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Evaluation of Metabolites of 1-Nitropyrene in Urine as a Suitable Biomarker for Exposure to Diesel Exhaust

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Objectives: Exposure to diesel exhaust (DE) is common in occupational and environmental settings and has been associated with several adverse health outcomes. Therefore, the ability to accurately quantify DE levels is crucial for understanding and controlling exposures. A DE-specific chemical component, 1-Nitropyrene (1-NP), has been proposed as a potential marker for exposure to DE in air and biological samples. In this study the suitability of 1-NP urinary metabolites as biomarkers for monitoring occupational exposure to DE was evaluated.

Methods: The study took place in a large underground metal mine that uses diesel engines extensively. Air and urine samples were collected from a cohort of 20 miners who performed a variety of jobs located within the mine. Four sampling campaigns were conducted, each 2-3 months apart. During each campaign personal air samples, pre- and post-shift urine, and job task/activity surveys were collected for each subject. Air samples (n=140) were analyzed for Elemental Carbon (EC) and 1-NP. Urine samples (n=170) were analyzed for 1-NP metabolites using an HPLC-MS/MS assay. The association between 1-NP metabolites in urine and exposure to 1-NP in air was assessed using a regression model to determine if 1-NP urinary metabolites are a suitable biomarker for DE. Additionally, the suitability of survey data as a surrogate estimate for DE exposure was evaluated using a predictive model for 1-NP metabolites based on job and time-activity covariates.

Results: A range of EC and 1-NP exposures was observed (EC: GM=8.3µg/m^3, GSD=2.5µg/m^3; 1-NP: GM=35pg/m^3, GSD=5.1pg/m^3). A range of metabolite levels, consistent with the variability in exposure, was also observed (8-OHNP: 0.05-0.44pg/mL; 6-OHNP: 0.06-1.13pg/mL). Very few workers reported off-shift exposure to DE, suggesting that metabolite levels reflect occupational exposures.

Conclusions: Levels of EC, 1-NP, and urinary metabolites in this cohort were high relative to environmental exposures, but were within the range of reported occupational levels.

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