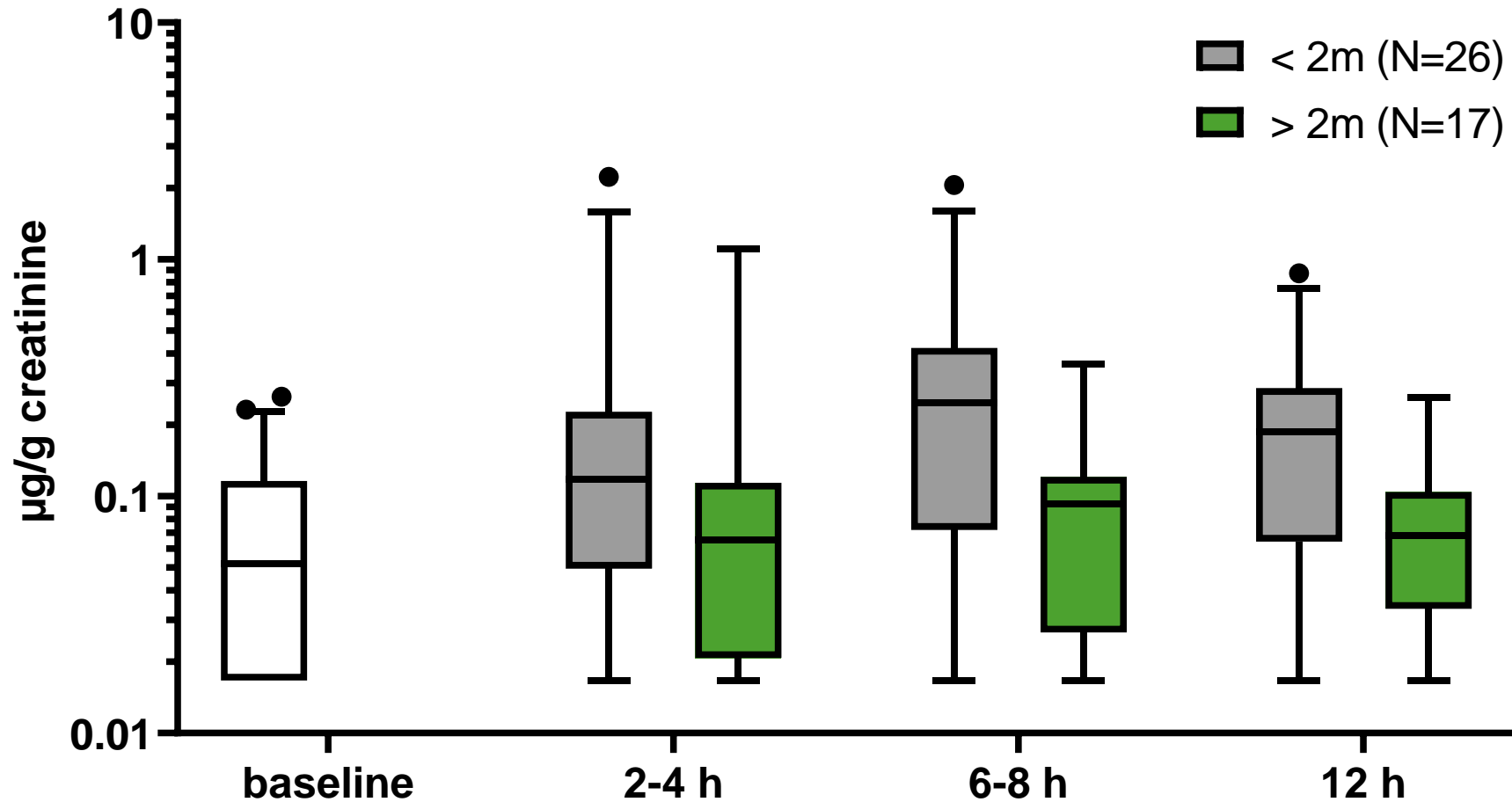
Reference Value:
 95th percentile of the non-occupationally exposed persons, depending on the smoking status (BAR)
 Non-Smokers: 0.30 µg/g crea
 Smokers: 0.73 µg/g crea

■ > Reference value
■ < Reference value
■ < LOQ

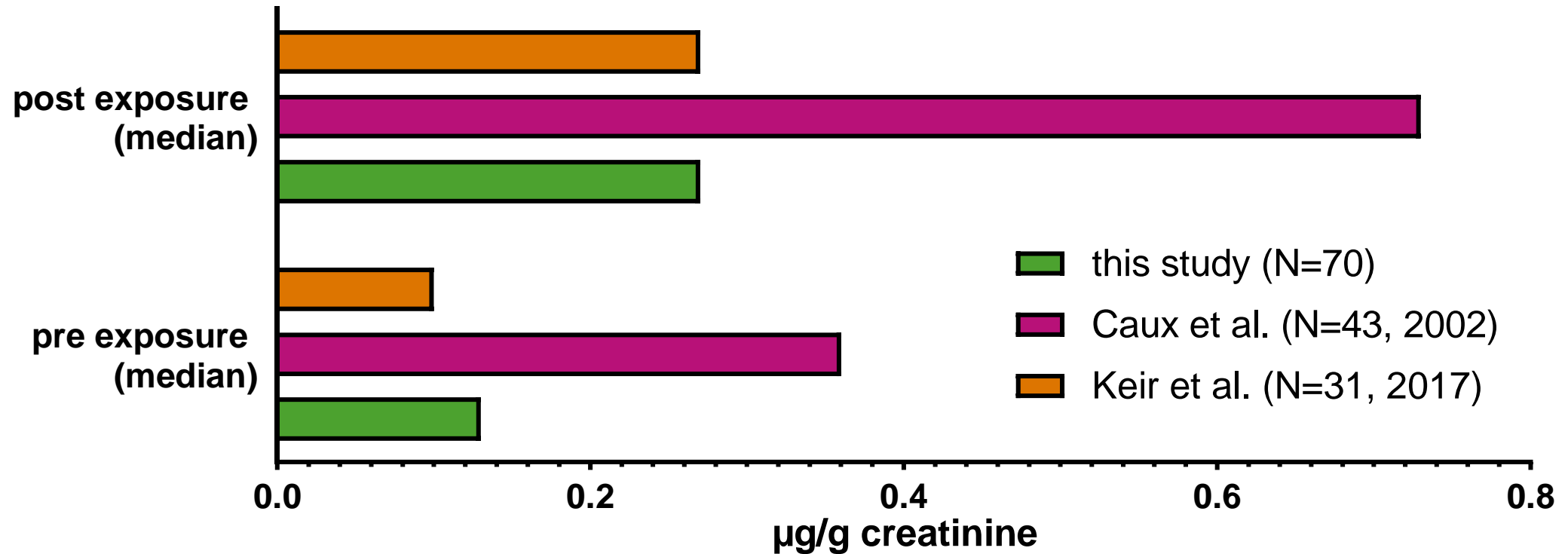
1-OHP within scenario „residential building” (n=48)



1-OHP concentration and visual range (“smoke density”)



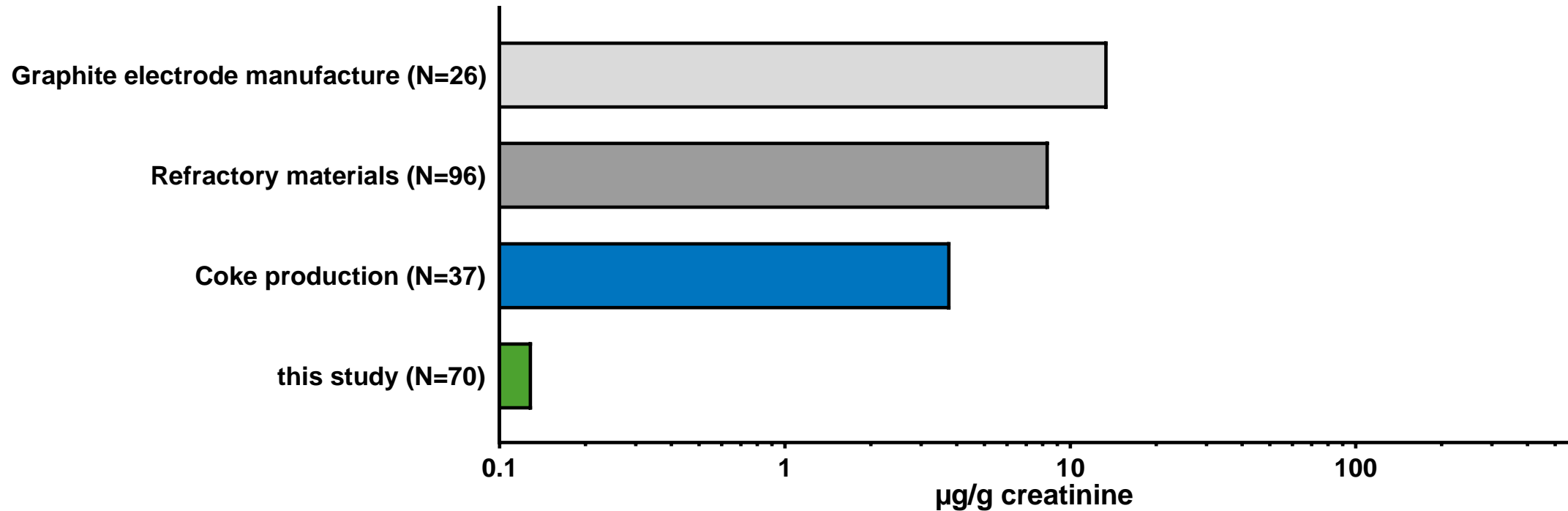
Comparison with other fire-fighting studies



Caux et al. Applied occupational and environmental hygiene 17 (5), 379–386

Keir J. L. A. et al. Environmental science & technology 51 (21), 12745–12755

1- OHP: fire fighters vs. commercial workers (median)



Marczynski B. et al. Archives of toxicology 83 (10), S. 947–957

Publication

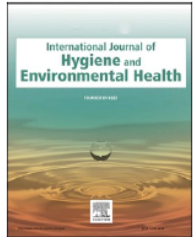
<https://doi.org/10.1016/j.ijheh.2023.114110>



Contents lists available at [ScienceDirect](#)

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh



Exposure to polycyclic aromatic hydrocarbons assessed by biomonitoring of firefighters during fire operations in Germany

Dirk Taeger^{a,*}, Stephan Koslitz^a, Heiko U. Käfferlein^a, Tim Pelzl^b, Birgit Heinrich^c,
Dietmar Breuer^c, Tobias Weiss^a, Volker Harth^d, Thomas Behrens^{a,1}, Thomas Brüning^{a,1}

^a Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Institute of the Ruhr University Bochum (IPA), Bochum, Germany

^b Unfallkasse Baden-Württemberg (UKBW), Germany

^c Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), Sankt Augustin, Germany

^d Institute for Occupational and Maritime Medicine (ZfAM), University Medical Centre Hamburg-Eppendorf (UKE), Germany

Exposure to hazardous substances in firefighting deployments

Identify & evaluate deployment scenarios

Operations with a risk of contamination can be, for example:

- Fire operations
- fire-fighting operations involving potentially infectious persons, e.g. traffic accidents, stretcher assistance, first aid, recovery of corpses
- technical operations involving animals, waste or sewage, e.g. pumping out cellars, sewage and waste treatment plants, animal rescues
- removal of animal carcasses
- hazardous materials operations

Assess risks of the scenarios & determine measures

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Assess risks of the scenarios & determine measures

Provision / procurement of PPE, e.g.

- PPE to protect against contamination,
- change of clothing,
- If necessary, replacement PPE for the emergency forces at the scene of the incident
- Provide cleaning and, if necessary, disposal facilities
- **Do not forget instruction and training!**

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Exposure prevention – during deployment

When is contamination likely to occur?

- If the smoke development in the working or occupied area of the emergency personnel was so strong that self-contained breathing apparatus was used
- Where there is a build-up of soot
- As soon as equipment and PPE smell of fire smoke or are visibly soiled, e.g. by soot adhesion

it must be assumed that the surfaces or PPE and equipment are contaminated.

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Exposure prevention or reduction, e.g.

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Exposure prevention or reduction, e.g.

- Remove contaminated PPE on site, clean roughly beforehand if necessary (asbestos!), pack
- Clean exposed body part immediately, shower within one hour
- Provide a change of clothing and, if necessary, replacement PPE
- Allow for recovery phase: Drinks/food, seating, weather
- Use suitable PPE for emergency personnel in a warm fire area
- Choose low-stress tactics
- Consider the spread of smoke

Exposure prevention or reduction, e.g.

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Exposure prevention – after deployment

Exposure prevention – after deployment

- Ensure proper cleaning of people, PPE and other material
- Keep the time between contamination and cleaning short
- If necessary, prevent contamination from spreading
- Keep a supply of changeable PPE, clothing and hygiene articles
- If necessary, proper disposal
- Documentation of exposures

**Pictures see DGUV-Information 205-035,
link at the end of presentation**

Conclusion

Conclusion – Biomonitoring

- Wide range of 1-OHP concentration (<0.02 – 4.26 µg/g crea)
- Internal exposure comparable to other studies from North America
- Skin is important for uptake of PAH
- Correctly fitted, functional protective clothing and wearing of SCBA as required reduces the absorption of PAHs
- Activity as a firefighter can be considered safe overall under the investigated protective conditions

Aim of prevention: Minimisation of exposure
ALARA – As Low As Reasonably Achievable

Conclusion – Exposure reduction

1. Contamination is still too often not related to fire smoke.
2. Exposure minimisation is necessary! i.e.
 - Respiratory protection and full PPE (also Captains/Chiefs) in fire areas,
 - Rapid removal of sooty PPE / equipment (PPE!),
 - professional reprocessing of people and material.
3. The denser / darker the smoke, the higher the stress on the firefighters!
4. If possible, choose low-stress deployment tactics!
5. Start planning as soon as possible!

Use information possibilities

- DGUV Information [205-035](#)
- [Video](#)



Firefighter exposures

stephan.koslitz@dguv.de

Phone: +49 30 13001-4416



Stephan Koslitz