Matters arising: Bioaccumulation of microplastics in decedent human brains

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Human exposure to microplastics and nanoplastics (MNPs) is an emerging concern with potential implications for health. In a recent study, Nihart et al. used pyrolysis gas chromatography–mass spectrometry (Py-GC–MS) to detect MNPs in human liver, kidney, and brain tissues, reporting the highest levels in the brain and polyethylene (PE) as the most abundant polymer. However, the study lacks key contamination controls and validation steps, raising questions about the reliability of the reported concentrations. We highlight methodological limitations that have broad relevance for advancing robust and reproducible MNP detection in human biomonitoring studies.

Lack of procedural controls and quality assurance measures

Detecting MNPs in human tissues poses significant analytical challenges due to the pervasive presence of plastic contaminants and the complexity of biological matrices. International best-practice guidelines, including ISO 24187:2023 and OECD test protocols, emphasise the need for comprehensive quality assurance and quality control (QA/QC) procedures. These include the systematic use of procedural blanks, field blanks, and validated protocols for tissue digestion and polymer recovery. Such measures are critical to differentiate real tissue-derived MNPs from contamination introduced during sampling, sample preparation, or analysis [2]. However, the study by Nihart et al. does not report the implementation of these QA/QC, making it difficult to exclude contamination from laboratory reagents, equipment, or airborne particulates, each of which is a well-documented source of false positives in MNP analysis [3]. Moreover, tissue samples in the study were collected across different years and locations, raising further uncertainty about whether harmonised, contamination-minimising protocols were used. In environmental MNP research, such variability has been shown to impact results significantly [4]. Importantly, this reflects a broader challenge in the field, highlighting the urgent need for standardised sampling and QA/QC procedures across all human MNP studies to ensure credible and reproducible findings

In their study, Nihart et al. used a 10% potassium hydroxide (KOH) digestion at 40 °C for 72 hours, followed by centrifugation and ethanol washing. However, KOH digestion is known to be suboptimal for lipid-rich tissues like the brain [5, 2], with incomplete tissue removal often resulting in residual particulates that can be misidentified as synthetic polymers. Indeed, the study reports digestion efficiencies below 90% for several brain samples (Figure S5), suggesting a significant fraction of undigested material remained.

The study does not describe polymer-spiking experiments to validate recovery efficiency, limits of detection/quantification and identification accuracy, as well as to understand potential impacts of the extraction method on particle integrity [2]. This limitation is not unique to this study but also reflects another broader challenge in human biomonitoring of MNPs, underscoring the requirement for certified reference materials that reflect relevant size, type, and morphology of particles, and are specifically designed for use in complex biological matrices.

Methodological limitations of Py-GC–MS for MNPs detection in biological tissue

Py-GC–MS is a well-established tool for polymer identification, but its specificity is limited when applied to biological samples. The consistent predominance of PE across all organs, time points, and individuals in the study of Nihart et al. (2025) is unexpected and may reflect methodological artefacts. Many biological lipids, especially long-chain fatty acids, produce pyrolysis products that can mimic PE mass fragments [6]. Without adequate spectral resolution, this overlap can lead to misidentification. Best practices recommend confirming polymer identity using multiple diagnostic mass traces and ensuring consistent retention time patterns relative to neighbouring peaks. This is especially critical, as an inexperienced analyst may overlook subtle but crucial differences, further increasing the risk of false positives. However, the authors note that such marker ions were absent in their spectra, which raises concerns that the observed PE signals may derive from residual fatty acids rather than polymeric PE.

This possibility is reinforced by the lipid-rich nature of brain tissue (~60% lipid by dry weight) [7], compared to the liver and kidneys (<5%) [8, 9]. If the digestion was incomplete, as suggested by the reported efficiencies, lipid-derived interference could disproportionately affect brain samples, potentially explaining the higher MNP concentrations observed in the brain relative to other tissues.

Furthermore, the observed increase in MNP concentrations over time may not reflect true bioaccumulation but could instead result from variability in lipid content or sample handling. For instance, rising global obesity rates have been linked to increased lipid accumulation in human brain and liver tissues [10, 11], potentially influencing analytical outcomes over multi-year sample series.

Conclusion

The detection of MNPs in human tissues is an emerging field with profound implications for public health, but it remains fraught with methodological uncertainties. Studies aiming to quantify MNPs in biological matrices should be anchored in robust QA/QC protocols, including the use of blanks, contamination-free sampling, digestion validation, and recovery experiments with reference materials. Furthermore, the application of Py-GC–MS for complex matrices such as brain tissue requires additional scrutiny. Polymer identification should be supported by multiple diagnostic mass traces and matrix-matched standards to ensure specificity.

These challenges are not unique to the study by Nihart et al. Rather, they reflect broader gaps in methodological standardisation across the field. As human biomonitoring of MNPs progresses, we encourage the community to adopt harmonised practices that enhance transparency, reproducibility, and confidence in reported findings. Only with such rigor can we generate reliable data to inform risk assessments, public policy, and future research priorities.

Ethics declarations

The author declares no competing interests.

Contributions

F.A.M and DM conceived the work. All authors contributed to the writing of the article.

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