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The chemical exposome in maternal blood and placenta and the potential use of sewage sludge to prioritize hazardous substances

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Abstract. Chemicals are part of our daily lives and we are exposed to numerous chemicals through multiple pathways. Relevant scientific evidence contributing to the regulation of hazardous chemicals require a holistic approach to assess simultaneous exposure to multiple compounds. Currently, the main way to obtain data on the exposure to organic chemicals is through human biomonitoring, that requires very complex and costly sampling campaigns. Finding efficient proxies to predict the risk of chemical exposure in humans is an urgent need to cover large areas and populations at a reasonable cost. We conducted a study to characterize the human chemical exposome in maternal blood and placenta samples of a population-based birth cohort in Barcelona (2018-2021, n>300). Ultimate HRMS-based approaches were applied including wide-scope target, suspect (for >2300 and >10000 chemicals, respectively) and non-target screening. More than sixty chemicals were identified including pesticides, personal care products or industrial compounds, among others, in the range of ng/mL and ng/g. In parallel, sewage sludge from the wastewater treatment plants serving the residence areas of the studied population were also screened, showing correlations with the type and concentrations of chemicals found in humans. Our findings were suggestive for the potential use of sewage sludge as a proxy of the human exposure and its application in early-warning systems to prevent chemical threats.
Keywords: Sewage epidemiology, Placenta, Blood.

1. Introduction

Chemicals in our environment contribute to the development of complex diseases, particularly chronic ones. Allergies, infertility, impaired brain development in children, cancer, and neurological disorders are increasingly prevalent and linked to environmental exposures. However, establishing clear evidence that specific chemicals cause adverse health effects is challenging, especially with the influx of new chemicals in the market. Limited knowledge about the presence and bioaccumulation of organic chemicals hinders a comprehensive understanding of the chemical exposome, which refers to lifelong environmental chemical exposures. Obtaining scientific evidence is crucial to grasp the presence and potential effects of new chemicals on human health. Regulators face challenges in identifying and addressing harmful chemicals in workplaces and daily life. Biomonitoring offers an accurate method to measure exposure and bioaccumulation of organic chemicals by directly analyzing relevant biofluids and tissues. Current analytical strategies in biomonitoring are limited as they only consider a small fraction of the vast range of chemicals. High-resolution mass spectrometry (HRMS) has revolutionized the identification of previously unknown chemicals of concern. Chemical repositories and screening tools have expanded the possibilities for large-scale investigations. While some projects have successfully employed these strategies to identify potential chemical exposures in humans, biomonitoring campaigns face logistical, ethical, and economic constraints that limit their scope. Finding efficient proxies to predict chemical exposure risks in humans is crucial for broader coverage. Sewage epidemiology, used to estimate population behavior regarding substance consumption and disease outbreaks, can play a significant role. This study explores using sewage sludge as a proxy for the human chemical exposome, demonstrating its potential for early warning systems to prevent bioaccumulation of hazardous chemicals without extensive biomonitoring campaigns.

2. Methods

Maternal blood (n = 10) and placenta samples (n=9) from from the Barcelona Life Cohort Study (BiSC). Sludge samples (n = 6) from wastewater treatment plants (WWTP)

serving the residence areas of the studied population. Wide-scope target analysis (>2300 organic chemicals), suspect screening including (>7500 chemicals, EXPHRMSMSAVAL list) and non-target analysis were applied to the samples. The similarity of human and sewage sludge samples was evaluated in terms of presence/absence of xenobiotics and overall matrix composition using nontarget approaches. UHPLC-QTOF (Bruker Daltonics) and UHPL-Q-Exactive Orbitrap instrument (Thermo Scientific) were used.

3. Results and Discussion

Forty-two chemicals were found in blood and placenta samples using the three different workflows, including pharmaceuticals, food-derived chemicals, herbicides, insect repellents, and industrial chemicals. Over 80% of these compounds were also detected in the sludge. Among 6538 features, more than 2000 were common in all three matrices. The experimental results indicate that screening sludge can provide valuable nformation about the potential bioaccumulation (or pseudobioaccumulation) risk of certain substances in humans.

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