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Geochemical and Spectral Methodologies for the Quantitative Characterization of Urinary Particulate Matter in Healthy Humans

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Research on particulate matter in urine is limited, despite its potential relevance to health monitoring. Urine is known to contain various undissolved particles, but studies on particulate content have tended to focus on specific matters of medical (diagnostic) interest, such as markers of kidney function or malignancies. Moreover, the emphasis has been on identification rather than on quantitative analysis. In this presentation we present a rigorous application of geochemical and spectral methodologies for the analysis of particulate matter in urine using flow cytometry, in terms of concentration types and size distribution of particles and, subsequently, to characterize and quantify the particulate content (suspended matter within a diameter range of 0.33-70 μm) in the urine of apparently healthy individuals. This approach enabled the identification and quantification of total particles, as well as the characterization of specific subtypes, including lipid-associated particles, protein aggregates, lipid-protein complexes, calcium ion-containing particles (e.g., calcium oxalate crystals), DNA-containing entities (such as cells and bacteria), and crystalline structures. We further report establishment of benchmark values for particulate concentrations, accounting for age, gender, and time of sampling, providing important insights into the number of particles traversing the urinary tract on a daily basis. Approximately 320×10^6 particles are estimated to pass through the urinary tract each day. Importantly, statistical analysis revealed no significant differences in particulate concentration based on gender, age, or sampling time. This study provides foundational data for future investigations and contributes to advancing our understanding of urinary tract function, with potential implications for identifying biomarkers of various health conditions.