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Microplastics: Its Impact on Human Health

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Plastic waste is a major global issue, affecting ecosystems and human health on a massive scale. Its widespread impact reaches across land and sea, causing significant environmental, economic and social challenges. In 2019, the global annual production of plastic products reached 460 million tons, with only Nine per cent being recycled. It is projected that by 2060, this production will reach to 1.2 billion tons.

Microplastics are ubiquitous in the global environment and are usually produced intentionally or generated when large synthetic polymer products degrade into smaller fragments, such as plastic packaging are not properly disposed off or treated. Microplastics refer to plastic fragments or the small plastic particles measuring less than 5 mm in diameter are found in the environmental resources such as soil, water and air and they have infiltered food chain, which ultimately becomes the part of human diet.

Primary microplastics are small plastic granules mainly used in the cosmetics, air blasting technology and also used in the vectors for drugs in medicines. Secondary nanoplastics are tiny plastic materials which are deteriorated from microplastics debris. Most prevalent waste materials are brought to the seas by rivers, floods and winds that pollute the ocean and beaches ecosystem. Discarded fishing craft, plastic bags, food containers and plastic drinks bottles (water bottles and cold drinks) pollute the water ecosystem. Mishandling of enormous anthropogenic activities could introduce many xenobiotic pollutants to water environments around the planet, either deliberately or accidentally.

Microplastics are easily ingested due to their micro-level sizes and they also move easily into the food chain and persists in the environment. Microplastics exists in micro-level to nano-level sizes. Due to these reasons, microplastics pose potential hazards to both human and environment. Some examples are physical and mechanical harms. Example for mechanical harm is causing abnormalities in internal organs especially, in marine organisms when they are ingested microplastics mistakenly.

Ecotoxicity may be caused by the polymer itself, impurities (residual catalysts or reaction by-products), additives (stabilizers) or other substances in the polymer matrix (dyes or lubricates). Microplastics may enter into the human body causes many health-related risks when they are not filtered mainly during sewage treatment processes. Hence, they flow into the sea and posing may risks for both the ecosystem and humans. Various examples that causes damage by microplastics such as accumulation of microplastics in the bodies of marine and aquatic organisms that may leads to malnutrition, inflammation, reduces fertility and mortality. Microplastics under 100 nm in size can reach almost all organs after entering the human body. Therefore, concerns exist regarding the negative effects of continuous microplastic accumulation in the human body. To counteract the harmful effects of microplastics, government has to begin establishing and promoting plastic waste management measures to promote the effective management of microplastics.

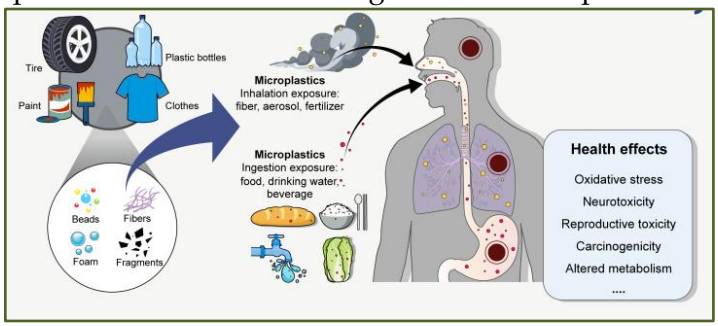

Fig. 1. Anthropogenic activity causes microplastics exposure to food web, also to food and organs of the human body and their health effects

Different Pathways Human Exposure to Microplastics

Microplastics causes many potential threats to human health due to their usual existence in the environment. There are different pathways human get exposed to the microplastics. It is very important to understand the pathways of human exposure to microplastics. Oral intake (Drink, food, food container and baby teat), inhalation (air) and skin contact (Personal care product and mobile phone case) are the common ways.

Oral Intake

Oral intake is the main exposure route of microplastics. Microplastics which exists in our daily necessities such as drinking water, bottled water, food,

food container, seafood, salt, sugar, tea bags, milk and baby teat. Take-out food containers made of common polymer materials (Poly propylene, Polystyrene, Polyethylene and Polyethylene Terephthalate) are used widely, from which microplastics are found. It is estimated that people who order take-out food 4 to 7 times weekly may intake 12 to 203 pieces of microplastics through containers. In addition, the surface of silicon rubber baby teats degrades when they are sterilized by steam, during which microplastic particles are released into the environment.

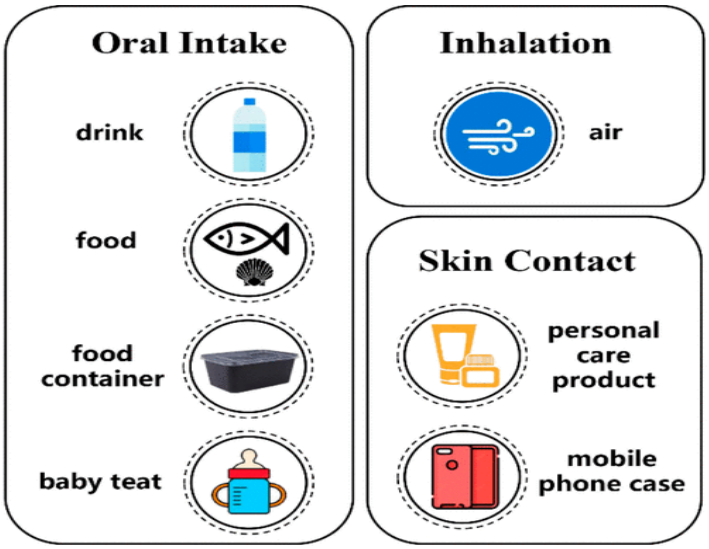

Fig. 2. Different pathways human exposure to microplastics

Inhalation

Microplastics in the air mainly includes particles such as polypropylene, polystyrene, polyethylene, polyethylene terephthalate and fibers. Largest source of microplastics in the atmosphere mainly comes from the road. Size of microplastics detected in lung tissue is smaller than that in the atmosphere. It is further confirming that humans can be exposed to microplastics by inhalation and prompts attention to the potential harm to the human body. Particle pollution has long been known to damage lung tissues, leading to cancer, asthma attacks and other health problems. If inhalation of microplastics is sufficiently high, these plastic particles may cause similar health problems.

Skin Contact

The biggest organ of the human body, human skin has a surface area of 1.5 to 2 m^2 and provides an interface with ubiquitous microplastics in the environment. Microplastics are usually do not pass through the skin barrier, but they can still increase exposure of risk by depositing on the skin (Dermal absorption). Dermal absorption occurred mostly when humans use personal care products, including hand cleanser, facial/body scrubs, face masks, and also toothpaste, which may result in the toxicity and possible absorption. Protective mobile phone cases can also generate microplastics during use, which may be also get transferred to human hands. Due to the size limitations of microplastics available for dermal penetration, the dermal route was thus more associated with the absorption of released monomers or organic plasticizers like phthalates and bisphenols which were endocrine disruptors.

During the dermal exposure of microplastics, some typical plastic additives, including brominated flame retardants (BFRs), bisphenols (BPs), triclosan (TCS) and phthalates, may also get be absorbed by the human body. Microplastics have a negative impact on skin health, with their ability to cause skin irritation, inflammation and disruption of natural skin functions.

Unfortunately, increased exposure to MPs can also bring health problems. For example, respiratory diseases, reproductive problems, change of microbiota, neurotoxicity, and even cancer are just a few of them. Therefore, this danger should be recognized and necessary precautions should be taken. Even small steps are needed in this area. It is extremely important for people to increase their awareness of this issue and for countries to prevent this threat with various policies. This review was written to explain how MPs threaten food safety and human health.

Impact of Microplastics on Human Health

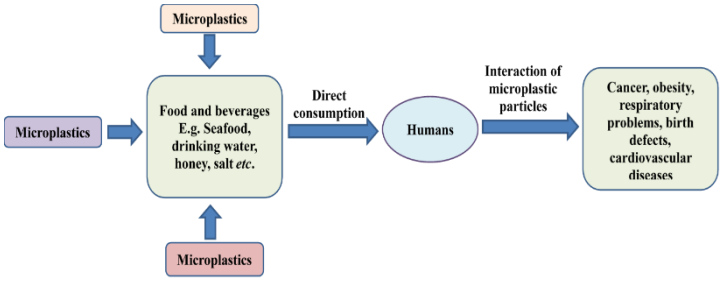

Fig. 3. Impact of microplastics on human health

Microplastics pose a danger to humans, animals and the environment and for example, if they are mistaken taken through food and beverages and then eaten. Extremely harmful micropollutants, such as residues of plasticizers, heavy metals and pharmaceuticals, can adhere to the microplastic. This increases the risk of physical and toxicological damage to organisms and ecosystems that can be caused by microplastics. Microplastics can have various harmful effects in the organism. These include physical effects that unfold directly *via* the effect of the plastic particles

as foreign bodies in the organism. As well as indirect effects, when additives contained in microplastics (e.g., plasticizers) or pollutants absorbed in the environment (e.g., heavy metals) are released in the organism.

Absorbed microplastics can be transported into the tissue, the bloodstream and thus also into internal organs and cells of living organisms. If the plastic particles are in the organism, there is a possibility that they will grow into the tissue. Furthermore, organ and cell dysfunction can occur, for example by causing inflammation, oxidative stress, damage to DNA or a reduction in membrane stability.

Even though microplastic concentrations are often below those found to be acutely toxic in the laboratory, it can cause stress due to chronic long-term exposure. Increased exposure to microplastics can also bring health problems main in the human being. For example, respiratory diseases, reproductive problems, change of microbiota, neurotoxicity and even cancer are just a few of them.

Future Prospects

Microplastics are posing many health-related problems to humans, animals and the environment. To overcome them some measures has to be taken. However, there are some solutions to eliminate the effect of microplastics on the humans and animals. Therefore, it is very important to make more researches to develop new standardization methods to analyse microplastics and determine their effect and risk on the human body.

- **Research and Monitoring:** Epidemiological studies are long-term studies which are needed to establish a clear link between microplastic exposure and specific health outcomes. Understanding exposure levels and mechanisms of toxicity will be crucial for risk assessment.
- **Regulation and Policy:** Bans and Restrictions and waste management are very necessary.
  - ✓ **Waste Management**: Enhancing waste management practices, such as recycling and reducing plastic production, will be essential in mitigating the release of microplastics into the environment.
- **Mitigation Strategies:**
  - ✓ **Biodegradable Plastics**: Developing and promoting the use of biodegradable plastics can help reduce the persistence of plastic waste in the environment.
  - ✓ **Innovative Technologies**: Advances in technology, such as nanotechnology and filtration systems, can aid in removing microplastics from water and air.
- **Public Awareness and Education:**
  - ✓ **Consumer Behavior**: Educating the public about the sources and risks of microplastics can drive changes in consumer behavior, such as reducing single-use plastic consumption.
  - ✓ **Community Involvement**: Community-led initiatives, such as beach clean-ups and advocacy for plastic-free alternatives, can contribute to reducing microplastic pollution.

Conclusion

Microplastics are much more challenging to remove due to their small size and huge quantity, which can be remain active for years and also pose a potential threat to human health through various exposure routes and mechanisms of toxicity. Many sources of food and landfill have microplastic waste that goes directly or indirectly to the human body by eating food or breathing air, which affect human health. Addressing this issue requires a multifaceted approach involving scientific research, regulatory measures, technological innovation, and public engagement. By understanding and mitigating the impacts of microplastics, we can protect both environmental and human health for future generations.

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