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NMR-based metabolomics for the identification of predictive urinary metabolic

biomarkers of workers exposed to welding fumes

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BACKGROUND & AIM

- NMR-based metabolomics is a novel tool in occupational exposure, providing a detailed characterization of metabolic phenotypes
- This work is aimed at defining the urinary metabolic profiles of workers of the same company exposed to two different chemical agents: welding fumes and volatile organic compounds



NMR ANALYSIS

- Urine samples of welding fumes (WF) exposed workers were collected at the beginning and at the end of the work-shift, while volatile organic compound (VOC) exposed workers provided first morning urine sample
- All the spectra were acquired on a JEOL JNM-ECZ 600R spectrometer, equipped with a 14.09 T magnet (600 MHz for ¹H resonance frequency) and an autosampler



OXIDATIVE STRESS BIOMARKERS

Methylguanidine (MG) and Pseudouridine (PSI) are the NMR variables related to the response to oxidative stress, reflecting high RNA turnover and hence a high protein turnover



HPLC-MS variables 8-oxo-7,8-dihydroguanosine (8-oxoGuo) and 3-Nitrotyrosine (3-NO2Tyr) are related to oxidatively generated damage and protein oxidation respectively



URINARY METALS

Urinary concentrations Pb and Hg were higher in welders than in VOC exposed workers. Furthermore, a positive correlation between MG and Hg have been found.



PLS-DA

NMR data matrix was combined with five HPLC-MS urinary biomarkers of oxidative stress and sixteen ICP-MS urinary metals. All the variables have been logtransformed, in order to make the distributions more similar to the normal one

Comparison between WF exposed workers, at the beginning of the shift (BS) and VOC exposed workers



Comparison between WF exposed workers at the end of the shift (ES) and VOC exposed workers



PLS-DA showed a higher urinary excretion of metabolites related to oxidative stress in WF exposed workers compared to VOC exposed workers, such as NMR variables methylguanidine and pseudouridine, HPLC-MS variables 8-oxo-7,8-dihydroguanosine and 3-nitrotyrosine, along with a higher excretion of urinary metals such as Pb and Hg

CONCLUSIONS

- The results showed the existence of an oxidative stress condition linked to the occupational exposure
- NMR-based metabolomic analysis showed an increased urinary concentration of MG and PSI, emerging as possible biomarkers of oxidative stress in WF exposure
- NMR spectroscopy has emerged as an effective technique to be used alongside more conventional analytical techniques for biological monitoring in the field of occupational exposure