

Plastics and human health



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Keywords: Microplastic; Additives; Human Health

Abstract: Since the 1950s, plastic has become ubiquitous, but its excessive consumption and problematic disposal are threatening the planet. Their slow degradation generates micro and nanoplastics, contaminating air, water, and soil. Toxic additives present in plastic also pose health risks, can be found in the human body, and are associated with several diseases. Studies show that microplastics cause cellular damage and can lead to serious problems. The plastic production chain is harmful, and recycling has proven ineffective. Reducing production, regulating chemicals, and supporting global agreements are crucial to mitigate these impacts.

Since the 1950s, our lives have been invaded by plastic. Items containing plastic are found in our clothing, household appliances, furniture, food packaging, cleaning products, cosmetics, toys etc. Plastic has become part of a supposedly fast, practical, and hygienic way of life, with the objects we use having an average lifespan of less than three years (Alliance Sorbonne Université, 2024).

The excessive production and consumption of plastic, especially single-use items, is already a threat to the stability of the planet's functions and to humanity. The complete degradation of polymers, whether at sea or in the soil, does not occur on a human time scale. The degradation of plastic under environmental conditions generates micro and nanoplastics¹ that remain in the environment for centuries. An estimate from 2023, after sampling in several marine areas, showed that there are 170 trillion plastic particles floating in the ocean (Eriksen et al., 2023). In all regions of the world, there are microparticles of plastic in the air. The soil is also largely contaminated by plastic, either from plasticulture, which is an agricultural technique that uses plastics to cover the soil, build greenhouses and tunnels, and control the microclimate, or from

1. To learn more about microplastics, we recommend the classes given by Prof. Walter Waldman in the course "Crise dos plásticos: da informação à ação" available through the links: [Video 1](#); [Video 2](#), [Video 3](#).

fertilizer packaging, dumps, or sewage sludge, which contaminate and harm soil biota and plant structure.

In addition to environmental contamination by microplastics, there is a serious problem regarding plastic additives. There are over 16,000 chemical substances that are added to plastic to give it different properties, of which 4,200 have already been identified as toxic, posing a risk to human health. These substances include the chemical groups phthalates, bisphenols, polyfluorinated alkyl substances (PFAs), among others. It is already known that plastic additives can contaminate food when present in packaging. The World Health Organization recommends that information about health and safety in the composition of chemical products should not be confidential, but information about the composition of additives in plastic products is not available in Brazil (Carney Almroth et al., 2025).

With this massive exposure of living beings to microplastics and additives, whether through water, food or air, it is easy to understand that these substances are also present inside their bodies. We ingest food containing microplastic, drink water contaminated with plastic, and inhale plastics inside our homes. Plastics can even be absorbed through the skin, in the case of cosmetics containing microparticles. The first studies in this field of knowledge showed microplastics in marine animals, due to the substantial contamination of the ocean. In humans, the presence of microplastics has been demonstrated in most organs, such as the lungs, brain, heart, liver, prostate, and kidneys. Microparticles have also been detected in the nasal cavity, blood, sputum, and urine. Microplastics circulate in our blood and reach breast milk. They are found in the placenta and fetus and have been identified in meconium and amniotic fluid. It is worth noting that nanoplastics, which are very small particles (1 μm), have greater potential for biological damage, as they can enter cells (Landrigan et al., 2023).

In recent years, the literature on the health effects of microplastics has grown significantly, with researchers around the world concerned with understanding the consequences of the presence of this toxic material circulating and deposited in our bodies. The vast majority of studies are conducted on either experimental animals or cell cultures, where it is possible to control the type of plastic administered, the route of administration, and the time of exposure, among other factors.

Plastics cause cellular damage linked to oxidative stress and inflammation in endocrine regulatory pathways and can cause damage to cell membranes and to cellular DNA. Experimental studies show that they can compromise immune function, alter cellular and energy metabolism, inhibit cell proliferation, degenerate tissues, trigger the development and dysfunction of abnormal organs, alter biochemical parameters, and even cause genotoxicity and carcinogenicity. All these cellular alterations can lead to the onset or worsening of chronic or degenerative diseases, endocrine disorders, metabolic disorders, and

cancers. In animals, microplastics can cause thrombosis in the brain and behavioral disorders. In the heart, they cause cardiac toxicity. In lung cells, microplastics can induce inflammatory proteins. In the reproductive system of mice, microplastics were shown to alter ovarian follicles, reduce the chance of pregnancy, and alter the number and motility of sperm. Microplastics can also be the carriers of pathogens and toxic substances, such as heavy metals and additives (Landrigan et al., 2023).

Science is still in the early stages of clinical studies on the adverse health effects of exposure to microplastics. There are still no standardized quantification parameters or non-invasive particle detection techniques, making it difficult to conduct these studies in clinical trials. However, an important study showed that individuals with microplastics present in atherosclerotic plaques of the carotid artery, a vital artery for supplying brain tissue, had a significantly higher risk (4x higher) of having an acute myocardial infarction, stroke, or death from any cause. There is some evidence that the cardiovascular system is an important site of damage from microplastic deposition (Marfella et al, 2024).

Plastic additives are a cause for great concern regarding their effects on health, with much more literature on the subject. There is significant worry regarding the reproductive health and health of young children in relation to these substances, especially phthalates, bisphenols, and PFAs. These substances have been found in urine, blood, breast milk, and some organs. There is considerable scientific evidence of associations between these substances and birth weight, newborn genital structure, puberty, miscarriages, polycystic ovary syndrome, endometriosis, sperm concentration and motility, various types of cancer, brain development and the IQ in childhood, cardiovascular disease, diabetes, obesity, and asthma.

The health-related damage caused by plastic is not limited to the products generated by its degradation. It is worth remembering that the entire plastic chain causes damage to health and the environment, from oil extraction to the manufacture of the material, to recycling and incineration. Plastic production contributes significantly to climate change, accounting for almost 4% of total global emissions, which is greater than all emissions from Brazil. Recycling has already proven ineffective, despite being promoted by the plastics industry, with very low global recycling rates, which generate a more toxic product, by mixing different polymers and unknown additives. Vulnerable populations, such as recycling workers, are highly exposed to the toxic products from this work, and toxic products have also been found in toys and household items made from recycled materials (Landrigan et al., 2023).

Thus, the health threat posed by these materials is enormous. Reducing the production of non-essential plastics and regulating hazardous chemicals is imperative. Civil society and governments must engage in regulating the plastic production by the industry. Unfortunately, the industry expects to increase its production of plastics by 2060. Therefore, strengthening and supporting the Global Plastics Treaty is vital to guarantee the life and health of living beings on this planet.

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