Opinion

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Emerging Impacts on Human Health Due to the Presence of Microplastics in Water

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Introduction

"Synthetic solid particles or polymeric matrices, with regular or irregular form and size ranging from 1 m to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water," according to the definition of microplastics (MPs). One of the major concerns about microplastic contamination is whether it poses a threat to ecosystems and human health. However, there is a lot of ambiguity around this topic. To assess the danger of microplastics to the environment and human health, data on exposure and impact levels of microplastics is necessary. The negative impacts of microplastics on organisms may be divided into two categories: physical effects and chemical effects. The former is concerned with microplastic particle size, shape, and concentration, whereas the latter is concerned with harmful compounds linked with microplastics. Despite the fact that data on microplastic exposure levels in ecosystems and organisms has quickly grown in recent decades, there is little information on the chemicals linked to microplastics [1].

While macroplastics are still a concern, microplastics and nanoplastics, which are produced by physical, biological, and chemical interactions with plastic, are becoming a more severe health threat. Micro and nanoplastics can enter human bodies through the usage of nanoplastic-containing items such as scrubs, lipsticks, mascara, shampoos, and other cosmetics, as well as through the ingestion of seafood [2].

Co-Contaminants and plastics

Chemicals can be found in microplastics in two forms: (i) additives and polymeric raw materials (e.g., monomers or oligomers) derived from the plastics, and (ii) chemicals absorbed from the environment.

Additives are chemicals that are added to plastic during the manufacturing process to give it qualities like colour and transparency, as well as to improve its resistance to ozone, temperature, light radiation, mould, bacteria, and humidity, as well as its mechanical, thermal, and electrical resistance.

Wood and rock flour, clay, kaolin, graphite, glass fibres, cotton flakes, jute or linen, cellulose pulp, and other materials are used as charges. Inert fillers are materials used to modify the strength, working and flow properties, and shrinkage of plastics, according to the definitions proposed by the American Society for Testing and Materials (ASTM-D-883), while reinforcing fillers, also known as fillers, are defined as those with some strength properties that are significantly superior to those of the base resin. When these fillers (such as carbon black in rubber) are combined with the polymer, an interface volume is created at the filler-resin contact surface. Increased modulus and mechanical characteristics such as impact strength and tensile strength in the composite polymer are due to the better properties of this interface layer. Because the impact is surface-related, fillers with smaller particle sizes have a higher reinforcing effect [3]. Clays, silica, glass, chalk, talc, asbestos, alumina, rutile, carbon black, and carbon nanotubes are some of the materials used.

Plasticizers are complex chemical compounds with a low vapour pressure, insoluble in liquids, chemical stability, and are placed between molecular chains to minimise physical attraction forces and improve mobility, workability, and distensibility. This increases the flexibility and plasticity of a produced resin, as well as the product's impact resistance during usage.

While these additions increase the characteristics of polymeric goods, many of them are hazardous, posing a significant risk of pollution of soil, air, and water. Studies on the influence of macro and microplastics on aquatic creatures with which they come into contact are currently continuing [4]. The combination of various types of polymers of various sizes and shapes, combined with the action of a large number of additives derived from plastics, results in a cocktail of contaminants that not only change the nature of plastic but can also leach into the air, water, food, and, potentially, human body tissue during use or disposal, exposing us to a variety of chemicals.

Impacts on human health

While a lot of studies have demonstrated that plastics have detrimental effects on the neurological system, hormones, and immune system, as well as cancer-causing properties, scientists are now attempting to understand how the body's fundamental machinery interacts with plastic particles.

According to a study, blood proteins such as albumins, globulins, and fibrinogens, which are involved in osmotic pressure, molecular transport, blood coagulation, and immune response, are absorbed on the surface of nanoplastics, forming plastic-protein complexes with sizes ranging from 13 to 600 nanometers. When proteins completely wrap plastic particles, the plastic-protein complexes are attracted to one another, causing the complexes to clump together. According to scientists, these clumps in the bloodstream can obstruct the passage of bodily fluids. Furthermore, blood proteins undergo structural and conformational changes as a result of this complex formation, leaving them non-functional [5].

Particles smaller than 2.5 mm can enter the gastrointestinal system by endocytosis by Peyer's patches' M cells (specialised epithelial cells of the mucosa-associated lymphoid tissues). Particles are transported from the intestinal lumen to the mucosal lymphoid tissues by M cells or by paracellular persorption. Persorption is the mechanical kneading of solid particles into the circulatory system through pores in the single-layer epithelium at the villus tips of the gastrointestinal tract (desquamation zones) [6]. Because of the persistent nature of microplastics, as well as their specific characteristics including hydrophobicity and chemical composition, the ensuing toxicity is thought to be inflammatory, with an accumulative impact that is dosage dependent. The discovery of microplastics in human faeces further verified this notion about the amounts of microplastics in males at a gastro-intestinal level: For every 10 g of stool, there were twenty plastic particles, primarily PE and PP (with sizes ranging from 5 to 500 mm). Indeed, up to 90% of ingested micro and nanoplastics should be removed by the human excretory system.

Recent in vitro investigations on the effects of plastics on the human body have mostly employed manufactured nanoplastics, which, owing to their size, charge, and shape, can impact their absorption as well as the translocation and generation of ROS. In fact, the interaction between positively charged polystyrene nanoparticles (60 nm) and the secretory layer of the gastrointestinal epithelium (first physical barrier after digestion) was investigated in the research. In the intestinal epithelial cell lines LS174T, HT-29, and Caco-2, nanoplastics shown a high capacity to interact with the secretory film, affect cellular viability, and trigger apoptosis. Those harmful effects were earlier reported in the work of, which used polystyrene nanoparticles of 20 and 40 nm to treat cancer colon–rectal human differentiated cells, Caco-2 [7,8].

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