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Impact of Microplastic on Human Health

Ms. Anju Kalyankar; Mr. Shivraj D. Jadhav

Dr. D. Y. Patil College of Pharmacy, Akurdi, Pune. Maharashtra, India.

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ABSTRACT -

The study provided insights into the associated health hazards by carefully examining the many routes of microplastic exposure, including ingestion, inhalation, and skin contact. Notably, eating microplastics has been connected to hormone imbalance, gastrointestinal problems, and possibly even the spread of harmful microorganisms. Microplastics in the air have the potential to affect respiratory and cardiovascular health, making inhalation of these particles extremely concerning. Although rarely studied, dermal contact increases the risk of allergic responses and skin irritation. Additionally emphasised were COVID-19's effects on microplastic contamination. The manuscript emphasises the urgent need for more study and public awareness by highlighting the need for a deeper mechanistic knowledge of microplastic interactions with human systems. Smaller than 5 mm in diameter, microplastics are now present in soil, water, and air as well as other environmental media. They have also gotten into the food chain and are eventually consumed by humans. This work adds to the body of information on the complex relationship between microplastics and human health by providing a thorough analysis of the topic. Microfibers from textiles, personal care items, and wastewater treatment facilities were among the sources of microplastics that were evaluated.

Keywords: Microplastic, Human Health

1 INTRODUCTION

Modern society relies heavily on plastics, of which 320 million tonnes are produced worldwide each year [1]. However, plastic materials' resilience and tenacity have led to serious environmental issues, such as the buildup of plastic garbage in landfills, rivers, and seas. Every year, almost 8 million tonnes of plastic debris end up in the ocean [2]. Larger plastic objects can break down and fragment into smaller particles known as microplastics when they are exposed to the aqueous environment due to a variety of reasons including mechanical stress, radiation, and microbiological activity [3, 4]. Microplastics pose a particularly serious threat to human health and the environment because of their potential consequences.

Microplastics are tiny particles of plastic, usually with a diameter of less than 5 mm. The formation of microplastics can result from a variety of processes, such as the decomposition of bigger plastic items [5, 6], the extraction of microfibers from fabrics during washing [7], and the incorporation of microbeads into personal hygiene products [8]. Furthermore, as larger plastic particles gradually break down into tiny bits in the environment, this can also contribute to the creation of microplastics [9, 10]. The widespread use of plastic products has led to the widespread presence of microplastics in a variety of environmental media, including soil [11], water [12], and air [13]. Microplastics, which were once thought to be exclusively harmful to marine life, have unavoidably and gradually made their way up the food chain and into the diets of humans. Because of this, there is rising worry about the possible effects of microplastics on human health. Investigations conducted recently have revealed evidence of microplastics in human saliva, stool, and even placenta [14, 15, 16], which has raised concerns about possible bioaccumulation and harmful health effects. There is evidence that microplastics can enter the body by eating, inhalation, and cutaneous contact, while the exact methods by which they may affect human health are still being studied. One common way that microplastics are exposed to the environment is by ingestion; they have been found in a variety of food and drink products, including beer, shellfish, and drinking water [17, 18].Microplastics can be inhaled through the air, especially in dusty interior situations [19], and they can come into touch with the skin when one uses personal care items or comes into contact with contaminated surfaces [20].

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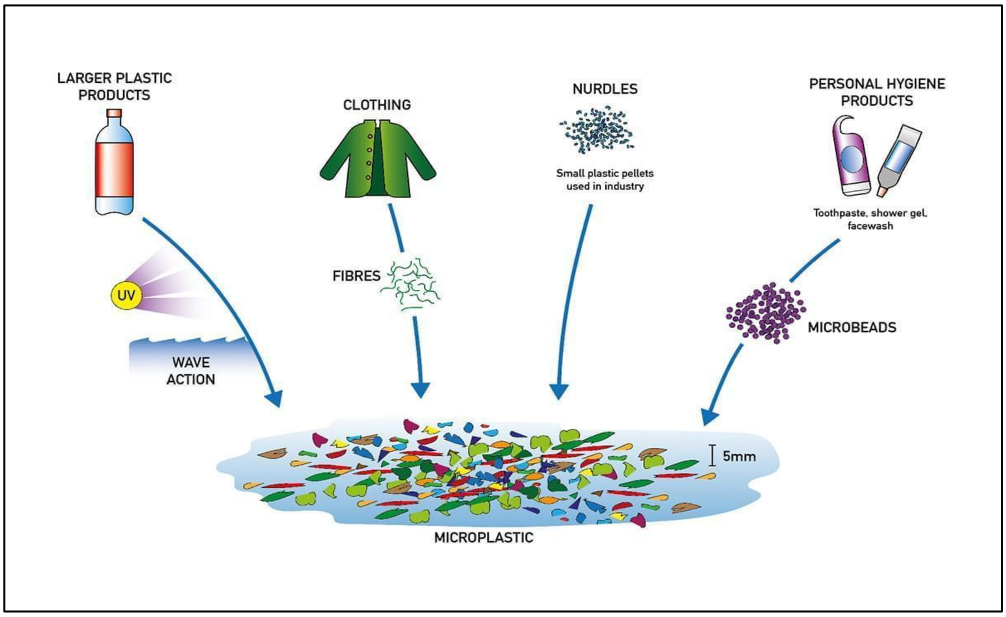

Research findings indicate that microplastics may pose a number of possible health risks, even if the exact effects of microplastics on human health are still not fully understood. These hazards include tissue injury, oxidative stress, and inflammation [21, 22]. In particular, reports have connected exposure to microplastic to negative effects on male fertility and sperm quality, which could be dangerous for a successful pregnancy [23]. Additionally, some research has indicated that microplastics might accumulate in the body over time and have detrimental long-term consequences on health [24, 25]. Microplastics, for example, have the potential to induce inflammation within the body, which in turn may precipitate various other health issues, including heart disease [26], cancer [27], and autoimmune disorders [28]. Furthermore, the presence of microplastics can lead to oxidative stress, a situation that can harm DNA and cells. Numerous health issues, such as neurological illnesses and issues with reproduction, may result from this [29, 30]. Chemical additions added to microplastics during production, such as phthalate esters and polychlorinated biphenyls, usually worsen these health impacts. As a result, microplastics are acknowledged as a new environmental and public health issue that may have an impact on both the environment and human health. It's critical to address the sources of these microscopic particles and draw attention to their possible effects on human health as research on the health effects of microplastics develops. Therefore, the goals of this study are to explore and clarify the complex relationship between human health and microplastics, highlighting the possible hazards associated with these pervasive pollutants. The study includes a thorough investigation of the origins of microplastics, the pathways by which they are exposed, and the ways in which they interact with the human body. The study aims to comprehensively comprehend the possible health effects of microplastics by identifying the channels through which they enter human systems, such as through ingestion, inhalation, and skin contact, through rigorous investigation.

2. Classifications of microplastics

microplastics, both primary and secondary Depending on their source and the surrounding environment, microplastics can take on a variety of shapes and features. An overview of the many types of microplastics and the physical characteristics that correspond with them is given in Table 1. The average size range of microplastic fragments is between a few micrometres (μ m) to a few millimetres (mm). While fibres are frequently longer and narrower than other varieties of microplastic, ranging from approximately 10 μ m to a few mm in length, pellets are commonly homogeneous in size and typically range in diameter from around 1 mm to a few mm. They range widely in diameter from less than 1 to 2.1. Main microplastics range in size from μ m to several micrometres [31].

- **Primary microplastics :-**

Primary microplastics are small plastic particles that are either created as a byproduct of industrial processes or are purposefully made in their micro-sized form [33]. These microplastics are intentionally made to fulfil certain functions, including acting as abrasive particles, resin pellets for effective polymer transportation between various manufacturing sites, or powders for injection moulding [34, 35]. Moreover, they may result from the deterioration of sizable plastic items during manufacture, use, or maintenance; examples are tyres that become worn down during driving or synthetic fabrics that fade during washing [36]. Particles can generally be in different forms, such as resin pellets, microfibers, and microbeads. Microbeads are microscopic plastic spheres that are commonly found in toothpaste and other personal hygiene and cosmetic products. The main purposes of these microplastics are as abrasives or agents that enhance texture. But because they are small, they can easily get into water systems, and it can be difficult to get them to filter out of wastewater treatment plants [37, 38]. Conversely, microfibers are minuscule plastic fibres derived from textiles such as upholstery, carpets, and synthetic clothes. The apparel and fashion industries produce over 70 million tonnes of fibre annually, and washing contributes significantly to the microfiber contamination that is found in rivers [39]. Textiles emit microplastics at many points throughout their life cycles, such as during manufacture, use, washing, and even disposal [40]. Moreover, microfibers have been found in a variety of sources, including carpets, cigarette filters, and personal hygiene products like wet wipes and face masks [40, 41]. The raw materials utilised in the manufacture of plastic items are resin pellets, sometimes referred to as nurdles or nibs [42]. A variety of plastic items are made from these tiny plastic pellets after they are processed and shipped. However, during manufacturing, transportation, or processing, these pellets may be handled carelessly or accidentally spilled, putting aquatic habitats in jeopardy [36].

The existence of primary microplastics in the environment has attracted a great deal of attention because of their extensive distribution and possible negative effects on marine life, which could then have an adverse effect on human health. Marine species may inadvertently absorb microplastics, which could have a negative impact on their survival and general well-being [43]. Moreover, primary microplastics have the capacity to absorb and transfer toxic substances, which increases the environmental risks they pose. Moreover, primary microplastics can also spread from sources including road markings [36], the coating and pre-treatment of maritime vessels, the wear and tear of synthetic cooking utensils, and shoe soles, among other things [44].

- **Secondary microplastics**

Secondary microplastics are microscopic pieces of plastic that result from the breakdown and breakage of bigger plastic products such as bags, bottles, and packaging materials. Secondary microplastics result from the slow weathering, deterioration, and disintegration of larger plastic objects, in contrast to primary microplastics, which are intentionally made in their micro-sized form [45,46]. Degradation of plastic products can be caused by chemical processes, exposure to sunshine (UV radiation), and mechanical forces (abrasion and waves). These procedures eventually result in secondary microplastics by progressively breaking down the plastic into smaller and smaller bits [47]. Because macroplastics are released into the environment so regularly, the general consensus is that secondary microplastics make up the majority of microplastics in the environment [48]. There are several kinds of secondary microplastics, such as fibres, microbeads, and fragments (Table 1). Plastic fragments are amorphous bits that break off from bigger plastic items during decomposition [32]. Thin strands of material found in textiles like clothes, ropes, and fishing nets are called fibres. Microbeads are small spherical particles that resemble the ones found in primary microplastics. Secondary microplastics have the potential to contaminate soil, water, and air ecosystems after they are discharged into the environment.

The ecosystem and living things are seriously endangered by these minuscule microplastic pieces. In particular, marine life is highly vulnerable to these harmful impacts. Unknowingly ingesting microplastics might cause ingestion-related issues and digestive troubles for marine creatures [50].

3. Sources of microplastics

Microplastics come from a variety of sources. Microfibers can leak into the environment through the use of personal care products containing microbeads and the laundering of fabrics, which releases microfibers. Larger plastic particles in the environment may break down and produce microplastics as a consequence. These bigger plastic particles have the potential to break down ever-tinier pieces over time. The microplastic that is created as larger plastics degrade can have a variety of shapes and forms depending on its size.

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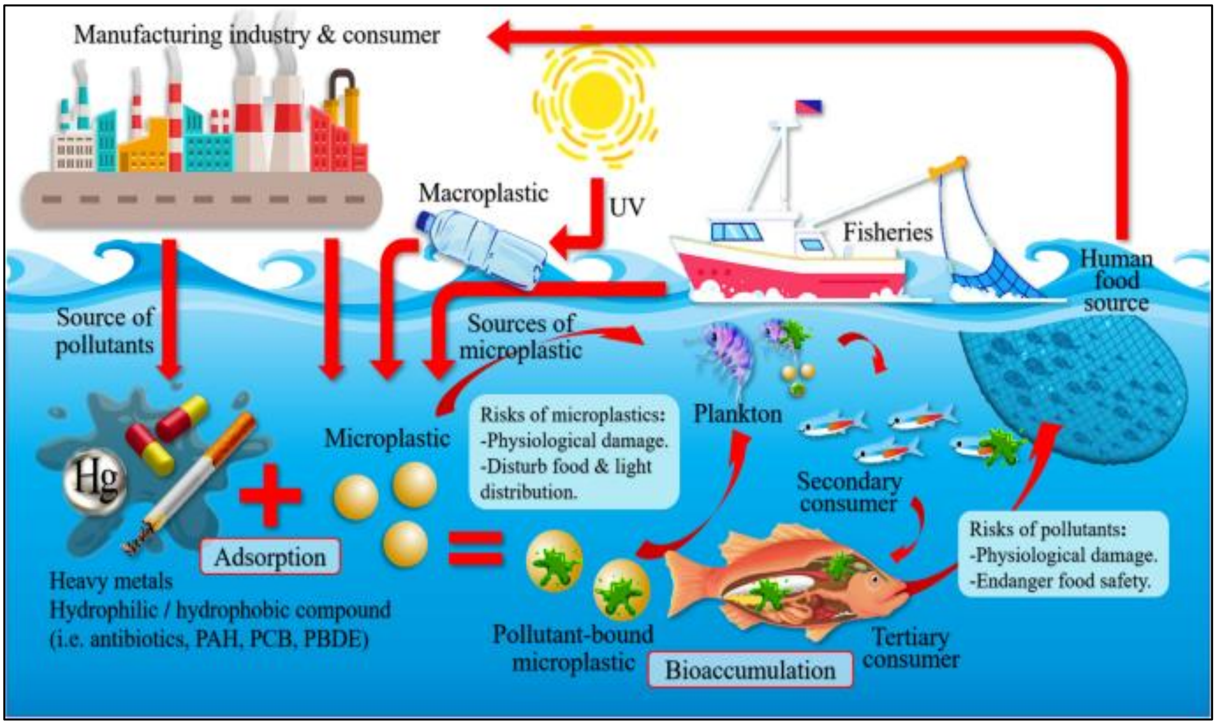

3.1. Microfibers from textiles

One of the main sources of microplastic pollution is textile microfibers. They are present in a variety of apparel products, such as athletic wear, fleece, and other synthetic textiles, and are usually made of polyester and nylon [51, 52]. Small fibres that can evade wastewater treatment plants and eventually make their way into the environment are shed by these synthetic textiles during laundry [53]. One of the main causes of microplastics (MPs) in the ocean is the discharge of synthetic textile fibres during cloth washing. When synthetic clothing is laundered, the mechanical and chemical stresses cause microscopic microfibers to be released, which leads to microplastic contamination [54].

Because these microfibers are too small for wastewater treatment facilities to filter, they wind up in the oceans and seas [55, 56]. Washing a single garment can release up to 1,000,000–1,000,000 fibres, washing polyester fabrics can release around 6,000,000 fibres, and washing acrylic fabrics can release 700,000 fibres [57]. De Falco et al.'s study [58] examined the role that washing synthetic clothing plays in the contamination caused by microplastics. Real-world washing tests were carried out with a domestic machine to investigate textile effects and microfibre release. After wastewater samples were gathered and filtered, it was discovered that there were between 640,000 and 1,500,000 microfibre discharges, ranging from 124 to 308 mg per kilogramme of fabric.The release was impacted by textile properties like twist and fibre content. A considerable proportion of cellulosic microfibers are shed by clothing comprised of a polyester/cellulose combination. Most of these shed microfibers—which are harmful to marine life—were captured by filters with holes of 60 µ or more.

3.2. Personal care products

Primary microplastics are more common in personal care items and come in a variety of forms, such as microbeads, microfibers, and microcapsules. The term "personal care products" refers to a variety of goods intended to preserve one's hygiene, improve appearance, and advance wellbeing. Products including soaps, shampoos, conditioners, body lotions, deodorants, and cosmetics are frequently included in this category. They might also include skincare items like sunscreens, serums, and moisturisers. Microbeads, with an average size of 250 m, often make up 0.5% to 5% of the content of cosmetic products. For example, a single usage of toothpaste alone releases about 4000 microbeads [57].

Plastic type	Common applications	Specific gravity
Polyethylene	Plastic bags, storage containers	0.91–0.95
Polypropylene	Rope, bottle caps, fishing gears, strapping	0.90–0.92
Polystyrene (expanded)	Cool boxes, floats, cups	1.01–1.05
Polystyrene	Utensils, containers	1.04–1.09
Polyvinyl chloride	Film, pipe, containers	1.16–1.30
Polyamide or Nylon	Fishing nets, rope	1.13–1.15
Poly(ethylene terephthalate)	Bottles, strapping, textiles	1.34–1.39
Polyester resin + glass fibre	Textiles, boats	>1.35
Cellulose Acetate	Cigarette filters	1.22–1.24
Pure water		1.000
Sea water		1.027
Brackish water		1.005-1.012

4. Routes of exposure to microplastics

Exposure to microplastics can occur via a variety of routes, including ingestion, inhalation, and skin contact. Marine pollution can affect a range of consumer products that come from the sea, such as fish and salt. When these products are consumed, this contamination may introduce microplastics into human systems.

4.1 Ingestion

Microplastics are ingested when tiny plastic particles are ingested through food or water. Seafood, bottled water, and other food items that have come into contact with microplastic contamination contain these particles.

4.1.1. Seafood

Because shellfish feed on particles in the air, they are particularly likely to carry microplastics in their flesh. Since microplastics are found in the water column, they may build up in the tissues of these species and end up in the food that humans eat. Numerous species at different trophic levels in the food chain have been found to consume plastic, including fish, invertebrates, marine mammals, and birds that eat fish [87]. There is evidence that more than 800 animal species have been exposed to plastic either by eating it or getting tangled in it [88].Because they are so small, microplastics can be easily consumed by a wide range of creatures, such as those that filter feed, eat organic matter, or feed on sediment [61,89]. Microplastic ingestion has been shown in controlled laboratory studies and natural environments involving a wide range of marine organisms intended for human consumption, such as fish [92,93], bivalves [96], seabirds [94], crustaceans [95], and zooplankton [90,91].

4.1.2. Bottled water

Numerous plastic water bottle brands have been found to contain microplastics. It is thought that the plastic bottles themselves, along with the bottling and shipping procedures, are the source of the microplastics. While drinking-water treatment is often successful in eliminating many types of waterborne particles, including microplastics, it is crucial to remember that some parts of treatment facilities, as well as their distribution networks, are composed of plastic [105]. Drinking water may eventually contain microplastics due to the eroding or degrading nature of these plastic components [106]. Furthermore, some bottled drinks have plastic bottles and caps, which could be a source of microplastic contamination in drinking water [106,107]. Apart from bottled water, human consumption of microplastics is largely influenced by tap water and other different types of water. An individual's annual consumption of microplastic particles is estimated to be between 39,000 and 52,000, with tap water contributing between 3000 and 4000 MPs (or 4.34 MPs per litre) to this amount [108].

4.1.3. Other food products

Microplastics have been found in a number of food items, including salt, milk, honey, and beer. During the manufacture or packing of these products, microplastics may get into the product. In all 24 of the German beer brands that were examined, Liebezeit and Liebezeit [113] discovered microplastic contamination. The fibre counts ranged from 2 to 79 fibers/L, the fragment counts from 12

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to 109 fragments/L, and the granule counts from 2 to 66 granules/L. In a different investigation, coloured fibres were discovered in all of the honey samples from various European countries that were analysed (counts ranging from 40 to 660 fibers/kg of honey) [114].There were pieces as well, however they were less common; there were 0 to 38 fragments per kilogramme of honey. It was thought that the coloured substance came from ambient sources added during bee transportation or honey processing. According to Li et al. [115], microplastics have been detected in a variety of commonly consumed beverages across the globe, such as beers (20–80 mL^{-} 1), bottled mineral water (10 mL^{-} 1), and tea leaves (200–500 g^{-}). Numerous microplastic forms, such as quasi-spherical particles, pieces, and fibres, were discovered. Concerns over the buildup of heavy metals and antibiotics were raised when sources of contamination were identified as the atmosphere, raw materials, and tools/containers.

4.2. Inhalation

When tiny plastic particles are breathed into the lungs, it is known as microplastic inhalation. The mode of exposure in question is especially concerning for those who work in industries that produce or use plastic items. Though historically disregarded, the importance of microplastics in the atmosphere has been demonstrated by new research indicating their existence in both indoor and outdoor environments, as well as atmospheric fallout [121]. When these microplastics are present in significant amounts, the health concerns that could result from breathing them in become critical [122].The ability of airborne fibrous microplastics to penetrate the respiratory system is largely dependent on their size. It is possible for inhaling plastic particles that are smaller than 3 µ m in diameter and fewer than 5 µ m in length [123]. The particles eventually end up being exposed through the gastrointestinal system even if the mucociliary process in the upper airways is likely to eliminate them [123,124]. Employees in sectors including waste management, recycling, and the production of plastics may inhale high concentrations of microplastics. Furthermore, those who live in areas where microplastic contamination is prevalent may potentially come into contact with microplastics through breathing. The wide dispersion of their sources affects the amount of airborne microplastics in the environment. The main culprits are identified as primary microplastics, which come from the breakdown of synthetic rubber tyres, synthetic textiles, and urban dust [125]. Microplastics have the ability to enter the atmosphere and travel great distances on wind, which could expose people who reside far from the pollution source. Roughly 7% of the microplastic pollution in the ocean is thought to be caused by wind transmission [125].

4.3. Dermal contact

The skin becomes in contact with microplastics when this happens. Microplastic-containing face and body cleansers and tainted water used for washing are two ways that humans can come into contact with microplastics [132]. The exposure occurs when microplastics pass through the skin's pores, yet each person's exposure can differ depending on how big and how different their skin pores are [133].Revel et al. [132] state that because microplastics must pass through the stratum corneum, which only allows particles smaller than 100 nm to pass through, the likelihood of microplastics absorbing through the skin is limited. However, it is imperative to consider the prospect of nanoplastic—even tinier plastic particles—penetrating the environment, as this possibility should not be discounted. Workers in sectors including waste management and the production of plastics may come into direct skin contact with microplastics.

5. Health impacts of microplastics

While research on the health consequences of microplastics is ongoing, studies suggest that exposure to these tiny plastic particles may have a number of negative effects on human health [135,136]. This section addresses the various health effects linked to microplastic exposure according on the ingestion source of the particles. The health effects of microplastic exposure on humans.

5.1. Ingestion

Ingesting microplastics has been associated with several adverse health effects, such as toxicity, endocrine disruption, and gastrointestinal problems.

5.1.1. Gastrointestinal problems

Exposure to microplastics has been linked to a number of health concerns, including digestive issues. Studies indicate that consuming microplastic particles through tainted food or water may cause a number of gastrointestinal problems [137]. These issues could involve changes in intestinal permeability, modification of gut microbiota, constipation, irritable bowel syndrome, and digestive tract inflammation [137,138]. Furthermore, it has been found that microplastics accumulate in the digestive tract, where they can cause obstructions and physical irritation [139]. Adjuvant activity—the ability of microplastics to strengthen the immune system in response to biomolecules adsorbed on their surfaces—is thought to be the source of the cellular effects of microplastics in the gastrointestinal tract [140].The symbiotic interaction between hosts and the natural gut microbiota population is significantly impacted by microplastic exposure, which can result in dysbiosis, a disruption. The immune system of the host may be negatively impacted by dysbiosis, which may result in chronic illnesses, heightened susceptibility to pathogenic infections, and changes in the genetic expression and capacity of the gut microbiota [141,142]. Microplastics in the intestines of zebrafish caused mucosal injury, increased permeability, inflammation, and disruptions in metabolic processes, among other detrimental effects [138].Elevated levels of microplastics caused modifications to immune cell populations, an increase in inflammation, and changes in gut flora [143]. Recent research has also looked into how humans digest microplastics. The effects of two distinct sizes of microplastics on human intestinal cells—3 µ m and 10 µ m—were investigated by Visalli et al. [144]. The results showed that both sizes of microplastics produced considerable cytotoxicity, with the impact on cell membranes being more noticeable for the smaller particles.

5.1.2. Endocrine disruption

Endocrine disruption is acknowledged as a possible consequence of microplastics. Endocrine-disrupting chemicals (EDCs) are just one of the many substances that microplastics can acquire and store from their surroundings. EDCs are compounds or combinations of substances that come from outside sources and have the ability to interfere with the endocrine system's regular operation, which could have a negative impact on an organism's health [147]. EDCs are present in microplastics made as reaction reagents or additives in plastics, and they include bisphenol A (BPA), nonylphenol, phthalate esters, and octylphenol [148,149].

These endocrine disrupting chemicals (EDCs) can be released by microplastics when they are consumed or come into touch with living things. Hormonal balance, reproduction, development, and general health may all suffer as a result of this disturbance [150,151]. The tiny size and extensive dissemination of microplastics raise the probability of coming across EDCs. Lin et al. [152] looked into the impact of polystyrene microplastics (PSMPs) on the bioavailability and reproductive disturbances brought on by microcystin-LR (MC-LR) in zebrafish. PSMPs increased MC-LR accumulation in zebrafish gonads and amplified the harm MC-LR does to reproduction. In addition, PSMPs interfered with the HPG axis and levels of sex hormones, worsening reproductive failure. By acting as carriers, PSMPs increased MC-LR's toxicity to reproduction and bioaccumulation in zebrafish. All examined Atlantic horse mackerel samples from the middle Mediterranean Sea had microplastics in their gastrointestinal tracts [153]. 60% of the male specimens had vitellogenin, a biomarker for endocrine disruption, found in their livers, showing that the fish species consumes plastics on a large scale. In Japanese medaka fish, exposure to microplastics and related substances resulted in aberrant germ cell proliferation and changed gene expression. These results imply that adult fish's endocrine systems may be affected by environmentally relevant quantities of plastic waste [154]. There is little knowledge of these addition chemicals' leaching capacities from different polymer types and their potential negative impact on human health, despite the alarming evidence of their potentially detrimental consequences [149].

5.2.1. Respiratory problems

Breathing in microplastics that are in the air may have an impact on respiratory health. These microscopic particles have the potential to irritate and inflame the respiratory tract, which can exacerbate pre-existing respiratory disorders like asthma and produce symptoms including coughing, wheezing, and shortness of breath [167,168]. The size of the fibre affects its toxicity. Longer fibres are more harmful to lung cells and have a higher persistence, yet less thick fibres can be breathed into the respiratory system. Alveolar macrophages and the mucociliary escalator are examples of natural processes that are unable to adequately remove fibres of 15–20 µ m from the lungs [169]. Less than 0.3 µ m thick and longer than 10 µ m fibres are the most hazardous [139]. The potential health effects of microplastics are especially concerning for people who work in industries that manufacture or use plastic products. When airborne microplastics are inhaled by workers in the flock and synthetic textile industries, respiratory symptoms linked to the development of interstitial lung and airway disorders may occur [170,171]. Previous studies that looked at the lung tissue of workers in the textile sector and found the presence of synthetic fibres reported respiratory discomfort [172]. An examination of the lungs of flock workers exposed to nylon flock showed that some individuals developed persistent interstitial lung illness and a steady decline in lung function even after they left the workplace, which resulted in secondary pulmonary hypertension and respiratory failure [173].Additionally, it has been shown that occupational exposure to polypropylene flock is associated with respiratory symptoms, reduced pulmonary function, elevated serum cytokine levels, and early signs of interstitial lung disease [170]. These findings highlight the significance of medical monitoring and exposure control measures in the polypropylene flock industry. Furthermore, the hydrophobic surface of airborne fibrous microplastics allows them to take in pollutants from their surroundings [174]. These microplastics have the ability to carry hazardous metals and polycyclic aromatic hydrocarbons (PAHs) when they are found in metropolitan areas with other vehicle pollutants. Genotoxicity and other harmful consequences on lung health may result from the discharge of these pollutants [123]. One of the possible negative consequences of PAH metabolism linked to fibrous microplastics is the creation of stable and unstable DNA damages [123, 175].

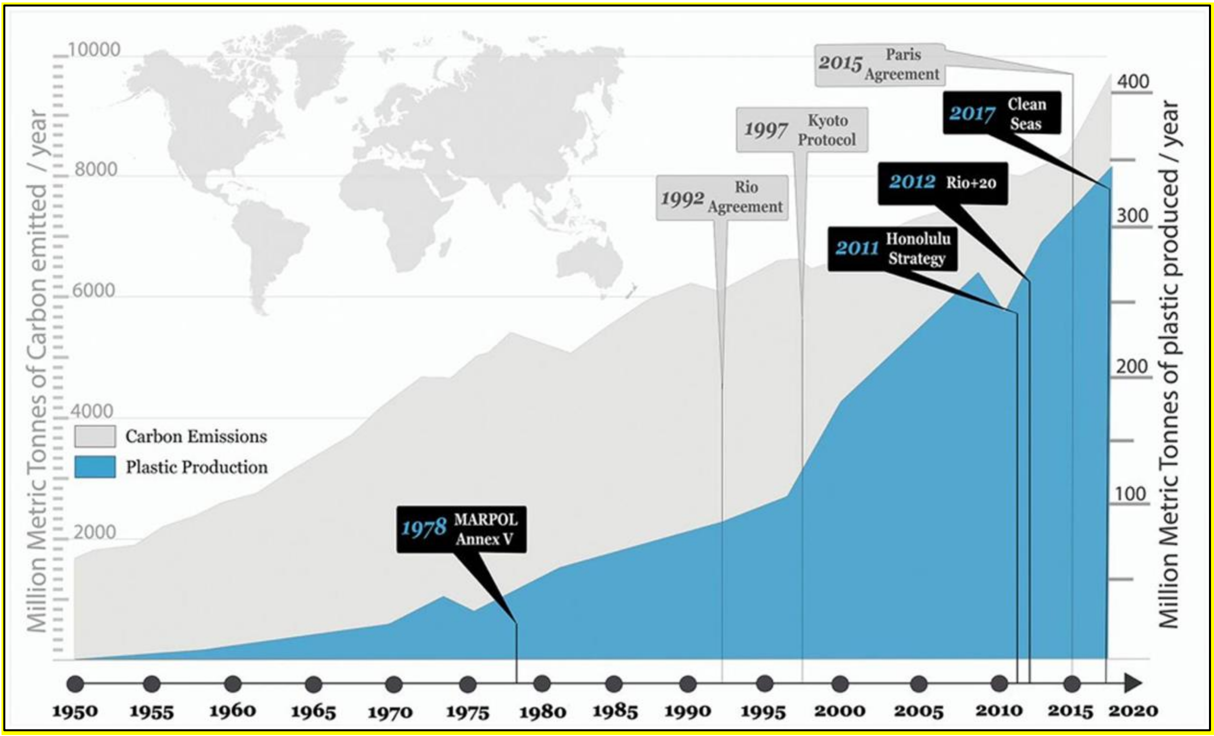
5.2.2. Cardiovascular problems

Research suggests that exposure to microplastics may play a role in the onset or exacerbation of cardiovascular diseases, such as hypertension, atherosclerosis, and irregular heartbeats [176,177]. These tiny plastic particles have been shown to increase the risk of cardiovascular issues by inducing oxidative stress, inflammation, impaired endothelial function, and interference with regular heart function [125,178]. An additional cause for concern is the capacity of microplastics to retain hazardous substances from the surroundings, as these substances may also have deleterious impacts on the cardiovascular system. Animal models are frequently used to study the role that microplastics play in cardiovascular problems. It has been demonstrated that increasing doses of microplastics impacted genes linked to inflammation and oxidative stress, decreased mammalian cell viability, and increased cell metabolism [179]. Increased exposure to microplastic in mice has also been demonstrated to alter gene expression, immune system function, and bone marrow cell metabolism pathways [180].Li et al. [181] studied the impact of PS microplastics on the cardiovascular system in rats. According to the findings, PS microplastics can cause cardiovascular toxicity by encouraging cardiac fibrosis and causing myocardial damage through oxidative stress. They also increased collagen production, oxidative stress, and the fibrosis-related Wnt/β-catenin pathway. In a similar vein, mice fed PS microplastics showed signs of weight growth, increased fat mass, higher insulin and fasting blood glucose levels, and insulin resistance [177]. Analysis of the gut microbiota and gene expression confirmed the link with obesity. These findings demonstrate that exposure to microplastics is an overlooked risk factor for the development of cardiovascular disease, particularly atherosclerosis. Additionally, recent studies have shown a link between cardiovascular disease and microplastics. When human kidney and liver cells were exposed to PS microplastics, they displayed altered reactive oxygen species levels, reduced cell proliferation, anomalies in their structural makeup, and altered gene expression of important enzymes [182]. The presence of ambient particles in thrombi taken from patients undergoing cardiovascular surgery was investigated by Wu et al. [183]. It demonstrated the build-up of various particles—including artificial ones—within the thrombi. These results highlight the need for additional research in this area and highlight the underappreciated harmful health effects associated with microparticle exposure.

5.2.3. Allergic reaction

When microplastic particles come into touch with the skin, they can potentially trigger allergic reactions and the immune system. Histamines and other inflammatory chemicals may be released by the body's immune system in response to its perception of these foreign particles as hazardous, which could result in allergy symptoms [81,187].Itching, redness, swelling, hives, and in rare instances, even more serious reactions like anaphylaxis, can be among these symptoms [188]. It is noteworthy that people who already have allergies or sensitivities may be more vulnerable to allergy reactions triggered by microplastics. Research has demonstrated that exposure to elevated levels of polypropylene microplastics might elicit immunological reactions and heighten cellular sensitivities [187]. Hwang et al. [189] found that while high concentrations of PS particles did not cause histamine release or allergic reactions in HMC-1 cells, they did cause early-stage inflammation in a different investigation into the effects of primary PS particles on human health.

Global scinario



CONCLUSION

The research on the impact of microplastics on human health emphasises how critical it is to solve this worldwide environmental problem as soon as possible. It is evident from examining the sources and pathways of microplastic pollution that synthetic fabrics, industrial processes, plastic trash, and microbeads all play a major role in the release of microplastics into the environment. The primary means by which these particles enter the food chain and eventually reach humans is through the ingestion of tainted seafood. It is important to note that exposure to microplastics can also happen through other channels, like soil absorption and airborne deposition.It has been established that microplastics can be harmful to human health and can cause oxidative stress, inflammation, and even poisoning. Even though research on the full extent of the health effects is ongoing, it is clear that action is needed to address the issue of microplastic contamination. Policymakers, businesses, and the general public should act proactively to reduce exposure to microplastics and lessen their negative impacts on the environment and human health while scientific research into these effects continues.

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