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

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

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 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