
Human Milk, Microplastics and Children's Health: An Equation to Be Solved

Luiz Antonio Del Ciampo¹

Ieda Regina Lopes Del Ciampo²

¹Department of Puericulture and Pediatrics - Faculty of Medicine of Ribeirão Preto - University of São Paulo - Brazil

²Department of Medicine - Federal University of São Carlos - Brazil

Author correspondent Luiz Antonio Del Ciampo

Avenida Bandeirantes, 3900 CEP. 14049-900 Ribeirão Preto - São Paulo - Brasil

Conflict of interest: none

doi: 10.51505/ijmshr.2025.9504

URL: <http://dx.doi.org/10.51505/ijmshr.2025.9504>

Received: Aug 20, 2025

Accepted: Aug 30, 2025

Online Published: Sep 25, 2025

Abstract

In the last 70 years, plastics have been increasingly produced and have contributed to the emergence of a major public health problem related to environmental pollution, since almost 80% of their degradation, called microplastics (MP), is deposited in the environment where it contaminates the atmosphere, water and food, with a great capacity to accumulate in the human body. The most common route of human contamination is the digestive tract and MP has already been detected in practically every part of the body, including human milk, which is the main food for children in their first two years of life. Therefore, considering the main physiological and metabolic characteristics of children and the importance of human milk for their nutrition, this article presents some aspects related to MP its mechanisms of action and effects on the body and current knowledge about the presence of this environmental pollutant in food and human milk.

Keywords: Human milk - Microplastics - Environmental pollution - Children's health

Introduction

Since the 1950s, plastics have been increasingly produced all over the world and have contributed to the emergence of a major public health problem related to environmental pollution, since almost 80% of the degradation of plastic waste is deposited in the environment [1], where it will last for many centuries, contaminating atmosphere, water, food and with a great capacity to accumulate in the human body [2,3].

Plastics are long-chain synthetic polymeric materials that have become ubiquitous in modern life due to resistance to corrosion, lightness and thermal and electrical insulation [4], and are used in a wide variety of commercial products due to low cost, ease of production and versatility.

Among the most commonly used polymers are polypropylene, polyethylene, polyethylene terephthalate, polycarbonate, polyvinyl chloride and polystyrene [2,4,5].

As they do not exist naturally and are not biodegradable, plastics accumulate progressively in the environment [2,6] in various ecological segments, where are partially broken down by mechanical abrasion, ultraviolet radiation, microbiological activity and chemical and thermal degradation [7] which end up producing tiny,[8,9] hydrophobic secondary particles, ranging in size from 5 millimeters to 100 nanometers, known as microplastic (MP)[4].

Because they are chemically stable, resistant to decomposition and have the capacity to adsorb and penetrate biological barriers, MP bind to other substances in the environment such as harmful chemicals and microorganisms. As a result, they act as vectors for human pathogens (such as fungi, bacteria and protozoa) [10], pesticides and heavy metals [1,10]. Health effects are also exacerbated by chemical additives, such as polychlorinated biphenyls and phthalate esters, added to MP during production [7]. In addition, antibiotic-resistant bacteria can be found in MP, making it possible for them to spread, which has a major impact on the treatment of bacterial infections [10].

Due to their ability to contaminate food and water sources, MP have already been detected in milk, sugar, meat, honey, sea salt, rice, energy drinks, beer, soft drinks, sea salt, fish, seafood, fruit and edible vegetables [5,10,11], and the contribution of plastic-based packaging to the contamination of all these products should also be highlighted [1,6,12].

MP in the human body and its effects

The human body can be contaminated by three main routes [9,11,13,14]: a) ingestion (most common), b) inhalation and c) dermal via particles smaller than 100 nm that can pass through intact skin.

In recent years, several studies have detected MP practically everywhere in the body, especially in blood, urine, feces, sperm, saliva, placenta [6,15], meconium, fetal appendages [16] and breast milk [5,11]. In contact with different organs, MP has the capacity to cause localized inflammation, oxidative stress and cytotoxic effects resulting in suppression of cell growth, apoptosis, mitochondrial dysfunction and stress on the endoplasmic reticulum system [9,14], causing acute and chronic effects with various repercussions on health [17].

Ingestion is the most important way in which MP enters the body. When they reach the intestine, very small particles (a few microns) are phagocytosed while those up to 10 μm are captured by cells in Peyer's patches [1,7,17], followed by translocation by dendritic cells through the lymphatic circulation, falling into the bloodstream (14,18) and can reach all organs [10,19] and accumulate in the lungs, liver, gastrointestinal tract and reproductive tissues [17], bone marrow [5], brain tissue [5], testicles, placenta [10] and lymph nodes [31]. Problems such as

inflammation, constipation, irritable bowel syndrome, dysbiosis and changes in intestinal permeability are the most frequently found in the gastrointestinal tract [10,17,19,21].

Oxidative stress results in cell damage and greater vulnerability to the development of neurological disorders [22] such as behavioral alterations [6] and cognitive performance [5]. Changes can also be found in the immune system, predisposing the body to infections [5,17,19]. Exposure to PM has also been associated with other alterations, since it can contain and absorb chemical substances such as bisphenol A, nonphenol, phthalate esters and octylphenol, which have the potential to interfere with the normal functioning of the endocrine system [9].

Children, breast milk and MP

The first years of life are a sensitive window for various health problems in human beings, as this phase involves growth, the development of organs and systems, as well as greater food requirements in relation to body weight [5]. Due to the reduced capacity of enzymes to act and remove harmful substances associated with the immaturity of organs and systems, children become vulnerable and at high risk to environmental aggressions [23]. Early exposure, even in small concentrations, to novel products can have lifelong consequences for human health, as children potentially have many more years to live than adults and more time to develop diseases caused by early exposure [24,25].

From the intrauterine period, children are indirectly in contact with MP. After birth, this contact becomes practically obligatory, since everything in the home contains some kind of plastic. Even when a child is exclusively breastfed during the first six months of life, their food is not free from contamination [26].

Breast milk is the ideal food and the only recommended nutritional source for babies during the first six months of life, followed by complementary feeding up to two years of age. In addition to nutrients, breast milk contains essential elements such as antibodies, bioactive compounds, enzymes and hormones that are fundamental for the growth, development and maturation of organs and systems [20,27]. Therefore, all efforts should be directed towards encouraging and supporting breastfeeding. However, just as nutrients and protective factors are passed on to the infant, unwanted substances and environmental contaminants such as MP can be found in breast milk.

The presence of MP in breast milk has been little studied and, to date, only 4 articles have been published on this fundamental issue for infant health. Ragusa et al analyzed milk samples from 34 Italian mothers one week after giving birth and found 27 (76.4%) to be positive, with a predominance of polyethylene, polyvinyl chloride and polypropylene. A study carried out on breast milk collected from 7 Chinese breastfeeding women found an average of 20.2 PM particles per ml of sample, the most common being: polyurethane, polyamide, polymethylmethacrylate, polyethylene terephthalate and polyethylene. Among 59 Thai postpartum women, MP was found in 23 (38.98%), the most common being: polypropylene, polyethylene, polystyrene and polyvinyl chloride [28]. Arshad et al studied breast milk samples

donated by 23 Pakistani lactating women and found microplastics in all of them, mainly fibers and pellets ranging in size from 5 to 18 micrometers [29].

Conclusions

Although the production of plastics aims to improve some everyday conditions, the presence of their constituents and waste in the environment has increased significantly, causing a negative impact on the ecosystem and human health [14].

The health consequences of contact with MP are not yet fully understood [24,30], and more research is needed to understand the pharmacodynamics and pharmacokinetics of these elements in order to implement actions to reduce deposition in water and food sources to preserve health. To date, MPs have been responsible for damage and inflammatory reactions to various tissues and organs with as yet unknown long-term consequences, as well as serving as a vehicle for substances harmful to the body. Particularly in relation to children, due to the characteristics of their body composition, immaturity of organs, systems and enzymatic activity [31], the risks and consequences of the presence of MP in their bodies are more accentuated.

Finally, the fundamental importance of breast milk for children's health must also be emphasized, and urgent measures must be taken to reduce contamination of this precious food and provide the best nutrition for children in their first two years of life.

References

- Molina E, Benedé S. Is there evidence of health risks from exposure to micro- and nanoplastics in foods? *Front Nutr* 2022;9:1-8.
- Zuri G, Karanasiou A, Lacorte S. Human biomonitoring of microplastics and health implications: a review. *Environ Res* 2023;237:1-9.
- Jayavel S, Govindaraju B, Michael JR, Viswanathan B. Impacts of micro and nanoplastics on human health. *Bull Nat Res Centre* 2024;48:1-19.
- Dar MA, Palsania P, Satya S, Dashora M, Bhat OA, Parveen S et al. Microplastic pollution: a global perspective in surface waters, microbial degradation, and corresponding mechanism. *Mar Poll Bulletin* 2025;210:1-19.
- Pettoello-Mantovani M, Bali D, Giardino I, Konstantinidis G, Pastore M, Vural M. The risk from widespread micro- and nano-plastic contamination on a global scale and the threat to children's health. *J Pediatr* 2025;280:1-5.
- Prüst M, Meijer J, Westerink RHS. The plastic brain: neurotoxicity of micro and nanoplastics. *Part Fibre Toxicol* 2020;17:1-16.
- Udovicki B, Andjelkovic M, Cirkovic-Velickovic T, Rajkovic A. Microplastics in food: scoping review on health effects, occurrence, and human exposure. *Int J Food Cont* 2022;9:1-16.
- Carpi-Souza O, Rocha LMV, Tavares MIB. Microplastics present in milk offered in early childhood. *Br J Health Rev* 2025;8:1-36.

- Donisi I, Colloca A, Anastasio C, Balestrieri ML, D'Onofrio N. Micro(nano)plastics: an emerging burden for human health. *Int J Biol Sci.* 2024;20:5779-5792.
- Kadac-Czapska K, Knez E, Grembecka M. Food and human safety: the impact of microplastics. *Crit Rev Food Sci Nutr* 2024;64:3502-3521.
- Ebrahimi P, Abbasi S, Pashaei R, Bogusz A, Oleszczuk P. Investigating impact of physicochemical properties of microplastics on human health: a short bibliometric analysis and review. *Chemosphere* 2022;289:1-15.