Inside the fire: advancing human biomonitoring in firefighters

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In recent decades, several European countries, including Portugal, have experienced increasingly frequent and severe wildfires, a trend expected to intensify due to climate change. Wildfire smoke contains hazardous pollutants such as polycyclic aromatic hydrocarbons (PAHs), many of which are classified as carcinogenic. The International Agency for Research on Cancer has classified occupational exposure in firefighting as carcinogenic to humans. Nevertheless, firefighting remains insufficiently studied, particularly under real wildfire conditions.

This study aimed to identify and integrate suitable biomarkers for monitoring occupational exposure and early biological effects among Portuguese wildland firefighters.

A longitudinal study design was implemented, assessing firefighters at two time points: before the wildfire season (baseline) and after participation in a real wildfire event. Information on sociodemographic characteristics, health status, lifestyle, and occupational factors was obtained through questionnaires. Biological samples (blood, buccal cells, and urine) were collected in both phases. Biomarkers of genetic instability, primary DNA damage, oxidative DNA damage, and inflammatory response were evaluated. Urinary hydroxylated metabolites of polycyclic aromatic hydrocarbons (OH-PAHs) were quantified as exposure biomarkers.

Significant increases in DNA damage and inflammatory biomarkers were observed following wildfire exposure. Positive associations were identified between biomarkers of effect and urinary OH-PAHs levels, supporting a link between internal exposure and early biological alterations.

These findings highlight measurable adverse biological changes associated with wildfire firefighting. The results reinforce the importance of structured biomonitoring programmes, preventive strategies, and occupational health surveillance to protect firefighters in the context of escalating wildfire events driven by climate change.

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