Unraveling Airborne Microplastics in Northern Taiwan: A Spatiotemporal Analysis of Sources, Characteristics, and Health Hazards

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Abstract

This study investigates the distribution, characteristics, and health risks of airborne microplastics (MPs) in four distinct outdoor environments—urban, suburban, industrial, and rural—in Taoyuan City, Northern Taiwan. Air sampling was conducted from January to December 2023 using both active and passive techniques. MPs were characterized based on shape, size, color, and polymer composition using microscopy and micro-FTIR analysis. Results show that fibers and fragments were the dominant shapes, with white particles and sizes between 101–300 µm being most prevalent. Polyethyl acrylate (PEA) emerged as the most abundant polymer, suggesting a strong link to industrial coatings and road surface degradation. Seasonal trends revealed higher MP concentrations during autumn and winter, attributed to atmospheric stability and cross-border air mass transport. The backward trajectory analysis using the HYSPLIT model confirmed seasonal shifts in air mass origins, particularly from northeastern China. Principal Component Analysis indicated wind speed and atmospheric pressure significantly influenced MP dispersion. Health risk assessments identified industrial and urban sites as posing the highest inhalation hazards, particularly for children, with calculated hazard indices in the "considerable" risk category. This study underscores the importance of monitoring atmospheric MPs in urbanizing regions and highlights the combined influence of local emissions and long-range transport on outdoor air quality and human health.

Keywords: Airborne microplastics, Outdoor air quality, Health risk assessment, HYSPLIT model.