PLASTIC PARTICLES AND ALLERGIES: MAIN OUTCOMES FROM THE IMPTOX PROJECT

This document provides an overview of key findings from the Imptox project, highlighting the potential health implications of micro- and nanoplastics (MNPs), with a particular focus on allergies.

- The Imptox project has developed a **framework to assess how micro- and nanoplastics contribute to allergy and asthma risks**. This framework integrates risk assessment data to identify and quantify hazards associated with MNP exposure via air and food. It provides insights, models population-level impacts, and guides public health interventions.
- Experimental animal studies focused on inhalation and ingestion of pristine, sterile and spherical MNPs combined with allergens. **The effects on allergic responses are highly variable because they are dependent on plastic composition, size and number**. The results are critical for understanding the impacts of MNPs on allergic sensitization and severity of pre-existing allergic disease, but will require further studies addressing real-world situations with mixtures of MNPs differing in plastic type, shape, size and numbers.
- **MNPs can carry allergens, pathogens, and antibiotic resistance genes**. MNPs provide a surface for the formation of a complex ecosystem called the 'plastisphere,' composed of a biofilm of bacteria, fungi, and algae, along with allergens, pathogens, and pollutants. This biofilm can be enriched with resistance and virulence genes, including those conferring resistance to antibiotics. Inhalation or ingestion of these particles may introduce harmful elements into the body, potentially **amplifying allergic reactions.**
- **The uptake of nanoplastics as well as of their potential co-contaminants,** such as cyanotoxins, has been shown in plant foods directly influencing dietary exposure.
- **MNPs are increasingly found in food** including seafood and dairy products, with potential migration from food packaging. MNPs can **interact with allergenic proteins**, forming "coronas" that alter their structure, potentially influencing immune responses and **triggering allergic reactions**. These interactions can also **delay digestion** and **alter nutrient absorption**, with possible negative effects on metabolism and health. Children, especially infants, are particularly vulnerable.
- **Prolonged exposure to nanoplastics can impair cell function**. Imptox studies simulating everyday exposure to low levels of nanoplastics have shown to cause significant damage to the mitochondria, the cell's energy centers, gene expression, function, and to suppress cell differentiation. These effects could heighten cytotoxicity, inflammatory responses and **contribute to the development or worsening of a variety of (allergic) diseases.**
- **Clinical studies with allergic children** are exploring the links between MNPs and allergic diseases. Research in 3 different regions in Croatia is assessing exposure routes, including inhalation, diet, and water, and analyzing biological samples. Lifestyle factors such as dietary habits and plastic usage are shown to have an impact. The results are key in understanding the impacts of MNPs on children's health and guide strategies for protection.
- **Artificial intelligence and neural networks** are being used to improve MNP detection. A real-time detection tool combines holographic imaging, fluorescence analysis, and machine learning to identify airborne microplastics with high accuracy. Neural networks integrated with advanced software are accelerating the analysis of MNPs in food and environmental samples. These tools provide valuable data **to explore how MNPs may carry allergens or influence immune responses.**

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