Health Leadership and Quality of Life. 2022; 1:125
doi: 10.56294/hl2022125

ORIGINAL

Microplastics and Human Health: An Emerging Concern in Aquatic and Terrestrial Environments

Microplásticos y la salud humana: Una preocupación emergente en los medios acuático y terrestre

Hari Narayan Hota[1], Malathi. H[2], Rajashree Panigrahi[3]

[1]Noida International University, School of Education. Greater Noida, India.
[2]JAIN (Deemed-to-be University), Department of Biotechnology and Genetics. Bangalore, India.
[3]Siksha 'O' Anusandhan (Deemed to be University), Department of Microbiology, IMS and SUM Hospital. Bhubaneswar, India.

Cite as: Narayan Hota H, Malathi H, Panigrahi R. Microplastics and Human Health: An Emerging Concern in Aquatic and Terrestrial Environments. Health Leadership and Quality of Life. 2022; 1:125. https://doi.org/10.56294/hl2022125

Submitted: 11-08-2022 **Revised:** 29-10-2022 **Accepted:** 14-12-2022 **Published:** 15-12-2022

Editor: PhD. Prof. Neela Satheesh

ABSTRACT

Introduction: microplastics in aquatic and terrestrial environments have become an increasing concern in the past several years because of their potential impact on human health. Microplastics are small particles of plastic, under 5mm in size, that are often found in products such as personal care products (microbeads); textiles (microfibers); plastic packaging; etc. These microplastics may persist in the environment and be consumed by organisms low on the food chain and humans high on it.
Method: microplastic exposure on human health has been investigated extensively by scientists, both in water and on land. That includes researching the sources and distribution of microplastics and their impacts on human health. Laboratory experiments have also been better carried out to understand the possible health hazards of microplastic exposure.
Results: there is also growing evidence from animal studies that microplastics can be harmful to human health. Microplastics are also linked to various health issues, including digestive problems, nutrient deficiency, and exposure to potentially dangerous chemicals that leach from the plastics. In addition to that, microplastics have also been shown to harbor bacteria and other pathogens that could contribute to additional population health problems.
Conclusions: microplastics pollution is an emerging threat to human health within aquatic and terrestrial environments. More research is needed to fully understand the potential risks and long-term effects of microplastics on human health. Microplastics pose a risk to human health, the ecosystem as a whole, and human health, and preventative measures need be implemented in order to decrease the generation and dispersion of microplastics into the environment.

Keywords: Terrestrial; Aquatic; Microbeads; Microplastics; Pathogens.

RESUMEN

Introducción: la presencia de microplásticos en medios acuáticos y terrestres se ha convertido en los últimos años en una preocupación creciente por su posible impacto en la salud humana. Los microplásticos son pequeñas partículas de plástico, de menos de 5 mm de tamaño, que suelen encontrarse en productos como los de cuidado personal (microperlas); textiles (microfibras); envases de plástico; etc. Estos microplásticos pueden persistir en el medio ambiente y ser consumidos por organismos situados en la parte baja de la cadena alimentaria y por los seres humanos en la parte alta.
Método: la exposición a los microplásticos en la salud humana ha sido ampliamente investigada por los científicos, tanto en el agua como en la tierra. Eso incluye investigar las fuentes y la distribución de los microplásticos y sus impactos en la salud humana. También se han realizado experimentos de laboratorio

para comprender mejor los posibles peligros para la salud de la exposición a los microplásticos.
Resultados: cada vez hay más pruebas procedentes de estudios con animales de que los microplásticos pueden ser perjudiciales para la salud humana. Los microplásticos también están relacionados con diversos problemas de salud, como problemas digestivos, deficiencia de nutrientes y exposición a sustancias químicas potencialmente peligrosas que se filtran de los plásticos. Además, también se ha demostrado que los microplásticos albergan bacterias y otros patógenos que podrían contribuir a otros problemas de salud de la población.
Conclusiones: la contaminación por microplásticos es una amenaza emergente para la salud humana en entornos acuáticos y terrestres. Se necesita más investigación para comprender plenamente los riesgos potenciales y los efectos a largo plazo de los microplásticos en la salud humana. Los microplásticos suponen un riesgo para la salud humana, el ecosistema en su conjunto y la salud humana, y es necesario aplicar medidas preventivas para disminuir la generación y dispersión de microplásticos en el medio ambiente.

Palabras clave: Terrestre; Acuático; Microperlas; Microplásticos; Patógenos.

INTRODUCTION

Microplastics have recently gained much attention, not least, because of their potential threat to human health. Microplastics are tiny plastic particles (less than 5 millimeters) which can either result from the degradation of larger plastic products, or are manufactured to be that size.[1] These little pieces of plastic can be found in most terrestrial and aquatic systems, and they can be detrimental to the health of both animals and plants — and possibly humans, too.[2] Microplastics are produced from a range of sources including plastic production, breakdown of larger plastic products, and degradation of microbeads from personal care products like toothpaste and exfoliating scrubs. These particles find their way into our water bodies through the discharge of wastewater, stormwater runoff, and improper waste management. In addition, they are introduced to te land through litter and the decomposition of plastic waste in landfills.[3] Because plastic does not biodegrade but rather diminishes into smaller and smaller pieces, microplastics are now prevalent throughout water bodies such as oceans, rivers and estuaries. The plastic debris falling apart to form small beads known as microplastics which eventually become part of our food chain, eaten by marine animals and birds. s microplastics to follow all the way into humans through our seafood and drinking water, where they can cause questionable health effects. The primary physical worry with microplastics lies in their accumulation in the human body. They are so small that they can readily gain access to the human body via ingestion, inhalation, and skin absorption. They can enter the body thereafter and disrupt normal bodily functions and cause damage.[4] In animal studies, these particles have shown inflammation, oxidative stress and cell damage that could impact human health. microplastics can be carriers for other pollutants that can harm the food supply. They can adsorb toxic chemicals present in the surrounding environment, including pesticides and heavy metals, guide them into the human body. This can expose someone to harmful substances that he/she would not have encountered otherwise. Microplastics are being consumed more frequently, as they are present in various food products: seafood, salt, honey, and even beer.[5] One recent study estimated that an average person could be consuming as much as 52 000 microplastic particles a year through their seafood consumption alone. That these preliminary findings are also somewhat alarming is perhaps no surprise, with research showing microparticles in the body from ingestion can lead to leaky gut syndrome, changes in gut microbiota and interference with nutrient absorption in animals. While the long-term human health implications of these changes are unknown, they raise serious questions about any potential health risks posed by microplastic ingestion. Inhalation of microplastics is another possible route of exposure. These particles are extremely tiny and might be airborne and can thus penetrate into the human body while inhaling.[6] Microplastics have been found in air at high concentrations in urban areas, where their release is predominantly associated with plastic waste and tire degradation. That's unnerving, given that breathing in microplastics has been linked to respiratory problems such as inflammation and decreased lung function. It is unclear how meaningful the long-term consequences of this mode of exposure might be, and additional studies are needed to assess health risks. Microplastics skin absorption effect in human health as a research direction is still relatively rare. Research has indicated that specific microplastics have the capacity to penetrate the skin barrier and bioaccumulate, resulting in skin irritation and inflammation.[7] For workers in the factory industry working with plastic, this may be particularly worrisome, as there is a risk of continuous contact with the microplastics on the skin. Microplastics and human health: Not just what we eat, breathe and absorb through our skin The mass production and proliferation of plastic products to microplastics accumulation in our biosphere is a major contributor to global warming. Plastics production is very energy-intensive, leaving its mark as a considerable part of GHG emissions.[8] So, addressing microplastic pollution does not just matter for human health, but also for the health of our planetary systems. The rising environment

https://doi.org/10.56294/hl2022125

of microplastic pollution and the association with human health is a central and emerging issue which must be addressed immediately. While the research on the effects of microplastics on human health is still quite early, the data is troubling. Therefore, limiting plastic production, managing plastic waste and increasing regulations of microbead use in personal care products are important measures that need to be taken to prevent this problem.[9] Small steps — consuming less plastic, avoiding single-use plastic products, recycling plastic waste correctly, and buying from companies that use sustainable packaging and practices — can also have a big impact. more studies are required to assess the problem's magnitude and its possible health consequences for people. Microplastics are among one of the most complex and emerging pollutants in aquatic and terrestrial environments and a potential risk to human health.[10] Their small size allows them to enter human body and they can accumulate inside the body, which can lead to health disorders, whose long term effects remain uncertain. It is probably not a healthy sign of progress that people, businesses and governments need to start to make a greater effort now to tackle plastic pollution — and prevent human health and environmental harm. The main contribution of the paper has the following:

- This work adds to awareness of the health risks of microplastic exposure. The widespread presence of microplastics in water and soil, as well as their potential to affect human health, provides insight into the environmental status quo.
- In-depth summary of all pathways by which humans can be exposed to microplastics including ingestion through the ingestion of food and/or drinking water, inhalation and dermal contact. It is important for implementing effective mitigation strategies, aimed at minimising human exposure to microplastics.
- Among potential health impacts to human health, the research includes hormonal disruptions, immune system disorders and respiratory problems. These results help to begin to provide important missing information about the long-term health impact of microplastics, which are needed to support policy and regulatory decisions about the use and disposal of plastics.

The remaining part of the research has the following chapters. Chapter 2 describes the recent works related to the research. Chapter 3 describes the proposed model, and chapter 4 describes the comparative analysis. Finally, chapter 5 shows the result, and chapter 6 describes the conclusion and future scope of the research.

METHOD

Microplastics, particles or fibers of plastic measuring less than 5 mm, have recently attracted much attention from environmental scientists for they're potential hazard to organisms including animals and humans. Microplastics may interact with microorganisms, affecting their behavior and leading to implications for gut microbiota and, potentially, for health and well-being. More research is suitable to gain real perception towards the impact of microplastics against microorganisms and gut microbiota. A study provide insights into the study intended to thoroughly cover what is known in the existing scientific literature concerning the potential health effects of microplastics and their associated additives on humans. It concluded that human health may be negatively affected in various ways through exposure to microplastics and their additives, including potential effects on immune function, reproductive health and endocrine disruption. However, further research and regulation are essential to fully comprehend and address these potential effects. Microplastics and nanoplastics, small plastic particles that have been found in the ocean and adversely affect marine animals have already been addressed by a study. These particles can be ingested by aquatic animals, potentially causing harm to humans who eat seafood. Microplastics and nanoplastics can also leach toxic chemicals, raising long-lasting environmental and health issues. A study have explored the One Health approach, which highlights the interrelationship between animal, human and environmental health. This angle looks at how animals (marine animals also)""are directly affected or affected by the ingestion of microplastics and ecological disruption as well as how that may affect human beings by way of contaminated food sources and harm. Furthermore, the ubiquitous presence of microplastics in the environment can have far-reaching effects on ecosystems and the overall well-being of our planet. Knowing and understanding these impacts from a One Health perspective is important for caring for the health and well-being of all living entities. Microplastics are small plastic fragments, less than 5 mm in size and common in the aquatic environment. They are capable of carrying pollutants such as heavy metals, pesticides and microorganisms, which are harmful to aquatic organisms and can potentially be transferred through the food chain to pose a threat to human health.

Microplastics, or small bits of plastic in both freshwater and terrestrial systems, have been discussed in detail elsewhere. Combined with heavy metals, they can be harmful to organisms and ecosystems. These factors may range from absorption and transport of toxins to organismal responses from physical and chemical impacts.

These interactions can interfere with vital ecological processes and, in the long run, pose risks to the health of the environment and its residents.

Table 1. Comparative Analysis of Existing Models

Author	Year	Advantage	Limitation
Lu, et al.[1]	2019	Potential biodegradation of microplastics by microorganisms can help reduce their negative impact on the environment and human health.	Data on the long-term effects of microplastic ingestion on gut microbiota and overall health is limited.
Campanale, et al.[2]	2020	Gaining a comprehensive understanding of the potential health impacts of microplastics and additives can inform future policy and regulatory decisions.	Due to limited scientific research, the potential long-term effects of microplastics and additives on human health are still not fully understood.
Sana, S. et al.[3]	2020	Improved understanding and awareness of the harmful effects of plastic pollution, leading to potential solutions and prevention measures.	Improved understanding and awareness of the harmful effects of plastic pollution, leading to potential solutions and prevention measures.
Prata, J. C et al.[4]	2021	Increased collaboration and understanding between disciplines, resulting in better identification and management strategies for microplastic pollution.	Lack of standardization in research methods and data collection makes it difficult to compare and generalize results across studies.
Huang, Wet et al.[5]	2021	Increased understanding of the adverse effects on both aquatic life and human health can lead to better pollution prevention and management strategies.	Insufficient data and research on the long-term effects of microplastics on human health.
Khalid, et al.[6]	2021	Microplastics can act as carriers of heavy metals, increasing their mobility and potential for uptake by organisms.	Difficulty in accurately evaluating the individual and combined effects of microplastics and heavy metals on organisms in natural environments.
Elizalde-Velázquez et al.[7]	2021	Improved transportation of nutrients and organisms on the surface of the water due to microplastics acting as rafts.	Insufficient research on long-term human health effects due to ingestion of microplastics from aquatic environments.
De-la-Torre, G. E et al.[8]	2020	Microplastics are small enough to enter the food chain, potentially harming human health and food security.	Inaccurate quantification of microplastics due to difficulties in sampling and analyzing in different environments.
Wong, J. K. et al.[9]	2020	One advantage of microplastics is their use in agriculture as a soil amendment, helping to improve soil structure and water retention.	Difficulty in accurately measuring and monitoring levels of microplastics due to their small size and dispersion.
Machado, A. et al.[10]	2018	"Microplastics can serve as a vector for persistent toxins, potentially exposing terrestrial organisms to harmful chemicals."	Non-biodegradability leads to accumulation and potential harm to soil, plants, and animals.

Microplastics, defined as tiny pieces of plastic, are less than 5 mm in length and pose a growing threat in aquatic ecosystems. Plastics are present in many forms and in huge quantities in every water body, which may prove hazardous to aquatic organisms and can lead to deleterious effects on human health via ingestion and absorption of hazardous chemicals. Microplastics, which are tiny plastic pieces less than five millimeters long, have been discussed previously and have impacted food security and potentially caught up in the food supply, which in turn threatens human health. Marine creatures consume these tiny particles and can eventually make their way into the human food system, posing a potential threat to humans and ecosystems alike. The ubiquitous abundance of microplastics (including microbeads and microfibers) into freshwater and terrestrial environments has also been a topic of previous reviews. They stem from the breakdown of larger plastic items and can be detrimental to wildlife and ecosystems. However, addressing these issues with sustainable solutions like reducing plastic consumption and an effective gravity waste disposal system can reduce their numbers and harm. A study have addressed microplastics, plastic fragments smaller than 5mm that are becoming widespread in terrestrial habitats. Microplastics can originate from several places — just littering or the degradation of larger plastic objects. They threaten land ecosystems by contaminating soil and water and potentially harming animals and plants.

DEVELOPMENT

The application addresses the emerging challenge of microplastics and human health in both aquatic and terrestrial systems with an integrated and multidisciplinary research approach. This involves researching microplastics to identify their sources, pathways, and effects on human health and the environment, designing and transacting effective mitigation strategies. Research would be directed towards primary sources of

https://doi.org/10.56294/hl2022125

microplastics, like plastic waste, textiles and personal care products, and pathways into the environment. This would enable targeted mitigation (e.g., waste management practices, product labeling). Studies would assess potential human health risks from microplastics that are ingested, inhaled or come in contact with the skin. That would provide data on the types and quantities of pollutants associated with microplastics, and their toxicological effects. The data would be used to effectively implement mitigation strategies to reduce entry of microplastics to the environment. Specific bans on types of single-use plastics, the use of sustainable materials and reusable goods, for example, could also help. Another important aspect would be increasing awareness to promote behavioral changes to help mitigate microplastic pollution through education, especially to stakeholders from a wide spectrum of society. This might require collaborating with industries, governments and communities to develop and implement sustainable solutions. It would be an all-encompassing, cross-sectional development to address the impending threat of microplastics and human and environmental health figure 1 shows the development model.

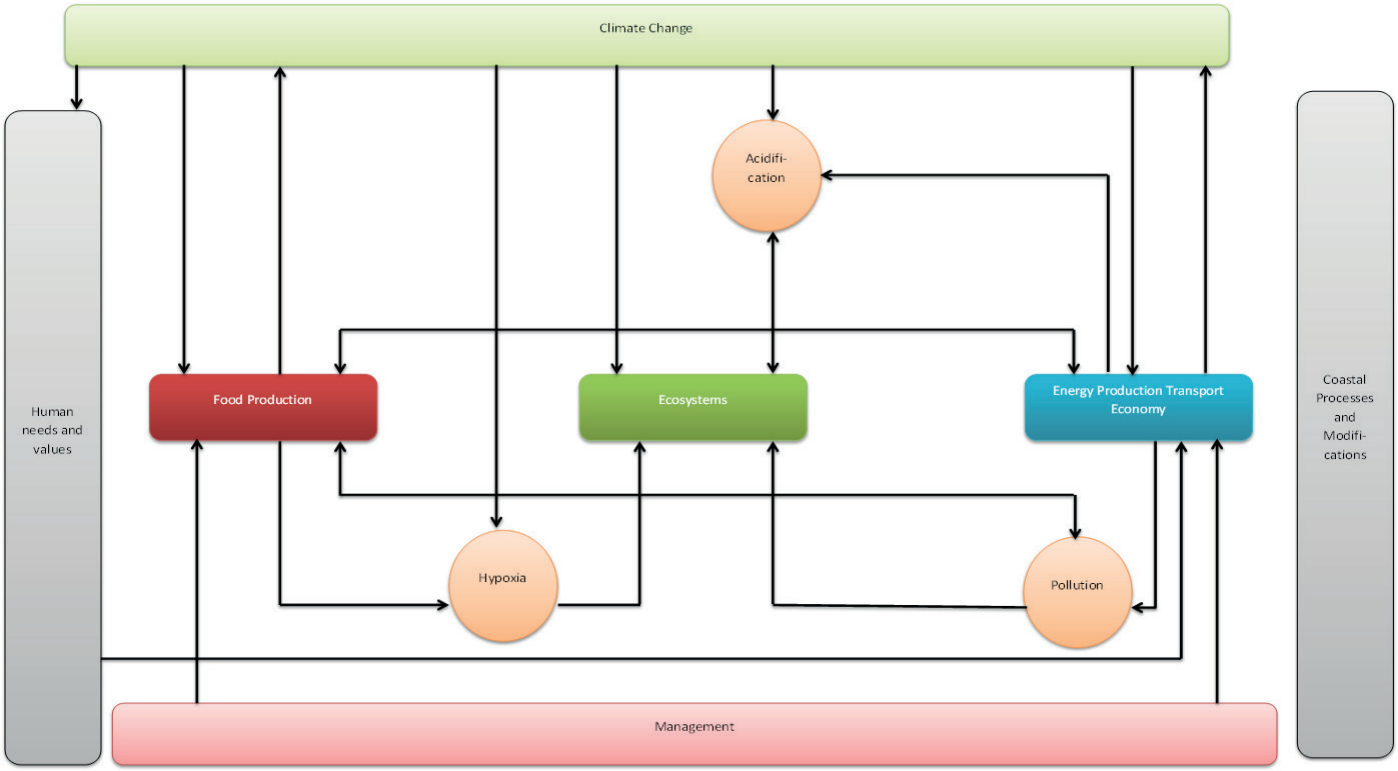

Figure 1. DevelopmentModel

The more complex processes are largely driven by increased atmospheric levels of greenhouse gases — carbon dioxide, methane, and nitrous oxide. Those gases hold heat from the sun and make surface temperature of the Earth increase thus, causing global warming and disturbing the weather systems. Its impacts can be felt across much of the Earth's ecosystems, human societies and economies. Ocean acidification is one of the most dangerous consequences of climate change. As the world warms, and as the water warms, the oceans soak up more carbon dioxide from the air. This leads to added acidity in the seas, which is damaging to marine life and can upset the food chain. These increased global temperatures are a major factor in the way each humans live and values. It propels shifts in weather patterns that can exacerbate extreme weather phenomena such as droughts, heat waves and floods, and hurricanes. It affects the availability of food or water and other natural resources, roiling conflicts among those displaced from their homelands. Climate change also impacts food production directly. Heat, shifts in rainfall patterns and extreme weather events can compromise crop production and affect farmers' livelihoods. It also affects the availability and quality of seafood, which affects global food security, too. Climate change also has a significant effect on ecosystems across the planet. Temperature rise, shifting precipitation and ocean acidification can lead to loss of biodiversity and degradation of habitat. This has profound consequences for the balance of ecosystems, and the services they provide, from clean air and water. Climate change also affects other sectors like energy production, transport and the economy. Shifts in weather patterns can interfere with energy production, resulting in blackouts and increased expenses. Extreme weather events can cause damage to physical infrastructures and disrupt transportation systems, affecting the transportation sector too. Which in turn can hurt industries across the board, and raise costs — and the overall economy — to address, adapt, and remedy climate change's effects. Climate change is also impacting coastal processes and modifications. More water means rising sea levels, storm surges

https://doi.org/10.56294/hl2022125

and more precipitation that can erode coastlines, damage infrastructure and flood coastal communities. This impacts industries like tourism and fishing, but also residents and their livelihoods. Climate change is a cause of hypoxia a depletion of oxygen in bodies of water. Runoff from agriculture can contribute to this, as can overfishing, leading to algal blooms that can negatively impact marine life and coastal systems. Climate change also exacerbates pollution levels — rising temperatures can lead to the buildup of ground-level ozone. It also impacts air quality, which poses respiratory and other health risks for humans and animals. Good climate change management can reduce and manage these impacts. It includes a combination of strategies(i.e. decreasing greenhouse gas emissions, implementing sustainable practices and adapting to irreversible changes. And it also needs to be part of an international response and tackling the underlying reasons behind climate change.

RESULTS AND DISCUSSION

Microplastics and their potential impact on human health is a nascent area of study, but it is beginning to raise alarms in both aquatic and terrestrial systems. Microplastics are small plastic particles measuring less than 5mm, and can come from larger plastic debris that degrade over time. Microplastics have been found in oceans, lakes, rivers, soil, air, food, and drinking water. Microplastics have been shown to carry toxic chemicals and pollutants, and, as a result, it is believed that humans can absorb these toxins through ingestion, inhalation, or via the skin. Microplastics also raise potential long-term health concerns when ingested, including inflammation, organ damage, and hormone disruption. Microplastics can build up in the environment, damaging wildlife and ecosystems. The results of this study highlight an urgent need for further research and systematic monitoring of microplastics, along with improved waste management to reduce the amount of plastic waste released into ecosystems. Action now could help prevent some human health or environmental risk later.

Size distribution of microplastics

The size distribution of microplastics refers to the range of sizes that these tiny plastic particles can be found in. According to the book "Microplastics and Human Health: An Emerging Concern in Aquatic and Terrestrial Environments," microplastics can range from 1 nanometer to 5 millimeters in size. However, the most commonly found sizes in the environment are between 1 and 5 millimeters..

Table 2. Comparison of Size distribution of microplastics

No. of Inputs	Comparison Models				
	MLWM	FCEM	HABM	TEM	Proposed Model
20	53	71	30	81	22
40	64	19	76	55	97
60	48	83	29	40	95
80	74	35	90	58	25
100	32	87	14	61	42

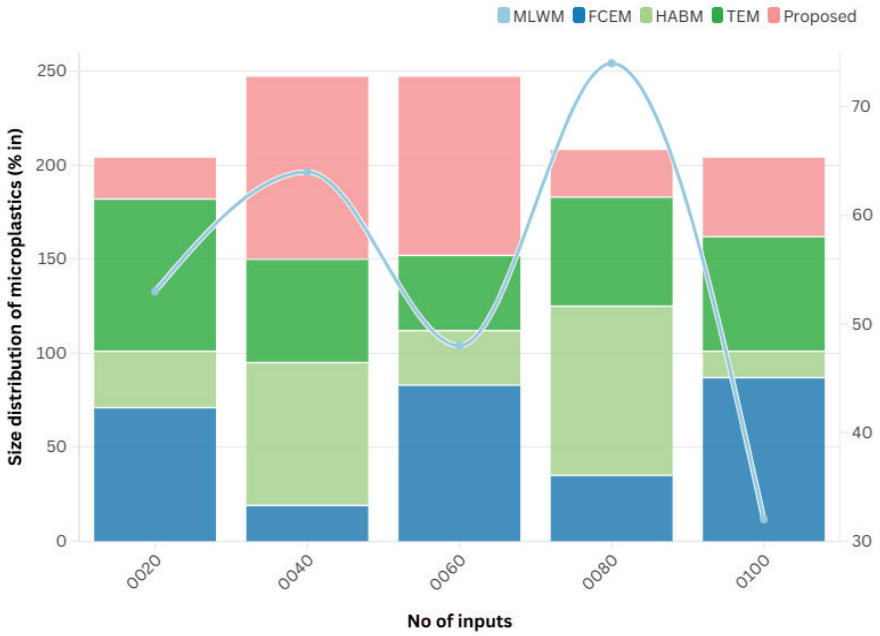

Figure 2. Computation of Size distribution of micro plastics

https://doi.org/10.56294/hl2022125

These particles can be further categorized into microplastics (1-100 micrometers), mesoplastics (100 micrometers - 5 millimeters), and larger plastic debris (>5 millimeters). Figure 2 shows the Computation of Size distribution of micro plastics.

The size distribution is important because it can determine the potential pathways and impacts of microplastics on both aquatic and terrestrial environments and their associated organisms

Persistence and degradation of microplastics

The persistence and degradation of microplastics is a complex process influenced by various environmental factors. Microplastics, which are defined as plastic particles less than 5 mm in size, can persist in the environment for hundreds of years due to their chemical composition and resistance to degradation. Factors such as UV light, temperature, and physical abrasion can contribute to the breakdown of microplastics into smaller particles known as nanoplastics.

Table 3. Comparison of Persistence and degradation of microplastics

No. of Inputs	Comparison Models				
	MLWM	FCEM	HABM	TEM	Proposed Model
10	14	20	13	16	29
20	15	17	19	18	30
30	12	14	21	22	28
40	16	24	23	15	26
50	18	27	25	20	30

These nanoplastics can then accumulate in the environment and potentially enter the food chain, posing a potential risk to human health. Figure 3 shows the Computation of Persistence and degradation of micro plastics.

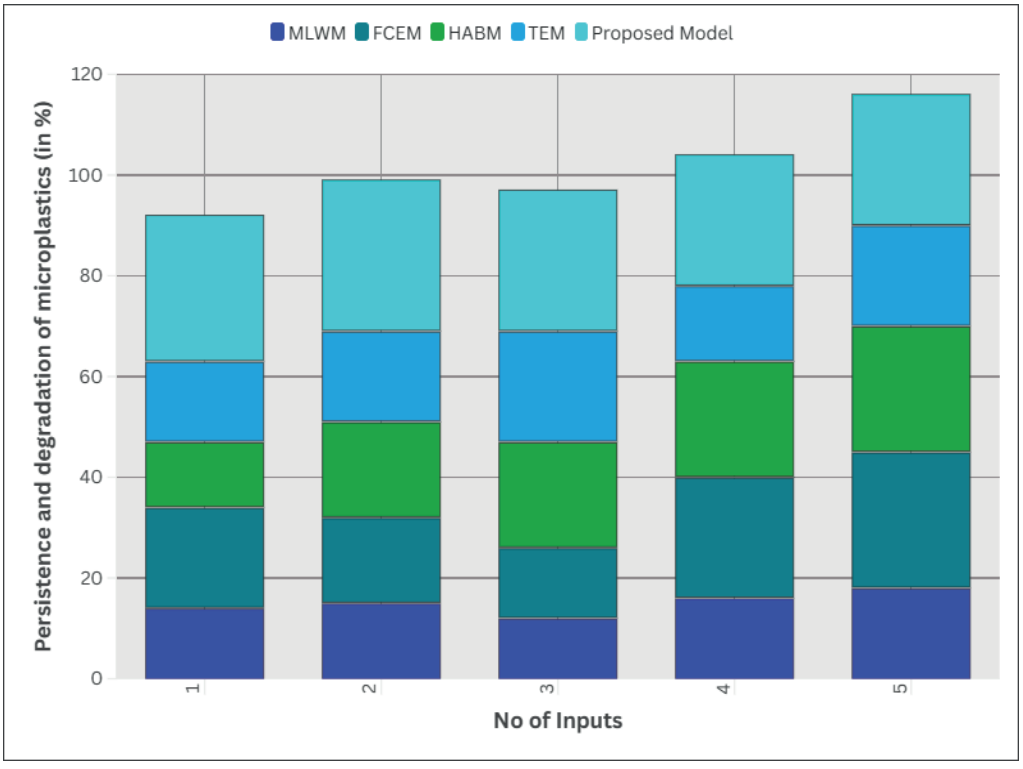

Figure 3. Computation of Persistence and degradation of micro plastics

It is critical to investigate the behavior and fate of microplastics further in order to address the emerging concern about their potential impacts on both aquatic and terrestrial environments.

Adherence of other pollutants to microplastics

Microplastics (<5mm) are small plastic particles that exist in ecosystems, aquatic, and terrestrial environments and are increasingly being recognized as a potential threat to human health. These particles can adsorb and

accumulate other pollutants like heavy metals, pesticides, and pharmaceuticals. That is because they are highly surface area and hydrophobic. After ingestion by organisms, microplastics can also exude these attached pollutants into the food chain, resulting in damaging effects on human and animal health.

Table 4. Comparison of Adherence of other pollutants to microplastics

No. of Inputs	Comparison Models				
	MLWM	FCEM	HABM	TEM	Proposed Model
1	75	78	25	16	25
2	78	58	36	19	29
3	83	52	45	20,3	36
4	84	49	57	24	48
5	90	43	78	32	58

They can also directly physically interfere with organisms, clogging their digestive systems and interfering with normal physiological processes. Figure 4 shows the Computation of Adherence of other pollutants to micro plastics.

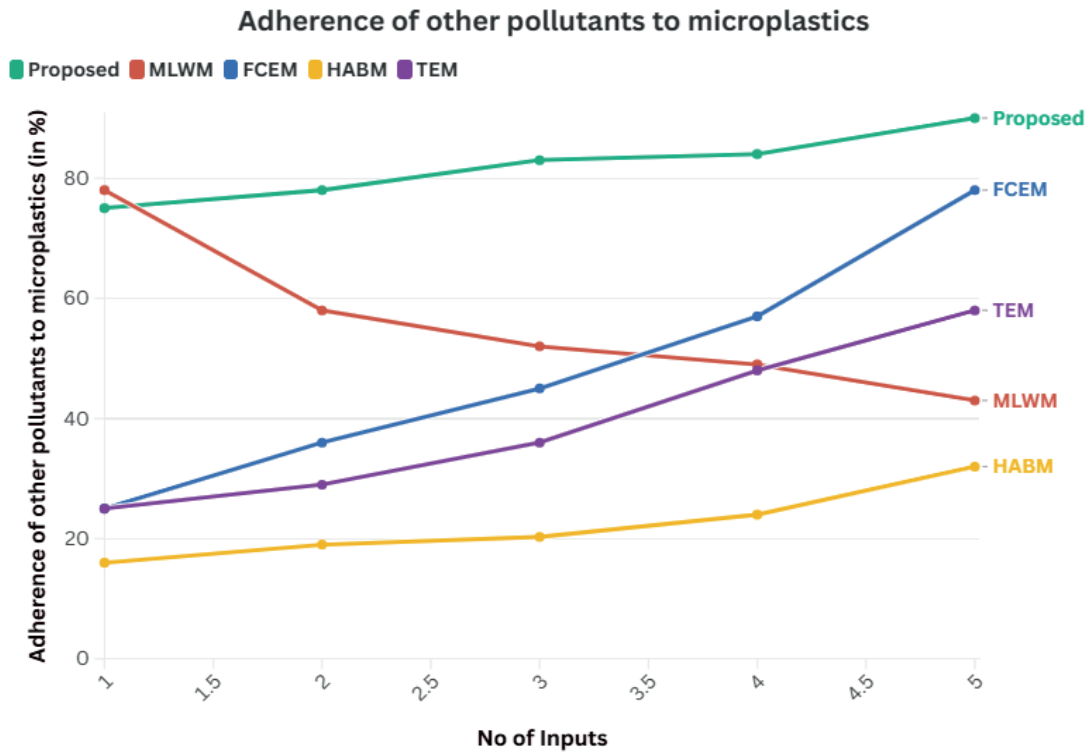

Figure 4. Computation of Adherence of other pollutants to micro plastics

Therefore, developing strategies to integrate microplastic reduction into broader plastic pollution management efforts is essential for addressing this environmental and public health problem.

CONCLUSIONS

Microplastics and their effects on human health have become a hot topic in aquatic and terrestrial systems in recent years. Microplastics are small plastic particles (size < 5 mm) generated either intentionally to be used in personal care or industrial products, or which are produced when plastic disintegrates in the environment. Studies have found that microplastic can be consumed by a number of different species, both marine and terrestrial animals, and accumulate in their bodies, where they can trigger toxic effects. Moreover, the microplastics also enter the human body through consumption of tainted food and water. Microplastic particles can not only have a physical effect, but also leech harmful substances into the environment, possibly leading to negative health implications for humans. Currently, we have not studied the long-term effects of microplastics on human health, but the potential risks should concern us. A clear correlation between microplastics and human health has not yet been determined, and the effects will likely continue to be assessed for years to come.

https://doi.org/10.56294/hl2022125

BIBLIOGRAPHIC REFERENCES

1. Lu, L., Luo, T., Zhao, Y., Cai, C., Fu, Z., & Jin, Y. (2019). Interaction between microplastics and microorganism as well as gut microbiota: A consideration on environmental animal and human health. Science of the Total Environment, 667, 94-100.

2. Campanale, C., Massarelli, C., Savino, I., Locaputo, V., & Uricchio, V. F. (2020). A detailed review study on potential effects of microplastics and additives of concern on human health. International journal of environmental research and public health, 17(4), 1212.

3. Sana, S. S., Dogiparthi, L. K., Gangadhar, L., Chakravorty, A., & Abhishek, N. (2020). Effects of microplastics and nanoplastics on marine environment and human health. Environmental Science and Pollution Research, 27, 44743-44756.

4. Prata, J. C., da Costa, J. P., Lopes, I., Andrady, A. L., Duarte, A. C., & Rocha-Santos, T. (2021). A One Health perspective of the impacts of microplastics on animal, human and environmental health. Science of the Total Environment, 777, 146094.

5. Huang, W., Song, B., Liang, J., Niu, Q., Zeng, G., Shen, M., ... & Zhang, Y. (2021). Microplastics and associated contaminants in the aquatic environment: A review on their ecotoxicological effects, trophic transfer, and potential impacts to human health. Journal of Hazardous Materials, 405, 124187.

6. Khalid, N., Aqeel, M., Noman, A., Khan, S. M., & Akhter, N. (2021). Interactions and effects of microplastics with heavy metals in aquatic and terrestrial environments. Environmental Pollution, 290, 118104.

7. Elizalde-Velázquez, G. A., & Gómez-Oliván, L. M. (2021). Microplastics in aquatic environments: A review on occurrence, distribution, toxic effects, and implications for human health. Science of the Total Environment, 780, 146551.

8. De-la-Torre, G. E. (2020). Microplastics: an emerging threat to food security and human health. Journal of food science and technology, 57(5), 1601-1608.

9. Wong, J. K. H., Lee, K. K., Tang, K. H. D., & Yap, P. S. (2020). Microplastics in the freshwater and terrestrial environments: Prevalence, fates, impacts and sustainable solutions. Science of the total environment, 719, 137512.

10. de Souza Machado, A. A., Kloas, W., Zarfl, C., Hempel, S., & Rillig, M. C. (2018). Microplastics as an emerging threat to terrestrial ecosystems. Global change biology, 24(4), 1405-1416.

FINANCING

No financing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Data curation: Hari Narayan Hota, Malathi. H, Rajashree Panigrahi.
Methodology: Hari Narayan Hota, Malathi. H, Rajashree Panigrahi.
Software: Hari Narayan Hota, Malathi. H, Rajashree Panigrahi.
Drafting - original draft: Hari Narayan Hota, Malathi. H, Rajashree Panigrahi.
Writing - proofreading and editing: Hari Narayan Hota, Malathi. H, Rajashree Panigrahi.