DOI: 10.21088/ijcd.2395.6631.11225.3

Indian Journal of Communicable Diseases
Volume 11 Number 2, July-December 2025

REVIEW ARTICLE

Emerging Threat of Microplastic Pollution: A Comprehensive Review

Ekta Arora[1], Shashi Saxena[2]

HOW TO CITE THIS ARTICLE:

Ekta Arora, Shashi Saxena. Emerging threat of Microplastic Pollution: A Comprehensive Review. Indian J Comm Dis. 2025;11(2): 63-65.

ABSTRACT

In the recent decades, Microplastic pollution has emerged as a critical environmental and public health challenge. Though the evidence regarding the health implications and mitigation strategies for the microplastics is on a rise, yet there are persist significant gaps in understanding the full extent of microplastics. A comprehensive review is thus essential to figure the magnitude of the burden, long term health implications and challenges and limitations in the mitigation strategies. An integrated waste management system, focussing on the four R's hierarchy–reduce, reuse, recycle, recover can serve as an important hallmark in source reduction and resource consumptions, thus contributing to reduce mismatched plastic pollution.

KEYWORDS

• Microplastics • Mismatched Plastic Pollution • Waste to Energy • Integrated Waste Management

INTRODUCTION

Background

In the recent decades, Microplastic pollution has emerged as a critical environmental and public health challenge. Though Plastics have a very recent existence, yet their excessive production and utilization at various levels have resulted in a significant threat to the environment.

Microplastics are particles of less than 5 mm size with primary microplastics, identified as tiny microbeads, made intentionally and are commonly used as cosmetic microbeads. When exposed to environmental conditions, plastics fragment through oxidative degradation producing particles <5 mm, known as secondary microplastics. Nano plastics, whereas, can easily penetrate the living cells to a greater extent, thus can pose high risk than microplastics due to their higher reactivity.[1]

AUTHOR'S AFFILIATION:

[1] Assistant Professor, Department of Community Medicine, ESIC Medical College, Faridabad, Faridabad, Haryana, India.

[2] Assistant Professor, Department of Community Medicine, ESIC Medical College, Faridabad, Haryana, India.

CORRESPONDING AUTHOR:

Ekta Arora, Assistant Professor, Department of Community Medicine, ESIC Medical College, Faridabad, Faridabad, Haryana, India.
E-mail: aroraekta09@gmail.com

➢ **Received:** 23-09-2025 ➢ **Accepted:** 06-11-2025

The microplastics are usually generated from the degradation of larger plastic debris, synthetic textiles, personal care products, and industrial processes. They have been detected in marine, freshwater, terrestrial, and even atmospheric environments, thus making them a strong contaminant in today's era.

Though the evidence regarding the health implications and mitigation strategies for the microplastics is on a rise, yet there are persist significant gaps in understanding the full extent of microplastics. A comprehensive review is thus essential to figure the magnitude of the burden, long term health implications and challenges and limitations in the mitigation strategies.

Problem statement

It is estimated that our oceans are filled annually with approx. over 14 million tons of microplastics.[2] It has also been demonstrated that worldwide over 90% of drinking water and table salt contain microplastics, thus highlighting their presence in the human food chain.[3] Microplastics also pose a serious threat since recent evidences have indicated human exposure through inhalation, ingestion, and dermal contact, thus leading to potential toxicological effects like oxidative stress, and inflammatory response.

Current cumulative plastic production has risen above 8 billion MT worldwide with coastal countries generating about 275 million MT of plastic, of which 4.8 to 12.7 million MT enter the ocean.[4] A United Nations (UN) estimate revealed the presence of about 51 trillion MPs in the seas, a value 500 times greater than the amount of stars in the entire galaxy.[5]

Health Implications of Microplastic pollution

Evidence has been generated regarding carrying of harmful chemicals by the microplastics. These chemicals include endocrine disruptors and carcinogens, thus adding to the biological impacts of microplastics including cancers. Influx through skin, ingestion while eating, or drinking and inhalation are identified to be the major routes of microplastic exposure. Amongst these, inhalation is particularly concerning since the inhaled micro/nano particles can directly interact with the respiratory tissues. Thus long term, and even low level of exposure in minute quantities can make a person prone to systemic inflammation, metabolic disorders, or cancer.[6]

MITIGATION STRATEGIES FOR MICROPLASTIC POLLUTION

Though removing all plastics from the environment seems a herculean task due to widespread plastic particles, yet clean-up actions can still help to reduce pressure of plastic pollution on environment. This can be achieved by source-reduction and waste management as a restorative strategy.

An integrated waste management system, focussing on the four R's hierarchy reduce, reuse, recycle, recover can serve as an important hallmark in source reduction and resource consumptions, thus contributing to reduce mismatched plastic pollution.[7]

1. At production level, source reduction can be achieved by:

(a) Replacing plastics with alternative, recycled, or biodegradable materials like glass.

(b) Improving recyclability by improving design and constituents

(c) Banning single-use plastics.

(d) Voluntary and mandatory measures

2. At consumption level, various measures can be deployed for waste management:

(a) Avoiding unnecessary packaging and labelling

(b) Opting eco-friendly options for packaging and labelling.

(c) Increasing awareness - Formal or informal education can help increase awareness to reduce consumption of plastics. These campaigns should focus on practical actions and long-term behaviour change for reducing the consumption of harmful products, reducing littering, and improving recycling rates.

LIMITATIONS IN COMBATING MICROPLASTIC POLLUTION

The detection of plastic particles mainly relies on analytical methodologies. But since, there is a dearth of standardized and affordable analytical technologies, we are unable to accurately track these plastic particles.

The pollution monitors are also not well equipped and designed to measure microplastics. This is a major bottleneck in air quality assessments, as no regulations are in place to include microplastics in monitoring protocols.

We are still dependent on the animal models for microplastics; hence we are unable to fully capture the human complexities associated with microplastic exposure. Also, the ongoing researches have captured data on synthetic microplastics rather than the fragmented plastics which exist in real life settings.

RECOMMENDATIONS & CONCLUSION

- **Various short-term measures can be taken for the regulation of microplastic pollution:**
  a. Imposition of high taxes or bans or punitive action on the use of single use plastics that are harmful to the environment.
  b. Discouraging unnecessary packaging (e.g., double packaging).
  c. Spreading education and awareness regarding the harmful impacts of microplastics.
- **Mid-term measures can focus on:**
  a. Strengthening the waste collection systems such as reductions in waste production and door-to-door collection system using biodegradable options.
  b. Implementing strategies focusing on waste to energy during recycling of waste formed during production.
- **Long-term measures:**
  c. Using renewable methods like biodegradable sources during collection of waste.
  d. Using bio-based plastics instead of fuel-based plastics, reducing production of degradable plastics that produce harmful microplastics and using biodegradable plastics in their place, thus reducing the harmful environmental impact of microplastic pollution.

- ***Disclosure statement:*** The authors report there are no competing interests to declare.
- ***Funding:*** The study has received no funding.
- ***There are no conflicts of interest to declare by the authors.***

REFERENCES

1. Osman AI, Hosny M, Eltaweil AS, Omar S, Elgarahy AM, Farghali M, et al. Microplastic sources, formation, toxicity and remediation: a review. Environ Chem Lett. 2023 Apr 4;1–41.
2. Plastic Pollution in The Ocean - 2025 Facts and Statistics [Internet]. Recycle Track Systems. [cited 2025 Sep 19]. Available from: https://www.rts.com/blog/plastic-pollution-in-the-ocean-facts-and-statistics/
3. Zhang Q, Xu EG, Li J, Chen Q, Ma L, Zeng EY, et al. A Review of Microplastics in Table Salt, Drinking Water, and Air: Direct Human Exposure. Environ Sci Technol. 2020 Apr 7;54(7):3740–51.
4. Statista [Internet]. [cited 2025 Sep 19]. Topic: Global plastic waste. Available from: https://www.statista.com/topics/5401/global-plastic-waste/
5. Usman S, Abdull Razis AF, Shaari K, Azmai MNA, Saad MZ, Mat Isa N, et al. The Burden of Microplastics Pollution and Contending Policies and Regulations. Int J Environ Res Public Health. 2022 Jun 1;19(11):6773.
6. Balakrishnan VS. Microplastics: an underestimated and underregulated crisis. Lancet Respir Med. 2025 Jul 1;13(7):581–2.
7. Solutions and Integrated Strategies for the Control and Mitigation of Plastic and Microplastic Pollution - PMC [Internet]. [cited 2025 Sep 17]. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC6651478/