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Microplastics Exposure and Health Risks in Pakistan: An Emerging Public Health Concern

***Munawar Hussain Soomro,[1,2] Salma Memon,[1,2] Manzoor Hussain Soomro[3]**

[1]*Department of Pediatrics, Cumming School of Medicine, University of Calgary, Calgary, Canada*
[2]*Owerko Centre, Alberta Children's Hospital Research Institute, University of Calgary, Calgary, Canada*
[3]*ECO Science Foundation, 1-Constitution Avenue, Islamabad, Pakistan*

*For Correspondence

Dr. Munawar Hussain Soomro

Department of Pediatrics, University of Calgary
Owerko Centre, ACHRI, Child Development Centre, 2500 University Dr. NW
Calgary, Alberta, Canada, T2N 1N4

Email: munawar.soomro@ucalgary.ca

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Over the past century, the world has seen an alarming increase in microplastic contamination due to the rapid expansion in use of plastic items and has led to an alarming rise in microplastic pollution across the globe.[1] Microplastics are tiny particles of plastic, less than 5 millimeters in diameter and can be found in air, water, soil, and/or food products.[2] Microplastics being ubiquitous in the environment, have become a matter of growing concern for human and animal health, which can interfere and cause disruption of endocrine, reproductive and immune systems.[2] Recently, microplastic exposure and human health have drawn global attention especially in the developed world; however the developing countries are facing unique and intensified risks due to an exponential increase in plastic usage for various reasons including poverty, inadequate waste management, lack of environmental regulations, high population density, lack of public education and awareness on the hazards of plastics, and limited public health infrastructure and awareness.[3]

Microplastics originating from multiple sources, managed inadequately, can lead to open dumping and burning, which breaks down plastics into microplastics through photodegradation. It is estimated that over 90% of plastic waste in low-income countries is mismanaged and breaks down into microplastics.[4] Other significant contributors include synthetic textiles, industrial activities, packaging materials, and personal care products. Microplastics infiltrate drinking water supplies, agricultural soils, coastal ecosystems, waterbodies, seashores, and even indoor environments.[2] Additionally, informal recycling industries, common in many low- and middle-income countries including Pakistan, often expose workers and surrounding communities to high levels of microplastic particles due to the lack of formal e-waste recycling facilities.[5]

Humans can be exposed to microplastics through ingestion (contaminated food and drinking water), inhalation (airborne microplastics in indoor and outdoor environments), and dermal contact.[6] Seafood, particularly shellfish and fish, have been identified as a significant dietary source of microplastics.[7] Recent studies have also detected microplastic particles in fruits, vegetables, table salt, and bottled water, highlighting the ubiquitous nature of exposure.[8, 9] The microplastics can pose several health risks by causing inflammation and damage to the tissues, particularly in the respiratory and gastrointestinal systems.[10, 11] Microplastics can act as carriers for endocrine disrupting chemicals (EDCs) which are hazardous chemicals, such as heavy metals, persistent organic pollutants (POPs), and plastic additives like phthalates and bisphenols, which may leach into the body through dermal, ingestion or inhalation. They can also serve as vectors through plastisphere, a microbial community that forms on plastic surfaces in the environment, for pathogenic microorganisms to grow and increase the risk of infections.[12] Studies suggest that chronic microplastic exposure may lead to oxidative stress, immune dysfunction, and endocrine disruption, with potential long-term consequences of reproductive toxicity, metabolic disorders, and even carcinogenesis.[11,13]

Pakistan is also facing disproportionate vulnerability to microplastic exposure due to inadequate waste management systems i.e., open dumping, burning of plastic waste, and insufficient recycling infrastructure which exacerbates environmental contamination.[14, 15] On the other hand, due to the lack of stringent policies to control plastic production, use, and disposal, intensifies microplastic generation.[3] There is a general lack of knowledge and awareness among the population about microplastic pollution, and its health risks, which in turn prevents behavioral changes at the community level. Workers in informal recycling sectors and industries using plastics often have higher and poorly monitored exposure levels.[5]

Therefore, it is utmost important to address this issue of microplastic pollution and its impact upon human health and

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environment in the country. The issue can be effectively managed through various approaches such as; by strengthening and investing in sustainable waste collection, recycling, and disposal systems, which is rather critical. Enforcing bans on single-use plastics bags, incentivizing eco-friendly alternatives, education and awareness of public on the health and environmental hazards of plastics, and setting microplastic standards for water and food safety, can make a substantial difference. Region-specific studies to assess exposure levels, identify hotspots, and understand health impacts more comprehensively, can lead to evidence-based policy making and implementation. Community based programs to raise public awareness about reducing plastic use, safe waste disposal, and personal protection measures and the concepts of circular economy, can provide sustainable solutions. Last but not the least, international partnerships, cooperation and collaboration, funding mechanisms to support the country in building resilience against microplastic contamination are much desired.

In conclusion, microplastic pollution constitutes a pressing global public health concern and represents a critical and growing threat, disproportionately impacting Pakistan, mainly due to the infrastructural and regulatory gaps as well as due to a lack of education and awareness among the masses. Thus, an immediate and coordinated policy action is needed to mitigate the health risks and environmental degradation. This necessitates integrated strategies that combine local capacity-building with international support frameworks. Although scientific understanding of microplastic-related health effects is still evolving, the evidence to date underscores the urgency of preventive interventions. Pakistan must prioritize environmental health agendas to ensure equitable protection, resilience and promote sustainable development for future generations.

Key words: Microplastics, Health Risks, Developing Countries, Pakistan

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CONFLICT OF INTEREST

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ABMS web address: www.abms.kmu.edu.pk
Email address: abms@kmu.edu.pk