URINARY LEVELS OF MONOHYDROXYL PAH METABOLITES IN PORTUGUESE FIREFIGHTERS: BACKGROUND LEVELS AND IMPACT OF TOBACCO SMOKE

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INTRODUCTION

- Firefighting occupational exposure is classified as possible carcinogen to humans by the International Agency for Research on Cancer and the US National Institute for Occupational Safety and Health [1,2].
- Tobacco smoke is a very important factor in the assessment of occupational exposure of workers, since the prolonged exposure to tobacco smoke is by itself the major cause of lung cancer [3]. The consumption of tobacco is responsible for the exposure to many smoke components including more than sixty known carcinogens, including some polycyclic aromatic hydrocarbons (PAHs) [4].
- PAHs are ubiquitous compounds formed during pyrolysis or incomplete combustion of organic matter, being well-known for their toxic, mutagenic, and carcinogenic properties to humans [5,6]. So far, the impact of tobacco smoke on firefighters' total exposure to PAHs is very limited.
- Full monitoring of firefighters' exposure to PAHs via all exposure routes should be performed through the quantification of their internal dose.
- The present study aims to perform the exposure assessment of Portuguese firefighters by six urinary PAH metabolites (OH-PAHs: 1-hydroxynaphthalene (1OHNaph), 1-hydroxyacenaphthene (1OHAce), 2-hydroxyfluorene (2OHFlu), 1-hydroxyphenanthrene (1OHPhen), 1-hydroxypyrene (1OHPy) and 3-hydroxybenzo[a]pyrene (3OHB[a]P) in smoking (S) and non-smoking (NS) firefighters.

EXPERIMENTAL

- A total of 21 healthy firefighters serving at Bragança fire station (North of Portugal) were selected through a structured questionnaire [7]. The collected information was age, weight, number of years as firefighters; participation in firefighting activities; tobacco smoking habits (including the number of cigarettes smoked per day for smokers) and on the most frequently consumed meals (boiled, roasted, and grilled) during the week before urine collection. Only firefighters that were not involved in firefighting activities within the last five days before sampling were considered. According to the information collected through the questionnaires, individuals were separated in two groups: smoking and non-smoking subjects.
- Firefighters collected a spot urine sample in sterilized 50 mL polycarbonate containers at the end of their work shift. Urine samples were frozen at -20 ºC until analysis.
- Extraction and chromatographic analysis of urinary OH-PAHs were done according to the detailed description in a previous study of this research group [8]. All determination were performed in triplicate.
- The concentration of urinary creatinine was determined according to the Jaffe colorimetric method [9] and used to normalize the urinary concentrations of OH-PAHs.

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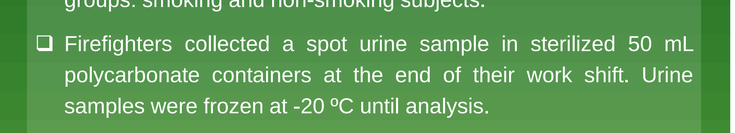

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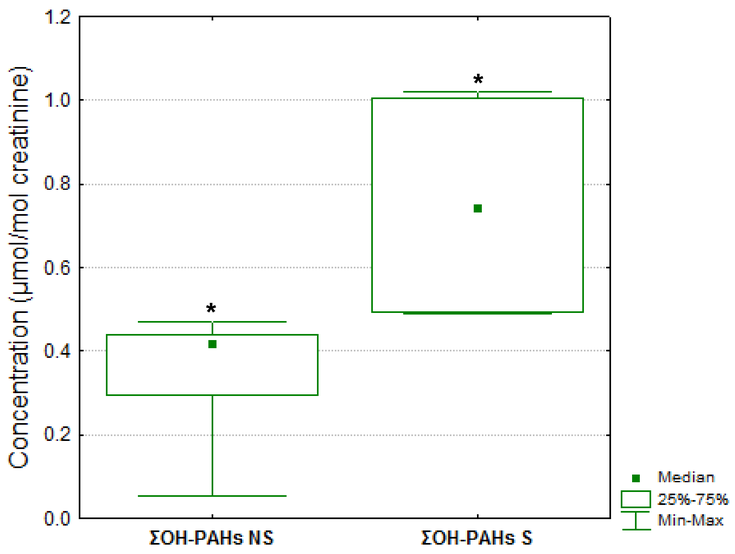
RESULTS

- All firefighters reported to have a diet exclusive of charbroiled and deep-fried foods within the five days before urine collection, thus making negligible the contribution of food to the overall exposure to PAHs.
- The concentrations of OH-PAHs were adjusted with the levels of creatinine for each firefighter' spot urine sample. Urinary creatinine concentrations ranged between 2,77 to 2,90 g/L for both smoking and non-smoking firefighters. No significant differences were found between the medians of these two groups (p>0.05).
- 1OHNaph and/or 1OHAce were detected in 100 and 80% of the smoking and non-smoking firefighters' urines, respectively.
- 1OHPhen, 2OHFlu, and 1OHPy were detected in the urine of all firefighters.
- 3OHB[a]P was never detected.

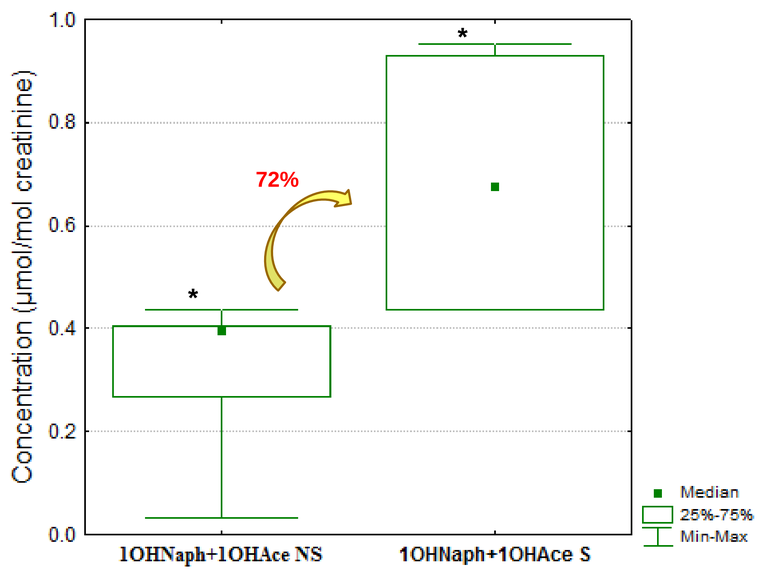
Biometric characterization of the firefighters that participated in the study (n=21)

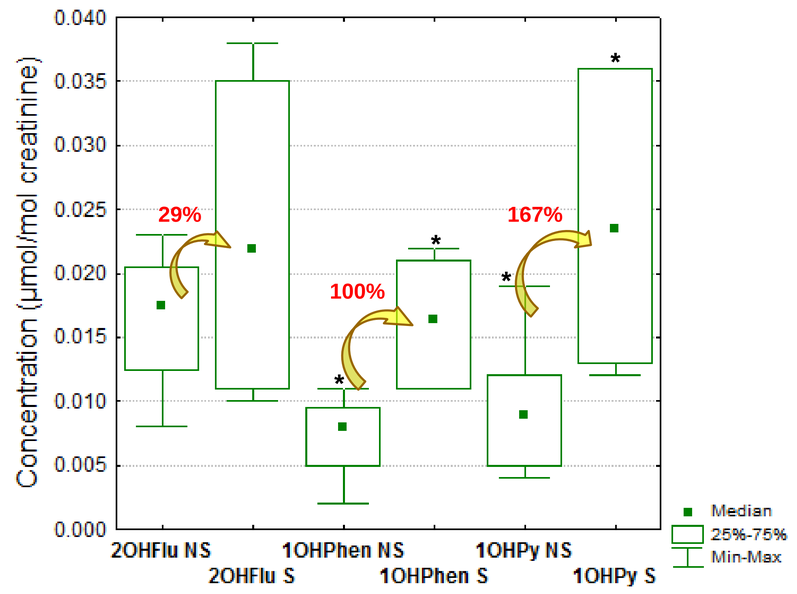
Characteristic	Smoking	Non-smoking
Firefighters (n)	6	15
Age (mean ± SD; min – max; years)	22 ± 1.4 (21-23)	40 ± 5.6 (34-48)
Body mass index (mean ± SD; min – max)	26 ± 2.4 (24-28)	29 ± 4.2 (25-36)
Number of years as firefighters		
≤ 10 years (%)	100	17
10 – 20 years (%)	0	33
≥ 20 years (%)	0	50
Number of cigarettes smoked per day (mean ± SD; min – max)	11 ± 1.4 (10-12)	n.a.
Diastolic blood pressure (mean ± SD; min – max; mmHg)	92 ± 7.1 (87-97)	86 ± 11 (72-106)
Systolic blood pressure (mean ± SD; min – max; mmHg)	138 ± 19 (125-152)	137 ± 11 (127-152)
Cardiac frequency (mean ± SD; min – max; heart beats/min.)	79 ± 5.7 (75-83)	72 ± 9.4 (62-84)
Respiratory pathologies	No	No
Allergies	No	No

n.a. – not applicable



- Urinary ∑OH-PAHs were 0.738 (0.491-1.02) µmol/mol creatinine for smoking and 0.429 (0.053-0.472) µmol/mol creatinine for non-smoking firefighters
- Concentrations increased 72% in smoking firefighters (*p=0.003, nonparametric Mann−Whitney U test)





- Smoking firefighters working at BRG fire station presented urinary levels of all individual OH-PAHs, except for 2OHFlu, 72-167% higher than in non-smokers (0.676 *versus* 0.394 µmol/mol creatinine for 1OHNaph and/or 1OHAce, 0.016 *versus* 0.008 µmol/mol creatinine for 1OHPhen, and 0.024 *versus* 0.009 µmol/mol creatinine for 1OHPy; *p≤0.001, nonparametric Mann−Whitney U test).
- Spearman correlations between the levels of OH-PAHs in smoking firefighters revealed that urinary 1OHPhen concentrations were globally well correlated with the levels of other PAH metabolites (r≥0.716, with p≤0,173, except with 1OHPy).
- The relation between the urinary levels of individual and total OH-PAHs with the number of smoked cigarettes for each firefighter revealed the existence of strong and significant positive correlations in smoking firefighters (r=0.878, p≤0.021 for ∑OH-PAHs; r=0.891, p=0.017 for 1OHNaph and/or 1OHAce and 2OHFlu; r=0.905, p=0.013 for 1OHPhen).
- Limited information concerning reference standard guidelines for urinary levels of OH-PAHs is available. The urinary levels of 1OHPy, in both smoking and non-smoking firefighters, was much lower than the guideline of 0.5 µmol/mol creatinine recommended by the American Conference of Governmental Industrial Hygienists for occupational exposure to PAHs in smoking and non-smoking workers [10].

CONCLUSIONS

- This study proved that smoking firefighters presented significantly higher levels of urinary OH-PAHs comparatively with the control group, revealing the higher predisposition of these firefighters to develop the potential health effects associated with the exposure to PAHs.
- Regarding the incidence of cancer in firefighters, some studies reported an elevated risk of developing several types of cancers, including urothelial, skin, lung, kidney and testicular cancers [11-13] throughout their professional career; however some findings remain contradictory. Thus more studies concerning both occupational and environmental exposure of firefighters as well as toxicological and epidemiological studies are needed to better estimate the overall and cumulative risks and the potential health effects of firefighters occupational exposure.

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