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Unveiling the presence of MNPs within the human body

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Abstract:

Micro and nanoplastics (MNPs) have emerged as critical contaminants of both the environment and human health. The current work synthesizes data from several studies to elucidate MNP occurrence in blood, saliva, and urine. Findings highlight polypropylene (PP), polyethylene terephthalate (PET), and polystyrene (PS) as frequently identified polymers of varied sizes and morphologies, with potential for systemic distribution and partial excretion. However, the lack of standardized extraction protocols and analytical procedures for their analysis hinders cross-study comparisons, underscoring the urgent need for uniform methodologies. Further exploration of additional biological matrices such as stool, cerumen, breast milk, and meconium, remains imperative to develop a comprehensive understanding of MNP exposure and associated health risks.

Keywords: Microplastics, Nanoplastics, Blood, Urine, Saliva

1. Introduction

Micro and nanoplastics (MNPs) have garnered significant scientific attention recently, as emerging contaminants with potential implications for both environmental and human health. These plastic particles are less than 5 mm and 1 μm in diameter respectively, originate from a combination of primary and secondary sources. Primary sources refer to intentionally manufactured particles, such as microbeads, commonly used in personal care and household cleaning products. Secondary sources mainly result from the environmental degradation and fragmentation of larger plastic items due to physical, chemical, and biological processes (Li and Liu 2024).

Human exposure to MNPs occurs primarily through ingestion and inhalation, with dermal absorption and intravenous introduction, being less common yet possible exposure pathways. Notably, a recent study estimates that an individual may ingest or inhale over 300,000 MNPs annually (Li and Liu 2024). Evidence of these particles has been documented in multiple human biological matrices such as blood, saliva and urine. Furthermore, MNPs have been spotted in vital organs such as the liver, heart, placenta, and reproductive tissues, raising critical concerns regarding their potential for systemic bioaccumulation and organ toxicity (Enyoh et al. 2023; Kyriakopoulos, Zorpas, and Inglezakis 2025).

The types of polymers detected in biological and environmental samples vary, with polypropylene (PP), polyethylene terephthalate (PET), and polystyrene (PS) being the most commonly reported. While the full extent of their biological impact is still under investigation, both in vitro and in vivo studies have indicated associations with inflammatory responses, oxidative stress, endocrine disruption, and cytotoxic effects (Enyoh et al. 2023; Li and Liu 2024; Roslan et al. 2024).

2. Materials and Methods

Using PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) a collection of articles and reports were chosen for the current work, by counting eligibility criteria and exclusion metrics. The primary databases used was SCOPUS where out of 74148 studies from 2000-2025 identified for the review, 109 of them were chosen concerning relevancy to the topic. The suitability of these articles chosen was constructed under the following inclusion criteria: (a) papers focusing on MNPs (b) Biological matrices. The elimination criteria were: (a) duplicate papers, (b) papers written in other languages than English, (c) not containing sufficient information. The keywords chosen for the search included “Micro” OR “Nano” AND “Plastics”, “Blood”, “Urine”, “Saliva”.

3. Results and Discussion

Although extraction methods such as TRIS-HCl buffer and potassium hydroxide (KOH) are commonly employed, a universally standardized protocol for the extraction of MNPs across all biological matrices has yet to be established (Li and Liu 2024; Roslan et al. 2024). Once extracted, these particles are commonly analyzed and characterized using micro-Raman spectroscopy (μRaman), micro-Fourier transform infrared spectroscopy (μFTIR), pyrolysis–gas chromatography–mass spectrometry (Py-GC-MS), and laser direct infrared imaging spectroscopy (LDIR) (Roslan et al. 2024).
Dominant polymers detected in blood included PE, PET, PS, and polymethyl methacrylate (PMMA), with particle

sizes exceeding 700 nm. In saliva, MNPs ranged from 100 to 500 μm in size and exhibited diverse morphologies, including spheres, fragments, films, and fibers. Common polymers identified were polypropylene (PP), PE, PET, PS, and polyvinyl chloride (PVC), with particles displaying a wide spectrum of colors, such as blue, red, yellow, and transparent, suggesting multiple environmental sources (Roslan et al. 2024). Urine samples have demonstrated the body's capacity to excrete microplastics, though this process appears to be size-selective. Across multiple studies, between 7 to 98 MNPs were usually detected per sample, typically ranging from 4 to 15 μm, with occasional detection of NPs as small as 10 nm. Identified polymers in urine included polyvinyl alcohol (PVA), PVC, PP, PE, and polyamide (PA) (Li and Liu 2024; Roslan et al. 2024). Stool, sputum, and hair samples have also been investigated for microplastic detection, yielding promising findings that highlight their potential for monitoring human exposure.

4. Conclusion

The confirmed presence of MNPs in blood, saliva, and urine demonstrates their ability to penetrate systemic circulation, interact with mucosal barriers, and undergo partial renal clearance. However, current research is constrained by methodological inconsistencies and the absence of standardized protocols for MNPs extraction and analysis across diverse biological media. Moreover, the lack of data on MNPs in other biological matrices, such as stool, cerumen, breast milk and meconium represent a critical gap in our understanding of the full extent of human exposure. These matrices are also worth investigating, as they may offer important insights into early-life exposure, excretory pathways, and mucosal accumulation of MNPs.

References

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