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Review

Human Exposure to Microplastics from Food-Contact and Daily-Contact Materials: Current Evidence and Perspectives

Lida Zhao, Bo Hu, Qingyuan Xia, Sha Huang and Shuting Zhuang *

School of Chemistry & Life Resources, Renmin University of China, Beijing 100872, China
* Correspondence: zst@ruc.edu.cn

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Abstract: Microplastics (MPs), originating from the degradation of ubiquitous plastic materials, have raised significant concerns about their potential risks to human health. Increasing evidence has substantiated the occurrence of MPs across diverse human tissues and biological fluids, highlighting potential risks to multiple organ systems. We summarize current knowledge on the presence and possible health implications of MPs in the digestive, respiratory, circulatory, nervous, reproductive, and cutaneous systems. Particular attention is given to exposure via food-contact materials, including commercial water bottles, disposable cups, infant feeding bottles and teats, takeaway food containers, kitchenware, food-storage containers, and tea bags, which represent frequent and direct sources of MPs ingestion. Moreover, we discuss MPs release from other daily-contact products, such as oral care and skincare formulations, textiles, protective equipment, and medical devices. By integrating available findings, this review aims to enhance scientific and public awareness and offer practical strategies to reduce daily microplastic exposure.

Keywords: microplastics; exposure pathways; food-contact materials; daily-contact materials; health risks

1. Introduction

Microplastic pollution has emerged as a critical global challenge. Driven by their durability, versatility, low cost, and light weight, plastics are extensively used across diverse sectors, including food packaging, healthcare, textiles, and construction. In 2020, the global use of plastics reached 464 Mt, and it is projected to surge to 884 Mt by 2050 [1]. The intensive production and use of plastics, combined with inadequate waste management systems, have led to the release of billions of tons of plastic waste into the environment [2,3]. Inevitably, environmental plastics are accumulating at an uncontrolled rate [4]. Due to physical, chemical, and biological factors, plastics in the environment gradually break down into small-diameter plastic particles. In recent years, studies have indicated that small plastic particles might gain entry into the human body and pose risks to physical health, which has aroused widespread concern.

Microplastics (MPs) are typically defined as plastic particles with a diameter of <5 mm [5]. Owing to their small size, MPs can be taken up by organisms through direct contact or trophic transfer and may ultimately accumulate in humans. Studies conducted recently have confirmed MPs occur in a wide variety of organisms, including humans [6]. MPs were first reported in human feces [7], providing direct evidence of human exposure. More recently, their presence has also been documented in human embryos [8]. Furthermore, nanoscale MPs have been demonstrated to penetrate the blood-brain barrier and accumulate in brain tissue [9]. Additionally, traces of MPs have been identified to exist in human cardiovascular [10,11] and reproductive systems [12]. Due to their small size, large surface area, and ability to adsorb various substances, MPs can act as carriers for a wide range of

pollutants, including persistent organic pollutants [13], heavy metals, and plasticizers [14]. Although advanced adsorbent materials have shown potential for removing environmental contaminants, the ubiquity of MPs highlights that preventing human exposure remains the more pressing challenge.

Considering the potential toxic effects, contamination from the food-contact plastic products has aroused great concern. Among the primary routes of human exposure to MPs, including ingestion, inhalation, and dermal absorption, ingestion is recognized as the most prominent [15,16]. According to Domenech and Marcos [17], the human body ingests ~2.93×10^{10} microplastic nanoparticles (MNPs) annually through diet, whilst inhalation contributes ~2.16×10^{3} MNPs. Given the widespread consensus that ingestion is the primary exposure route, the release of MPs from food-contact plastic materials has garnered considerable attention. Current research has confirmed that various food-contact plastics, such as water bottles, disposable cups, takeaway containers, and so on, can release MPs, with the release generally increasing under conditions of higher temperature or mechanical stress. Furthermore, MPs have been detected in other daily-contact materials, including textiles and cosmetics. While plastic products generate substantial quantities of MPs, the emission of MPs from food-contact materials can be partially controlled and prevented through proper handling, thereby reducing human exposure risk. Despite growing interest in MPs, a comprehensive review summarizing the characteristics of MPs exposure from food-contact materials and other daily-contact materials is still lacking.

Numerous studies have investigated MPs detection in human tissues and various exposure pathways, yet existing reviews often address only specific aspects. Li et al. [18] reviewed the toxic impacts of MPs in biological models, while Kutralam-Muniasamy et al. [19] and Roslan et al. [20] examined the bioaccumulation of MPs within human tissues. Exposure routes, including ingestion and inhalation, and dermal absorption, have been discussed by Prata et al. [21] and Zhang et al. [22], with Zhang et al. [22] specifically addressing MPs exposure via salt, drinking water, and air. Notably, the gap in research on contact materials is particularly prominent: there is a lack of a comprehensive and up-to-date review that summarizes the characteristics of microplastic exposure from food-contact materials or other daily-contact materials.

This review aims to raise scientific and public awareness of MPs exposure and to inform strategies for reducing microplastic exposure in daily life. Firstly, it integrates data on MPs detection in human tissues to provide supporting evidence for exposure assessments. Subsequently, recent progress on MPs release from food-contact and other daily-contact materials is discussed in detail.

2. Literature Retrieval Methods

For the purpose of conducting a comprehensive systematic literature review, we opted to employ a multi-database retrieval approach in our research. Peer-reviewed journal articles were collected from major bibliographic databases, namely the Web of Science Core Collection, Scopus, and PubMed. The search strategy was constructed by combining core keywords, such as “microplastics”, “nanoplastics”, “plastic particles”, “human tissue”, “human body”, “food contact”, “food packaging”, “daily exposure”, “oral care”, “exposure pathways”, and “health risks”. The time window was 1 January 2008 to 17 November 2025.

We also retrieved relevant monographs and book chapters from authoritative academic publishing platforms, including SpringerLink and Elsevier ScienceDirect. At the same time, conference proceedings were accessed through specialized databases. The Web of Science Conference Proceedings Citation Index was also searched. After removing duplicates, we screened titles and abstracts and then assessed full texts. In total, ~100 publications (journal articles, book chapters, and conference papers) were included for analysis.

3 Evidence and Risks of Microplastics in Human Body

MPs have been widely detected in various environmental media, including ambient air [23], household dust [24], drinking water [25], and food [26], potentially posing exposure risks to humans. Human exposure to MPs occurs primarily through inhalation and ingestion. In particular, when the size of MPs reaches the nanoscale, they can penetrate mucosal barriers and reach deep into the respiratory tract [27]. Evidence from studies detecting MPs in human faecal [7] and colon [28] samples confirms MPs’ ability to enter the human body. Once internalised, MPs can enter the blood circulation, leading to systematic distribution to distal organs and accumulation in critical organs such as the lungs, liver, heart, and brain (Figure 1) [29]. In recent years, as concerns about the health risks of MPs have grown, studies have focused on their presence and distribution in the human body. As shown in Table 1, quantitative analyses have confirmed the detection of commonly used polymer types—such as Polyamide (PA), Polyethylene (PE), Polypropylene (PP), and Polyvinyl Chloride (PVC) in various tissues and biological samples [30]. While most existing studies concentrate on MPs within the micrometre range, recent evidence indicates that particles in the nanometer scale can also be detected in human tissues [9].

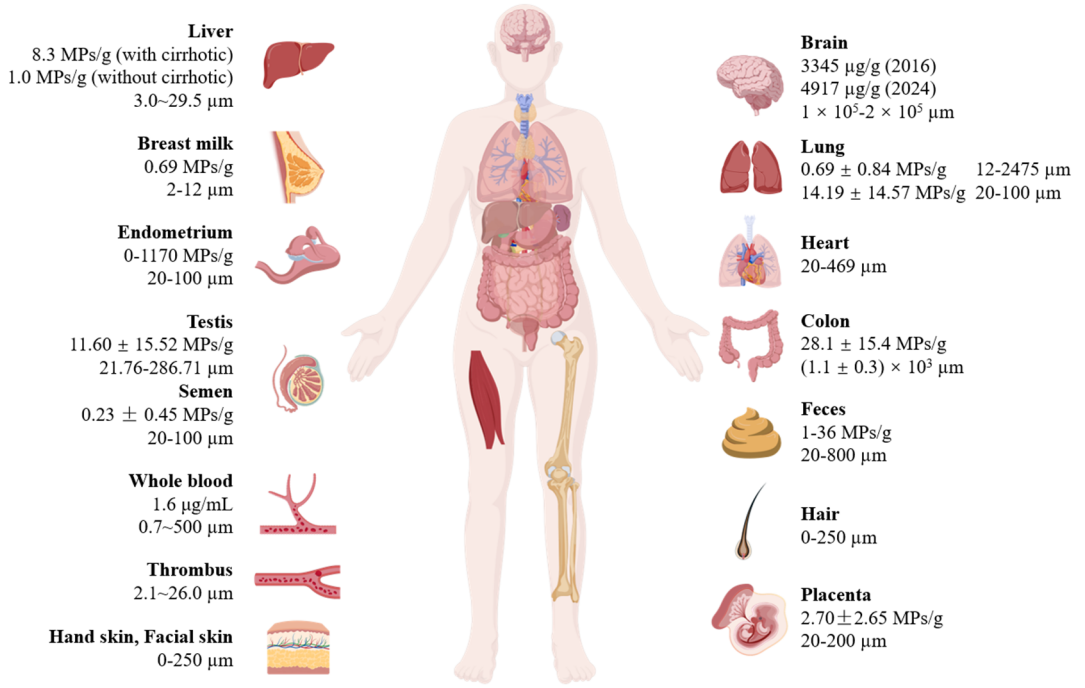

Figure 1. An illustration of MPs presence and size range in human [9–11,30–40]. Adapted with permission from Ref. [29]. Copyright 2025, Oxford University Press.

Table 1. Reported data of MPs in human.

Systems	Samples	Region	MPs			Ref.
			Main Polymer Types	Abundance	Size/μm	
Digestive system	Colon	Malaysia	PC, PA, PP	28.1 ± 15.4 particles/g	(1.1 ± 0.3) × 10^3	[31]
	Feces	China	PET, PS, PE, PVC	1–36 particles/g	20–800	[32]
Respiratory system	Lung	Brazil	PP, PE	-	1.6–16.8	[27]
	Lung	England	PP, PET	0.69 ± 0.84 particles/g	12–2475	[30]
	Lung	China	PVC, PBS, PA	14.19 ± 14.57 particles/g	20–100	[33]
Circulatory & metabolic systems	Whole blood	Holland	PET, PE, PS	1.6 μg/mL	0.7–500	[10]
	Heart	China	PET, PU	-	20–469	[11]
	Thrombus	China	LDPE	-	2.1–26.0	[34]
	Liver	Germany	PS, PVC, PET, PMMA	8.3 particles/g (with cirrhotic) 1.0 particles/g (without cirrhotic)	3.0–29.5	[35]
Nervous system	Brain	America	PE, PP	3345 μg/g (2016) 4917 μg/g (2024)	1 × 10^5–2 × 10^5	[9]
Reproductive system	Testis	China	PS, PE, PVC	11.60 ± 15.52 particles/g	21.76–286.71	[36]
	Semen	China	PP, PE, PET, PVC	0.23 ± 0.45 particles/g	20–100	[36]
	Endometrium	China	EAA, CPE, PE	0–1170 particles/g	20–200	[37]
	Placenta	China	PVC, PP, PET, PE	2.70 ± 2.65 particles/g	20–200	[38]
	Breast milk	Italy	PE, PVC, PP	0.69 particles/g	2–12	[39]
Skin & cutaneous appendages	Hair	Iran	PE, PET, PVC, PS	-	0–250	[40]
	Hand skin	Iran	PE, PET, PVC, PS	-	0–250	[40]
	Facial skin	Iran	PE, PET, PVC, PS	-	0–250	[40]

Beyond the physical presence of MPs, experimental evidence suggests that these particles may trigger biological responses through conserved toxicity pathways, with oxidative stress and inflammation repeatedly identified as key mechanisms [41,42]. Although direct human mechanistic evidence remains limited, in vitro and in vivo studies consistently indicate that MPs exposure can increase reactive oxygen species production and disrupt redox balance. These changes are often accompanied by pro-inflammatory signaling (e.g., NF-κB and, in some models, the NLRP3 inflammasome) and increased cytokine production such as IL-1β [43]. Moreover, MPs-induced effects also vary with particle size, exposure dose, and duration, with smaller particles, higher doses, and longer exposures tending to be associated with greater bioavailability and stronger oxidative and inflammatory responses [42,43]. Taken together, these mechanistic insights provide an important biological context for interpreting MPs detection in human tissues and support the need for evaluating MPs' potential impacts in a system-specific manner. Accordingly, it is crucial to investigate their distribution characteristics and potential impacts across various physiological systems, such as the digestive system, the respiratory system, the circulatory and metabolic systems, the nervous system, the reproductive system, and the skin and cutaneous appendages.

3.1 Digestive System

The digestive tract serves as the primary exposure pathway for MPs entry into the human body, mainly via ingestion of contaminated food. While direct evidence of adverse effects in human gastrointestinal system remains limited, studies in animal models have revealed that MPs may trigger oxidative stress and inflammatory reactions in intestinal tissues [44]. In humans, recent studies have provided evidence that MPs are not always completely excreted, as they have been detected not only in fecal samples but also embedded within intestinal tissues.

Ibrahim et al. [31] examined surgically resected colon tissues and identified a range of MPs, such as PP, PA, and Polycarbonate (PC), showing an average abundance of 28.1 particles/g and a mean particle size of 1.1 mm. The detection of MPs in the intestinal excretory system was further verified in another study conducted by Zhang et al. [32]. Polyethylene Terephthalate (PET), Polystyrene (PS), PE, and PVC were detected in adult male feces with particle concentrations ranging from 1–36 particles/g and particle sizes between 20 and 800 μm. Together, these results underscore the persistence of ingested MPs in the gastrointestinal tract and suggest a risk of tissue accumulation over time.

3.2 Respiratory System

With the intensification of environmental microplastic pollution, the respiratory system has gradually attracted attention in exposure research, as it serves as a primary interface between the human body and the atmosphere [45]. Inhaled MPs can reach and persist in lung tissues, which may contribute to negative health outcomes, as one study has shown that MPs may be related to the development of ground-glass nodules [46]. Due to these concerns, an increasing number of studies have focused on detecting MPs in human lungs, and their presence has been reported in various countries worldwide.

A study conducted in Brazil confirmed PP and PE MPs in lung tissues, spanning 1.6–16.8 μm in size, reflecting the widespread occurrence of small- to medium-sized MPs in local air samples [27]. In the UK, the mean level of 0.69 particles/g was reported in lung tissue, predominantly composed of PET, exhibiting lengths between 12 and 2475 μm and widths ranging from 4 to 88 μm [30]. Meanwhile, Zhu et al. [33] examined human lung tissues in China and identified a relatively high level of PVC, Polybutylene Succinate (PBS), PA contamination, occurring at an average concentration of 14.19 particles/g and particle sizes between 20 and 100 μm. Collectively, these findings from diverse geographical contexts provide empirical evidence of airborne microplastic exposure and underscore the importance of the respiratory pathway in MPs bioaccumulation within the human body.

3.3 Circulatory and Metabolic Systems

After entering the human body, MPs may migrate beyond the initial sites of exposure. The circulatory system, which includes the heart, blood, and blood vessels, is crucial for transporting MPs throughout the body. Meanwhile, the metabolic system, represented by organs such as the liver, is essential for processing and detoxifying foreign substances. Studies have recently examined microplastic contamination in human blood, heart, and liver tissues, revealing their widespread presence and laying the foundation for further research on their potential health impacts.

Evidence is growing that MPs can reach and remain in the cardiovascular system. Using a highly sensitive Pyrolysis gas chromatography-mass spectrometry technique, microplastic particles as small as 700 nm were detected in the whole blood samples from 22 healthy volunteers in the Netherlands [10]. The most common polymers identified were PET, PE, and styrene-based plastics, which together made up over 90% of all particles found. The average concentration reached 1.6 μg/mL, with particle sizes ranging from 0.7 to 50 μm and inter-

individual variability. This study directly quantified MPs in human blood, confirming their ability to circulate systemically and potentially reach various organs.

Human heart tissues have been found to contain various types of microplastics, such as PET and Polyurethane (PU), in sizes ranging from 20 to 469 μm [11]. While direct evidence of adverse cardiac effects in humans remains limited, experimental studies suggest that MPs may disrupt mitochondrial function, potentially contributing to structural and functional damage in heart tissues [47]. In blood samples taken before and after surgery, similar particles were also detected, suggesting that MPs may circulate through the bloodstream and accumulate in heart-related tissues. Further support comes from the detection of Low-Density Polyethylene (LDPE) particles in arterial thrombus, particularly in cases of aortic dissection and lower limb artery disease, where the detection rate reached 87% and particle sizes ranged from 2.1 to 26.0 μm [34]. These results indicate that they might be linked to vascular issues such as thrombosis, highlighting the need to fully grasp their potential effect on cardiovascular health.

As for metabolic organs, Horvatits et al. [35] examined liver tissue from autopsy samples in Germany and detected multiple types of MPs—including PVC, PET, PS, and Polymethyl Methacrylate (PMMA). The concentration was significantly higher in cirrhotic livers (~8.3 particles/g) than in non-diseased livers (~1.0 particles/g), with particle sizes between 3.0 and 29.5 μm. The results suggest that chronic pathological conditions may enhance microplastic accumulation in hepatic tissues.

3.4 Nervous System

The nervous system is one of the most intricate and delicate systems in the human body. Recent studies now warn that nano-sized MPs can penetrate the blood–brain barrier and accumulate in brain tissue, posing a possible threat to this vital network [9]. Nano-sized MPs have been shown to cause damage to the nervous system in animal experiments. Studies indicate that nano-sized MPs can cross the blood-brain barrier and accumulate in brain tissues, thereby inducing neuroinflammation and promoting apoptosis [48]. However, there are differences between animal and human studies in terms of exposure doses, metabolic pathways, and long-term effects; therefore, directly extrapolating conclusions from animal experiments to humans has certain limitations.

Nihart et al. [9] identified PE nano-sized MPs (100–200 nm) in the prefrontal cortex of 91 human brain samples. Notably, in samples from individuals diagnosed with dementia, the median concentration of MPs reached as high as 26,076 μg/g, significantly exceeding levels observed in non-dementia samples. Although a definitive causal relationship between microplastic exposure and neurological disorders has yet to be established, these findings demonstrate the potential of MPs to breach the blood-brain barrier and exert chronic irritative or neurotoxic effects on brain tissues. Moreover, the median concentration of MPs showed a marked increase, growing from 3345 μg/g in 2016 to 4917 μg/g by 2024. The marked rise within just a few years may be attributed to the continuous intensification of environmental microplastic pollution, suggesting a concerning trend of increasing accumulation in human tissues. This emerging evidence highlights a novel direction for future research into the potential link between microplastic exposure and neurodegenerative diseases.

3.5 Reproductive System

MPs have been detected in both the human reproductive systems (e.g., testes, semen, and endometrium) as well as maternal reproductive-lactation system (e.g., placenta and breast milk). Research has indicated that MPs present in maternal-derived tissues may infiltrate fetal tissues through maternal-fetal transmission routes, and may potentially affect infants' health [49].

Zhao et al. [36] analyzed 6 testicular tissues and 30 semen samples from Beijing (China), and revealed tissue-specific burden: testicular tissues contained 11.60 ± 15.52 particles/g, while semen contained 0.23 ± 0.45 particles/mL. Similarly, in Southern Italy, MPs have also been detected in semen samples [12]. Animal studies confirmed microplastic exposure alters murine testicular structure, reducing sperm quality and fertility [50]. While such experimental models provide valuable mechanistic insights, their direct extrapolation to human reproductive health is constrained by differences in reproductive physiology, exposure duration, and compensatory mechanisms between rodents and humans. Although the mechanisms behind the reproductive toxicity of MPs in humans remain unclear, current evidence indicates that they pose a threat to the entire body through inflammation, metabolic disruption, and physical damage [51].

MPs have also been detected in the female reproductive system. Sun et al. [37] identified 13 distinct microplastic polymer types through systematic analysis of 20 human endometrial specimens, with particle concentrations peaking at 117 particles/100 mg. Lifestyle factor analysis revealed significant associations between elevated microplastic levels in the endometrium and frequent consumption of bubble tea or carbonated beverages, as well as chewing gum habits in the study cohort.

MPs in the mother's bloodstream can cross the placental barrier to reach the fetus, while those in lactating mothers may also pass into breast milk and be ingested by infants. In a study conducted in Zhejiang, China, MPs were detected in all 17 placental samples, with an average content of 2.70 ± 2.65 particles/g [38]. At the same time, MPs may enter the fetus through the placenta and affect fetal development. Breast milk is also a pathway for the transmission of nutrients between mothers and infants. In Italy, MPs were identified in 26 of the 34 breast milk samples, where the particle sizes varied from 2 to 12 μm. These MPs may be ingested by infants, potentially endangering their health [39].

3.6 Skin and Cutaneous Appendages

Due to microplastic pollution, human skin and hair surfaces with high surface area are susceptible to MPs adsorption. Abbasi and Turner [40] analyzed samples from 2000 adult participants across various regions of Iran by rinsing hair, hand, and facial skin samples with filtered water. Over 16,000 MPs were found in the rinse water samples of all participants. Among them, the number of MPs in hair samples was the highest, with an average of > 3.5 particles/person per day. The number of MPs in males is approximately twice that in females in experiments with equal numbers of male and female samples.

Given the variations in living environments and lifestyles across different regions, significant differences exist in microplastic abundance on the skin and hair surfaces of individuals from diverse geographical locations and occupations. This difference is to some extent associated with personal habits and protective behaviors. For example, research indicated that headscarf use among women can effectively reduce direct contact with MPs [40]. It could be one of the reasons why there are more MPs in male samples than in female samples in the Iranian region. This demonstrates that physical barriers offer a practical means of mitigating microplastic accumulation in hair and on skin. Consequently, targeted personal protection strategies represent a critical avenue for reducing human microplastic exposure.

Beyond accumulation, MPs might have adverse biological impacts on the skin and hair follicles. Research indicated that MPs elevate reactive oxygen species accumulation in skin and hair follicles, causing skin tissue death and mitochondrial dysfunction [52]. Through murine experiments, Li et al. [52] observed that MPs can induce skin and follicle damage, damage hair structure, and reduce follicle density. Given structural similarities between human and mouse skin or hair follicles, humans exposed to MPs may experience comparable damage.

4 Microplastics from Food-Contact Materials

In daily life, food inevitably comes into contact with plastic products made for commercial water bottles, disposable cups, infant feeding bottles and teats, takeaway food containers, kitchenware and food-storage containers, tea bags and so on, as shown in Figure 2. During the manufacturing, storage, transportation, and use of food containers, plastic materials are frequently exposed various stressors, including elevated temperatures, moisture, ultraviolet (UV) radiation, and mechanical abrasion [53]. These physical and chemical factors can induce surface erosion, micro-cracking, and localized fragmentation of the plastic matrix. As a result, MPs may be generated and subsequently released into food, particularly under conditions involving heat or prolonged contact (Table 2). Once ingested, these MPs may enter the human body, raising potential health concerns.

Figure 2. Reported MPs from food-contact materials.

Table 2. Reported data of MPs from food-contact materials.

Products	Region	MPs			Object or Method	Ref.
		Polymer Types	Size/μm	Abundance		
Commercial water bottles	Italy	PET, HDPE	0.54–39.9	148 ± 253 particles/L	-	[54]
	Iran	PP, PET, PS	2440 ± 660	8.5 ± 10.2 particles/L	-	[55]
	Germany	PET, PP, PS, PE	<5	2649 ± 2857 particles/L 4889 ± 5432 particles/L	Disposable bottle Reusable bottle	[56]
	Germany	PP, PET	5–100	2–44 particles/L 28–241 particles/L	Disposable bottle Reusable bottle	[57]
	America	PE, PET, PP	5–1440	49–166 particles/L	-	[58]
	9 different countries	PP, PS, PP, PET	>100 6.5–100	10.4 particles/L 315 particles/L	Nile red staining	[59]
Disposable cups	China	PP	0–0.21	3 ± 1.13 mg/cup	-	[60]
	India	PE	25.9–764.8 0.15–4.28	2.5×10^5 particles/L $(102.3 \pm 21.1) \times 10^9$ particles/L	FM SEM	[61]
	China	PP, PET, PE	<100	1808–3723 particles/L 3028–4293 particles/L	Treatment 5 min Treatment 30 min	[62]
Infant feeding bottles	Ireland	PP	<20	1.31×10^6–1.62×10^7 particles/L 6.97×10^4–2.67×10^5 particles/L	PP baby bottle body and PP accessories Baby bottle with only PP accessories	[63]
Infant feeding teats	China	Silicone, PA	-	$(1.3 \pm 1.0) \times 10^6$ particles/y	-	[64]
Takeaway food containers	China	PP	0–0.21	$(12 \pm 5.12) \times 10^3$ μg /package $(38 \pm 5.29) \times 10^3$ μg /package	Circular Rectangular	[60]
	China	PP, PE, Expandable PS	0.8–38	1.90×10^4 particles/L 1.01×10^5 particles/L 2.82×10^6 particles/L	PP PE Expandable PS	[65]
	China	PP, PET, PS, PE	43–500	3–29 particles/container	-	[66]
Plastic cutting boards	Middle East, South Asia	PE	1279.2 ± 835.0	$(1.19 \pm 0.41) \times 10^3$ μg/g	-	[67]
	America	PP, PE	25–200	7.4–50.7 g/y 49.5 g/y	PE board PP board	[68]
	Australia	PP	nano, micro	100–300 particles/mm 3000 particles/mm^2	-	[69]
Plastic kitchenware	Germany	Melamine, PS, PP, PE, ABS, SAN	<20	331–898 particles/container	-	[70]
Packaged meat	France	Extruded PS	130–450	$(4.0–18.7) \times 10^{-3}$ particles/g	-	[71]
Tea bags	Canada	PA, PET	nano, micro	1.47×10^{10} particles/pack	-	[72]

4.1 Commercial Water Bottles

Commercial water bottles are favoured for their light weight, ease of production, and cost-effectiveness, making them widely used in various applications. However, because most of these bottles are made from plastics such as PET, High-Density Polyethylene (HDPE), PP, and PS, the release of MPs into drinking water is inevitable during use, resulting in potential ingestion by consumers. Current research has detected traces of MPs contamination in bottled water, spanning multiple brands and countries [57,58].

Mason et al. [59] examined 259 bottled water samples from 19 locations across 9 nations, utilizing Nile Red staining to detect MPs. They found that 93% of the bottles exhibited microplastic contamination. Compared to single-use plastic bottles, recyclable bottles typically release more MPs [56,57]. The extent of MPs contamination varies by country and brand, and is exacerbated by mechanical stresses during production and transportation, which raises potential exposure concerns for consumers.

Research into microplastic content in drinking water bottles, as demonstrated by Winkler et al. [54], has revealed diverse release behaviors from both bottle bodies and caps. Their work found PET bottle bodies and

HDPE caps as significant sources of MPs, with released particles ranging in size from 0.54 to 39.9 μm and averaging a concentration of 148 particles/L. The study also examined mechanical stressors—squeezing and crushing—and found that intense squeezing and crushing release more MPs.

Makhdoumi et al. [55] attributed microplastic release in bottled water primarily to wear and degradation during the packaging, manufacturing, and transportation stages. By employing stereomicroscopy and thermal needle tests, MPs were distinguished from other crystalline materials in the water samples from each bottle, with a concentration of ~8.5 particles/L.

These studies further indicate that water bottles release a certain number of MPs during production, packaging, transportation, and consumption, potentially serving as a route through which humans are exposed to MPs [73]. The interaction between the material properties of water bottles and the external stresses they undergo, such as selecting materials that release fewer MPs or adopting appropriate stress treatments, could become a key area of research in microplastic control.

4.2 Disposable Cups

Disposable cups (e.g., disposable paper cups and plastic cups) commonly used for beverages like coffee, milk tea, and juice, typically have an inner hydrophobic PE plastic film to prevent leakage [74]. Recent evidence indicates that the plastic lining of disposable cups can shed MPs into beverages. That means every sip becomes an unwitting microplastic cocktail. The abundance and characteristics of released MPs were found to vary with mechanical stress, water temperature, and exposure time. In specific conditions, such as under strong mechanical stress, high temperatures, or extended exposure times, the release of MPs is enhanced, which has triggered growing concerns among the public regarding the potential risks of microplastic contamination.

Fadare et al. [60] showed that mechanical agitation alone is enough to release MPs. They added 10 mL of room-temperature ultrapure water to a disposable paper cup and subjected it to two 2–3 min shaking cycles. After freeze-drying the liquid, the residue—mainly MPs—was analyzed, revealing an average of 3 mg/cup and particle sizes < 210 nm.

Thermal stress on MPs release from disposable paper cup was uncovered by Ranjan et al. [61]. They evaluated the degradation of hydrophobic PE plastic film when exposed to hot water (85–90 °C), simulating the typical behavior of individuals who prefer drinking their beverages within 15 min of purchase. After disposable paper cups were filled with ultrapure water and left to stand for 15 min, the release of MPs was identified. Fluorescence Microscopy (FM) detected ~2.5×10^5 particles/L, while Scanning Electron Microscopy (SEM) identified a much higher concentration of submicron-sized particles, ~1.023×10^{11} particles/L. This discrepancy could be ascribed to the differing detection limits of the instruments utilized.

Furthermore, prolonged contact between water and plastic was found to lead to a higher release of MPs [62]. For example, after 5 min of exposure, the microplastic release from disposable paper cups ranged from 1808 to 3723 particles/L, whereas after 30 min, it increased to between 3028 and 4293 particles/L. Additionally, their study found that stronger shaking and higher water temperatures amplified the release of MPs, further supporting the role of mechanical and thermal stresses in enhancing microplastic contamination.

4.3 Infant Feeding Bottles and Teats

With limited breastfeeding conditions or other factors, many infants rely on feeding bottles and teats for formula feeding or expressed breast milk. Plastic feeding bottles are preferred over glass alternatives due to their lower cost, durability, and resistance to breakage. However, concerns over the release of MPs from plastic feeding bottles in daily use have been brought up in recent studies [63,64]. Even more concerning is the fact that teats, which are unavoidably made from plastic or silicone-based materials, have also been recognized as notable sources of microplastic emission. Given the unique physiological vulnerability of infants, the potential health risks posed by MPs released from feeding bottles and teats warrant particular attention.

PP is a commonly used material in food-contact items, with 82.5% of baby bottles worldwide containing PP components [63]. To simulate the process of preparing formula milk by mixing it with hot water and shaking, Li et al. [63] thoroughly cleaned each new baby bottle and immersed it in 95 °C distilled water for 5 min. After air-drying, they added 70 °C distilled water into the bottle and mechanically shook it on a reciprocating shaker at 180 rpm for 60 s. The results showed that baby bottles with both the main body and accessories made of PP released MPs in the range of (1.31×10^6–1.62×10^7) particles/L, while bottles with only PP accessories released MPs in the range of (6.97×10^4–2.67×10^5) particles/L. The study further revealed that high temperatures (95 °C) and disinfection procedures significantly exacerbated microplastic release. As the temperature rose from 25 °C to 95 °C, the release amount increased by two orders of magnitude, and after disinfection, the release amount increased by

35–84%. Additionally, repeated use of the bottles led to a further increase in microplastic release, with developed countries facing higher exposure risks due to the more widespread use of formula milk.

Silicone rubber teats, commonly used in baby bottles, are typically disinfected using steam. Su et al. [64] employed optical-thermal infrared micro-spectroscopy (O-PTIR) to analyze microplastic content on the surface of steam-disinfected silicone teats and in the washing water. Their findings indicated that steam disinfection resulted in the release of significant numbers of MPs, which babies are directly exposed to during feeding. Each teat could release $(1.3 \pm 1.0) \times 10^6$ MPs annually during use, with an infant ingesting around $(0.66 \pm 0.51) \times 10^6$ MPs by the age of 1. It's estimated that an infant could potentially ingest $(1.0 \pm 0.75) \times 10^6$ MPs between birth and 18 months. These particles may enter the body through the digestive tract, potentially increasing the risk of long-term health issues, including immune system impairment and endocrine disruption.

As infants' and children's physiological development is not fully complete at this stage, the accumulation of these MPs may pose a risk to their health. Makhdoumi et al. [55] estimated the daily intake of MPs for adults and children using the formula: $EDI\ (MP/kg/day) = (C \times IR)/bw$, where C denotes the concentration of MPs (particles/L), and bw represents the body weight—set at 70 kg for adults and 16 kg for children. Their findings revealed that when the same volume of water is consumed, children's daily intake of MPs is roughly 4 to 5 times greater than that of adults, which further underscores the heightened vulnerability of infants to microplastic pollution exposure.

4.4 Takeaway Food Containers

With the rapid growth of the online food delivery industry, disposable plastic packaging containers are increasingly used on a daily basis. While these containers are popular due to their convenience, most plastic food delivery containers soften or deform at high temperatures, reducing their structural stability and subsequently releasing MPs at higher temperatures. Additionally, vibrations or shocks during transportation may also lead to the emission of MPs, further contaminating the food and posing potential health risks to consumers. Studies have also found that the amount of microplastic released differs based on both the shape (e.g., circular, rectangular) and the material (e.g., PP, PE, Expandable PS) of the takeaway containers.

The shape of takeaway containers made from PP was found to influence the number of MPs released. Fadare et al. [60] found that each circular container contained ~12 mg/container, while each rectangular container had a higher microplastic content, ~38 mg/container. Additionally, the study showed that MPs were more easily released after simple washing, a form of mechanical stress, with the majority of the released microplastic particles having sizes < 50 nm.

In another experiment [65], the release of MPs was analyzed in takeaway containers made from PP, PE, and Expandable PS. Given the Chinese preference for hot food, the conditions were set to reflect local consumption habits (approximately 100 °C for 1 h). The results demonstrated varying release levels across the materials: Expandable PS had the highest concentration (2.82×10^6 particles/L), followed by PE (1.01×10^5 particles/L), and PP with the lowest concentration (1.90×10^4 particles/L). These findings also indicate that the thermal properties of takeaway containers significantly influence the release of MPs.

To explore the release of MPs during food consumption from takeaway containers and throughout the delivery process, Du et al. [66] simulated the friction between food and utensils by directly rinsing takeaway containers with water. In another series of experiments, they introduced hot water into untreated containers and shook them to simulate the delivery process. The results indicated that the microplastic concentration in these containers varied between 3 and 29 particles/container.

In the study carried out by Su et al. [64], the formula $TN = T * N$ was utilized to calculate the amount of MPs that infants ingest through teats, where T refers to the microplastic concentration of the sample (in particles/kg or particles/L), and N refers to the amount of the sample used. This calculation model is highly similar to the one used in the study by Makhdoumi et al. [55]. Accordingly, we made the following assumptions: for people who order takeaway 4 to 7 times a week, the average daily intake of MPs per takeaway order is the mean value of 3 to 29 particles. Calculated on the basis of an average of 5 takeaway orders per week, the annual microplastic intake derived from the formula $TN = T * N$ is approximately 4160 particles/year. This value is much lower than the amount of MPs ingested through drinking water (90,000 particles/year [75]). This further indicates that humans need to consume a sufficient amount of water every day to replenish moisture. Therefore, compared to takeaway products, drinking utensils such as bottled water and disposable paper cups are the main sources of microplastic intake.

4.5 Kitchenware and Food-Storage Containers

The preparation and handling of food are critical aspects of daily life, and the emission of MPs from kitchenware and food-storage containers has become an increasingly pressing issue. Different food preparation and processing methods introduce varying levels of thermal and mechanical stress, which significantly influence the number of MPs released into food. For instance, under high-temperature or high-friction conditions, the level of microplastic contamination typically increases significantly and may even lead to the release of toxic substances.

Wooden cutting boards are often vulnerable to bacterial contamination. Due to the convenience, low cost, and ability to minimize bacterial growth of plastic cutting boards, they are widely used as an alternative to wooden ones. However, these plastic products can release MPs into food during use, raising concerns. Recent studies have identified microplastic contamination during cutting board use. Yadav et al. [68] calculated that individuals are exposed to 7.4–50.7 g of MPs annually from PE cutting boards and 49.5 g from PP cutting boards. Furthermore, grooves formed on cutting boards during food preparation may release 100–300 MPs/mm per cut, while scratches could release up to ~3000 MPs/mm^2 per cut, which could potentially be ingested by humans [69].

Habib et al. [67] examined the release of MPs from kitchen plastic cutting boards into meat during processing. The microplastic content released from new cutting boards ranged from $(1.19 \pm 0.41) \times 10^3$ μg /g of meat. Notably, MPs were released in higher quantities when using older plastic cutting boards compared to new ones. The study also highlighted that different preparation methods contributed varying numbers of MPs. For instance, deep-frying meat at high temperatures resulted in more MPs being released compared to untreated or pressure-cooked meat. This pattern mirrors the findings with takeaway containers, where higher temperatures lead to increased plastic wear and more MPs being released due to loose connections and degradation.

Reusable kitchen plasticware made from materials like acrylonitrile Butadiene Styrene (ABS), Styrene Acrylonitrile (SAN), Polyether Sulfone (PES), and melamine can also be significant sources of MPs. Jander et al. [70] found that the quantity of MPs released due to wear varied depending on the plastic type. Melamine was found to release the highest number of microplastic particles (898 particles), while LDPE released the fewest (331 particles). The study also revealed that at high temperatures (200 °C and 250 °C), MPs in kitchen plastic containers could decompose into toxic substances such as styrene, benzaldehyde, and formaldehyde, further emphasizing the toxicological hazards linked to MPs.

Beyond kitchenware, MPs have also been identified in packaged meat [71]. Expandable PS and Extruded PS, commonly used in food packaging for their ability to prevent oxygen, water vapor, and microbial contamination, can also release MPs that subsequently contaminate food. The study found that Extruded PS contamination levels in packaged meat spanned 4.0 to 18.7 particles/kg. Furthermore, considerable variability was found in the quantity of MPs released from the inner and outer surfaces of packaging, even among products from the same brand. Although consumers typically rinse meat before handling, experiments have shown that MPs can still be detected on the surface of meat, even after thorough washing.

4.6 Tea Bags

The introduction of tea bags has significantly enhanced the convenience of tea preparation. However, recent research has raised worries about the potential release of MPs into tea from certain plastic tea bags, which could pose significant health risks to consumers.

Hernandez et al. [72] investigated commercially available plastic tea bags containing PE, and their findings indicated that a single tea bag, when immersed in hot water (95 °C) for 5 min, released ~11.6 billion microplastic particles (>1 μm) and 3.1 billion nanoparticles (<1 μm), totaling around 14.7 billion particles. The primary morphological forms of these particles were fragments, fibers, and spheres, with PE being the dominant chemical composition. In contrast, when the tea bag was soaked in water at 25 °C, the particle release significantly decreased, by 2–3 orders of magnitude, indicating that the brewing temperature is crucial for the release of MPs.

This release of MPs far exceeds that from other common plastic food-contact materials. For instance, individuals who rely solely on bottled water for hydration ingest about 90,000 microplastic particles annually [75]. In comparison, someone who drinks four cups of tea brewed from plastic tea bags each week could ingest up to 1.6 trillion particles per year. The potential health implications of this exposure are concerning, as nanoscale particles may be absorbed through the digestive system into the bloodstream, carrying with them plasticizers, additives, and environmental pollutants that could cause further bioaccumulation and related health risks.

5 Microplastics from Other Daily-Contact Materials

Plastic-containing materials are ubiquitous in daily life, found in an extensive selection of products, including oral care products, skincare items, textiles, and medical devices. These products may inherently contain MPs, and

some have been shown to release MPs during regular use (Table 3). Given their frequent and close connection with the human body, they represent a potential source link to microplastic exposure. The processes of microplastic generation and transfer could directly or indirectly impact human health. For instance, MPs from face masks may be inhaled into the body through respiration, while those from infusion tubes can enter the bloodstream and persist for extended periods. Additionally, MPs from contact lenses may come into direct contact with the eyes, potentially causing irritation or damage. At the same time, MPs released into the environment accumulate through the food chain and food web, eventually bioaccumulating in the human organism.

Table 3. Reported data of MPs from other daily-contact materials.

Product Categories	Plastic Products	Region	MPs				Ref.
			Polymer Types	Abundance		Size/μm	
				Value	Unit		
Oral Care Products	Toothpaste	Turkey	PE	$(3.9–10.5) \times 10^3$	μg/g	4–20	[76]
		China	PVC, PA	25.0–112.5	particles/g	484–800	[77]
	Toothbrush	Australia	PA, SiO_2	17	particles/ (1.2 mm × 1.2 mm)	-	[78]
Dermal Contact Products	Facial scrubs	China	PE	205–2235	particles/g	533 ± 174	[77]
	Body scrubs	Spain	PE	123–3730	particles/g	264.49–551.39	[79]
	Personal care products	China	PE, LDPE	-	-	363–945	[80]
		UAE	PE	2611 ± 658	particles/g	12.3–273.4	[81]
	Wet wipes	Korea	PET	21–267	particles/application	0.26–12	[82]
Textile Products	Daily textiles	Switzerland	PET	$(0.025–0.1) \times 10^3$	μg/g	100–800	[83]
	Glove	Bushehr, Iran	LLDPE	32.6 ± 13.4	particles/package	500–1000	[84]
	Masks	Italy	PP	$(2.1 ± 1.4) \times 10^{10}$	particles/package	0.1–100	[85]
		Bushehr, Iran		32.6 ± 13.4	particles/package	500–1000	[84]
Medical Devices	Plastic infusion packaging	China	PE, PA, PS	1–2	particles/package	4–151	[86]
		China	PA, PVC, PET	11.8×10^3	particles/L	10–30	[87]
	Blood collection needles	China	PU, PET	$(4–16.43) \times 10^4$	particles/L	10–30	[87]
	Contact lens	China	-	9.07×10^4	particles/y	-	[88]
	Rubber bands for orthodontic treatment	-	-	7.5×10^{-2}	particles/μm²	-	[89]

5.1 Oral Care and Skincare Products

MPs intentionally added to personal care products, while necessary for enhancing performance, are released in large quantities into the environment, posing significant ecological threats. This creates a conflict between functional needs and environmental risks. For instance, MPs function as abrasives in toothpaste and facial cleansers to improve cleaning efficacy. In body care items, they contribute to properties such as viscosity, binding strength, abrasiveness, shine, and the capability to generate a protective layer on the skin. Given the high concentration of MPs in these products, their release into the environment has drawn significant research interest. In 2012, approximately 4360 tons of MPs were incorporated as additives in personal care and cosmetic products across the European Union [90], most of which ultimately enter domestic sewage systems with regular use. MPs from oral care products, skincare items, and daily textiles collectively contribute to microplastic contamination in domestic wastewater. The abundance of MPs present in water from toothpaste and facial cleansers can respectively reach up to 112.5 particles/g and 2235 particles/g [77]. Moreover, Fang et al. [78] estimated that a single brushing session could release approximately 22,000 pieces of MPs from a toothbrush. Many of these MPs shed from the bristles ultimately enter the wastewater.

Primary treatment at sewage treatment plants only removes about 25% of MPs. Even after conventional primary and secondary treatments, a small amount of MPs remains that cannot be completely captured, ultimately escaping into aquatic ecosystems [91]. In aquatic ecosystems, MPs possess a strong adsorption capacity, allowing

them to bind with hydrophobic organic pollutants such as polychlorinated biphenyls. As a result, they can act as carriers for these contaminants, with the concentration of pollutants adsorbed onto their surface potentially reaching up to 1 million times that of the surrounding seawater [91]. About 700 marine species continue to ingest MPs and the associated toxicants, leading to bioaccumulation. These contaminants eventually make their way into the human food chain via seafood consumption.

Many countries continue to use PE extensively in their products, contributing further to the microplastic burden, which had seen little improvement until the last decade. Due to the limited efficiency of current wastewater treatment in removing MPs, numerous countries have started implementing policies to restrict or ban the intentional use of MPs in personal care products to mitigate their environmental impact. For example, the 2015 Microbead-Free Waters Act became law in the United States, prohibiting the use of rinse-off cosmetics containing microbeads, while France became the first EU country to ban solid plastic particles in exfoliating rinse-off products. Other countries, including Canada, South Korea, and the UK, have implemented similar measures [92]. However, the lack of such regulations in some countries underscores a regulatory gap that remains to be addressed.

5.2 Textiles and Clothing

Synthetic fibers have become a dominant material in the textile and clothing industry, but their widespread use contributes significantly to microplastic pollution. Polyester, nylon, and other synthetic fibers, derived from petrochemical processes, are commonly used in everyday garments because of their durability, low cost, and ease of care. However, these materials can release microplastic fibers during the wearing and washing processes. Besides oral care and skincare products, textiles and clothing used in daily life contribute substantially to environmental microplastic pollution.

The primary pathway for MPs release from textiles and clothing is through washing, as fibers shed from the fabric during laundering. From the perspective of microplastic release from garments, microplastic fibers inevitably detach from textiles and clothing during the washing process, with a maximum release of PET fabric reaching 100 μg/g when detergent is added [83]. These microfibers then enter household wastewater streams, where they are only partially removed by conventional sewage treatment processes. As a result, a considerable fraction of textile-derived MPs remains in treated effluent.

Quantitative analyses have confirmed the significant contribution of textiles and clothing washing to microplastic levels in domestic wastewater. Tang et al. [77] found that the abundance of MPs (particle concentration) in household laundry wastewater ranges from 2900 to 7100 particles/L, making it a major source of MPs in domestic sewage, accounting for 85.1% of the total microplastic content in one liter of household wastewater. These MPs then enter domestic sewage systems, ultimately contributing to the broader issue of microplastic contamination in wastewater. MPs from textiles and clothing also have the ability to carry pollutants and toxic substances, they exist in wastewater further heightens the possible damage to aquatic ecosystems, and finally, human health is endangered via exposure through the food chain, as contaminated marine organisms are consumed [91].

5.3 Protective Equipment

Throughout the COVID-19 outbreak, the application of personal protective equipment surged dramatically. Based on a report from the World Health Organization dated 2020, global monthly consumption of disposable masks and gloves respectively reached 89 million and 76 million units [93]. These personal protective equipment items, primarily made from plastics, particularly masks composed of PP fabric, inevitably experience wear during use. Exposure to factors such as physical disturbances (like friction and deformation during wear) can lead to the release of MPs. Notably, under simulated use conditions involving physical disturbance, a single mask can generate up to 3.8×10^9 MPs [94].

Empirical evidence supports the release and human exposure to MPs. For instance, Ma et al. [94] conducted controlled experiments, eliminating interference from environmental air and physiological saline, and observed a marked increase in microplastic concentrations in nasal secretions after wearing surgical masks. Prior to mask use, the concentration was ~2.6×10^3 particles/g (dry weight). However, after wearing the mask for 1–2 h, whether during breathing or speaking, or for 1 h while jogging, the concentration rose to about 1.06×10^4 particles/g (dry weight). Notably, in the jogging scenario, the higher breathing rate resulted in a more pronounced presence of particles. This finding indicates that masks release MPs during use, which can be inhaled and remain in the nasal cavity, leading to direct human exposure.

As masks are worn for extended periods, additional MPs are released, which may be inhaled through the respiratory system. This raises significant concerns regarding the long-term health hazards linked to continuous

exposure to MPs, particularly for high-risk groups such as healthcare workers who wear masks for prolonged durations. The cumulative effects of microplastic inhalation and its chronic health implications warrant further investigation, given the potential public health concerns.

5.4 Medical Devices and Supplies

Plastic-based medical devices, while valued for their practicality and affordability, have become a previously overlooked source of microplastic exposure due to their frequent and direct contact with the human body. From infusion packaging to contact lenses, these devices can release MPs during routine use, potentially posing risks to human health. This emerging concern calls for greater scrutiny of microplastic release from commonly used medical tools.

Plastic infusion packaging, which includes components such as bottles, bags, tapes, and caps, can release MPs through physical wear and even standard handling. Despite being manufactured with high precision and smoothness to minimize particle release, MPs were identified in infusion solutions stored in plastic bottles and bags commonly used in clinical settings [86]. Chen et al. [87] further demonstrated that infusion tubes and blood collection needles release MPs during use. In a simulated 4 h infusion process at room temperature, infusion tubes released an average of 11.8×10^3 particles/L, while blood collection needles, in a simulation of illegal reuse (soaked in physiological saline for 30 min), released an average of 82.7×10^3 particles/L. Importantly, over half of the released particles were within the 10–30 μm size range, allowing them to bypass conventional filtration systems and potentially enter the human circulatory system. The data from this study suggests that microplastic contamination during intravenous operations could be more common than had been recognized before, raising concerns about systemic distribution and interference with blood flow.

Similarly, contact lenses represent another underappreciated pathway for microplastic exposure, especially through ocular contact. Made primarily from hydrogels, contact lenses can degrade and release MPs under environmental stressors such as UV radiation. Liu et al. [88] reported that after 300 h and 900 h of simulated sunlight exposure, individual lenses released an average of 4258 and 9590 MPs, respectively. These particles can accumulate on the ocular surface and potentially interact with corneal cells. Laboratory studies have shown that both murine ocular tissue cells and human corneal epithelial cells can internalize PS, triggering oxidative stress and apoptosis [95]. Such findings not only highlight the release of MPs during daily lens use but also indicate a potential threat to eye health, especially for individuals with long-term exposure.

Despite the widespread use of plastic in medical devices, there are currently no regulatory guidelines addressing the release or safety thresholds of MPs in these products. Although the absolute quantity of MPs entering the body through medical applications seems to be limited, the cumulative effects of chronic, low-dose exposure, particularly for patients requiring long-term treatment, remain poorly understood. This lack of research clarity underscores the urgent need for focused studies and regulatory action on MPs released from medical products.

6. Conclusions

Growing evidence indicates that MPs are widely detected in the human body, with differences in concentration and distribution across different organs and tissues. Current data indicate that MPs are enriched in the brain, liver, placenta, and lungs, with the concentration up to 4917 μg/g in healthy individuals. Their concentrations are lower in semen, breast milk, urine, skin, and hair. These variations may be related to detection methods, measurement accuracy, and sample acquisition difficulty, but inherent differences in biological distribution cannot be excluded. Notably, MPs can cross the blood–brain barrier and accumulate in neural tissues, while those in the reproductive system may impair fertility and transfer to offspring, causing irreversible harm. Nevertheless, research on the specific health hazards of MPs remains at an early stage.

Advances in MPs detection technologies have enabled researchers to detect increasingly smaller MPs (now down to the nanoscale) and to quantify their abundance with greater accuracy. However, several challenges persist. First, the lack of standardized units for MPs concentrations and extraction procedures makes it difficult to directly compare results across studies. This is compounded by the methodological diversity in MPs extraction and quantification from complex matrices (e.g., biological tissues, consumer products). Variations in digestion protocols, separation techniques, and detection limits can significantly influence reported abundances and polymer profiles, further hindering cross-study comparisons and reliable exposure assessment; second, research samples are geographically limited, mainly from China, the United States, France, and Italy, restricting the representativeness of global exposure assessments; third, the toxicological mechanisms have not been elucidated, especially the mechanisms under low-dose and chronic exposure; fourth, the interrelationships between MPs and

co-existing contaminants in the human body (such as heavy metals, additives, pathogens, etc.) are not clear. All these require further research.

With the increasing use of plastic products in food processing, MPs will inevitably enter food, then enter the human body through the digestive system and further distribute in various organs. Although humans are facing risks posed by MPs, given the advantages of plastics in terms of functionality and cost-effectiveness, there are few higher-performing alternative materials available for the foreseeable future, so the use of plastics and the generation of MPs remain unavoidable. However, exposure can be reduced through a systematic, risk-informed set of practical measures. First, source-level strategies focus on reducing reliance on plastics by adopting material alternatives (e.g., glass or wood) and, where feasible, supporting the development and application of biodegradable bioplastics. Second, use-phase management aims to limit microplastic release during everyday use by reducing the consumption of single-use plastic items, including disposable chopsticks, spoons, and straws, and by avoiding conditions that may accelerate plastic degradation. In particular, avoiding exposure to high temperatures, such as reheating food in plastic containers, can help reduce microplastic release. Finally, advanced filtration technologies can provide an additional barrier against MPs ingestion, including membrane-based filtration systems offering a practical means to reduce microplastics in drinking water.

We systematically synthesize available evidence on MPs from food-contact and daily-use products, yet current knowledge remains incomplete. The true significance of this field lies not only in documenting the occurrence of MPs but also in raising public awareness and encouraging preventive practices. Such awareness will, in turn, stimulate more comprehensive research and guide the development of effective prevention and control strategies. Ultimately, advancing our understanding of microplastic exposure and health effects will be essential for safeguarding human well-being in the plastic-dependent world of the future.

Author Contributions

L.Z.: writing—review & editing, writing—original draft, visualization, validation, investigation, supervision; B.H.: writing—review & editing, writing—original draft, visualization, validation, investigation; Q.X.: writing—review & editing, writing—original draft, visualization, validation, investigation; S.H.: writing—review & editing, writing—original draft, visualization, validation, investigation; S.Z.: conceptualization, writing—review & editing, supervision, funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

This is a research review paper. The data used in the paper has been cited with appropriate references.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

Abbreviations

MPs: Microplastics; MNPs: microplastic nanoparticles; PE: Polyethylene; PP: Polypropylene; PET: Polyethylene Terephthalate; PVC: Polyvinyl Chloride; PA: Polyamide; PC: Polycarbonate; PU: Polyurethane; PS: Polystyrene; PMMA: Polymethyl Methacrylate; LDPE: Low-Density Polyethylene; HDPE: High-Density Polyethylene; EAA: Ethylene Acrylic Acid; CPE: Chlorinated Polyethylene; ABS: Acrylonitrile Butadiene Styrene; SAN: Styrene Acrylonitrile; PES: Polyether Sulfone; FM: Fluorescence Microscopy; SEM: Scanning Electron Microscopy; O-PTIR: optical-thermal infrared micro-spectroscopy; UV: Ultraviolet.

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