Review Article

Microplastic Pollution and Human Health: Emerging Evidence and Public Health Implications for Bangladesh

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Abstract

Microplastics are persistent plastic particles increasingly detected in water, air, soil, food, aquatic organisms and human biological samples. Exposure occurs mainly through ingestion and inhalation, with potentially greater occupational contact in textile production, plastic manufacture, recycling and waste handling. Experimental studies indicate biologically plausible effects involving oxidative stress, inflammation, epithelial-barrier dysfunction, mitochondrial injury, immune alteration and genotoxicity. Toxicity may also be influenced by plastic additives, adsorbed pollutants and microorganisms attached to particle surfaces. Microplastics have been reported in human stool, blood, placenta, breast milk and lung tissue, demonstrating gastrointestinal passage, inhalation and possible systemic distribution. However, human investigations are generally small and cross-sectional, and particle detection does not establish disease causation. Evidence concerning respiratory, gastrointestinal, cardiovascular, reproductive, neurological and metabolic outcomes remains largely experimental. Bangladesh may be vulnerable because of rapid urbanisation, inadequate waste management, industrial and textile activities, dense river networks and reliance on aquatic food resources. Local studies have documented contamination in urban lakes, major rivers, coastal environments, drinking-water systems and commonly consumed fish, but nationally representative exposure data and human biomonitoring are unavailable. Public-health priorities include reducing unnecessary plastic use, improving waste segregation and recycling, strengthening wastewater and industrial controls, protecting exposed workers and expanding laboratory and surveillance capacity. A precautionary response is justified, provided uncertain associations are not presented as confirmed human disease.

Keywords: Microplastics; Nanoplastics; Human exposure; Environmental health; Toxicity; Bangladesh.

Introduction

Plastic materials are indispensable in healthcare, food distribution, construction and consumer products, but their durability has created a persistent waste stream. By 2015, an estimated 8.3 billion metric tons of virgin plastic had been produced worldwide, generating about 6.3 billion metric tons of waste, most of which accumulated in landfills or the environment.[1] Weathering, ultraviolet radiation and mechanical abrasion progressively fragment discarded plastics into micro- and nanoplastics. WHO identifies food, water and air as important pathways of human exposure.[2]

Plastic particles have been reported in human blood, placenta and lung tissue, indicating that some may cross biological barriers or remain within internal compartments.[3,4,5] These findings demonstrate exposure rather than toxicity: studies are small, analytical methods differ and contamination control is not uniform. Experimental research supports oxidative, inflammatory and barrier-disrupting mechanisms, but evidence linking typical environmental exposure to specific human diseases remains incomplete.

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Bangladesh may face increased exposure because of rapid urbanisation, plastic consumption, textile activity, densely connected rivers and coastal ecosystems, inadequate waste segregation and limited wastewater treatment. Seasonal flooding and drainage congestion may further redistribute poorly managed plastic waste. Microplastics have been detected in fish from the northern Bay of Bengal, while a national action plan promotes reduction, reuse and recycling of plastics.[6,7] The medical significance of these environmental findings remains uncertain because local biomonitoring and longitudinal health studies are lacking. This narrative review summarises sources, exposure, biological effects and human-health evidence, with particular attention to Bangladesh and feasible public-health priorities.

Definition and Classification

Microplastics are generally described as solid, polymer-containing particles smaller than 5 mm, although definitions differ in their lower size boundary and treatment of semi-synthetic materials and additives.[8,9] For this review, microplastics are considered approximately 1 µm to less than 5 mm; smaller particles are termed nanoplastics, whose upper boundary varies between 100 and 1,000 nm.[10]

Primary microplastics are manufactured at small dimensions, such as industrial pellets and microbeads, whereas secondary particles arise from fragmentation of larger products. They occur as fibres, fragments, films, foams, beads and pellets and include polyethylene, polypropylene, polystyrene, polyethylene terephthalate, polyamide and polyvinyl chloride. Size, shape, density, surface charge, weathering and polymer composition influence transport, contaminant adsorption and biological uptake.

Sources and Environmental Distribution

Major sources include degradation of packaging, bottles, bags, paints, construction materials, fishing equipment, agricultural films and healthcare waste. Synthetic textiles release fibres during manufacture, use and laundering, with emission varying by fabric construction, detergent, temperature and washing conditions.[11] Tyre and road wear contributes polymer-containing particles to dust, runoff and drainage networks, particularly in densely trafficked urban areas.[12]

Municipal and industrial wastewater receives particles from households, laundries, surface drainage and plastic-processing facilities. Treatment plants retain many larger particles through screening, settling and sludge separation but do not achieve complete removal, leaving smaller particles in treated effluent.[13] Airborne synthetic fibres have also been documented in urban and suburban fallout, showing that atmospheric transport can redistribute particles beyond their original source.[14]

Microplastics have been reported in tap water, beer, salt, fish and bivalves intended for consumption.[15,16] Particles retained in sewage sludge may enter terrestrial systems through disposal or agricultural application, and repeated application can increase accumulation in soil.[17] After release, particles move between air, water, soil and sediment through runoff, river flow, deposition, settling and resuspension. Such detection confirms environmental and food-chain contamination but does not quantify human retention or health risk. Distribution depends on particle size, density, weathering and biological growth, while evidence for long-term biomagnification remains inconsistent.

Human Exposure and Biological Fate

Ingestion and inhalation are the principal exposure routes. Dietary contact may occur through water, seafood, salt, food processing and plastic packaging; airborne fibres arise from textiles, furnishings, industry and outdoor dust. Indoor environments may be important because people spend prolonged periods near synthetic fabrics and settled dust. Occupational exposure may be greater in textile production, plastic manufacture, recycling and waste handling. Infants, children and pregnant women warrant research attention because of life-stage susceptibility, although increased clinical risk has not been established. Penetration through intact skin remains insufficiently demonstrated.[2]

Microplastics detected in human stool confirm ingestion and gastrointestinal passage, not tissue absorption or toxicity.[18] Lung-tissue findings support inhalation and retention but do not define exposure duration or clinical effects.[5] Larger particles are expected mainly to remain in the gut and be excreted, whereas smaller particles may interact with mucus and epithelial cells or cross barriers through endocytosis, specialised intestinal cells or disrupted junctions. These mechanisms are derived primarily from experimental models.

In vitro uptake of 1-10 µm polystyrene particles was limited, and a related 28-day mouse experiment did not show detectable tissue injury under the selected conditions.[19] This illustrates that uptake does not

inevitably produce measurable damage. Particles crossing respiratory or intestinal barriers may enter blood or lymph; human blood and placental findings indicate systemic availability and maternal-interface exposure but do not prove fetal transfer or harm.[3,4] Biological fate is likely to vary with particle size, shape, surface chemistry and interaction with proteins or lipids. Clearance may occur through faecal elimination, mucociliary transport and immune-cell removal, while long-term human residence and accumulation remain uncertain.

Mechanisms of Potential Toxicity

Potential toxicity depends on particle size, shape, polymer, surface properties, weathering and associated chemicals. Smaller particles have greater surface area relative to mass and may interact more readily with cells. Proposed effects include generation of reactive oxygen species, lipid and protein damage, mitochondrial dysfunction, inflammatory signalling, epithelial-barrier disruption, immune alteration, apoptosis and indirect genotoxicity.[20,21]

Plastic additives, including bisphenols, phthalates, flame retardants and stabilisers, may leach from polymers and contribute effects distinct from the particle itself.[22] Weathered particles can also adsorb metals, persistent organic pollutants and microorganisms, creating a combined exposure to particles, plastic-associated chemicals and environmental contaminants.[23] Some additives interfere with hormone synthesis, transport or receptor signalling, but endocrine effects cannot automatically be attributed to microplastics alone.[24] Biofilms formed on particle surfaces may additionally alter transport and biological interactions. Adsorption, however, does not guarantee release or uptake within the body.

Interpretation requires caution because many studies use pristine spherical polystyrene, high concentrations and short exposure periods that do not represent heterogeneous, aged environmental mixtures. Differences in particle preparation, dose expression, contamination control and experimental species further limit comparison. Current evidence supports biological plausibility, particularly oxidative stress, inflammation and barrier dysfunction, but does not establish that these mechanisms consistently cause clinical disease at typical human exposure levels.

Potential Effects on Human Health

Respiratory Effects

Airborne particles may deposit from the upper airway to the alveoli according to aerodynamic size and shape. Lung-tissue detection confirms that some particles are retained[5]. Experimental studies describe epithelial injury, oxidative stress and cytokine release, and elongated fibres may be more difficult for macrophages to clear than compact fragments. Historical occupational observations in synthetic-fibre industries raise concern about high exposures, but these settings differ markedly from ordinary community exposure. Population-level evidence linking routine exposure with asthma, chronic obstructive pulmonary disease, impaired lung function or fibrosis remains insufficient.

Cardiovascular Effects

Proposed cardiovascular pathways include endothelial injury, oxidative stress, vascular inflammation and altered platelet or lipid activity. In patients undergoing carotid endarterectomy, micro- and nanoplastics detected in plaques were associated with a higher incidence of myocardial infarction, stroke or death during follow-up.[25] The study involved patients with established vascular disease and may be affected by residual confounding and measurement uncertainty. It is important emerging human evidence, but it does not prove that particles independently initiate atherosclerosis in the general population.

Gastrointestinal and Hepatic Effects

Ingested particles encounter intestinal mucus, microbiota and epithelium. Experimental findings include altered tight-junction proteins, permeability, inflammation and microbial composition, although other models show limited uptake without injury.[19,21] In mice, polystyrene exposure disrupted the intestinal barrier and bile-acid metabolism through a proposed gut-liver pathway.[26] Human evidence is largely limited to particle detection in stool and selected tissues. Direct translation to inflammatory bowel, metabolic or liver disease is not justified because dose, duration and environmental particle mixtures differ.

Reproductive, Endocrine and Developmental Effects

Placental, breast-milk and reproductive-tissue findings indicate exposure during sensitive life stages, but human studies are small and cross-sectional and rarely measure clinical outcomes. In mice, chronic polystyrene exposure has been associated with impaired spermatogenesis and testosterone production, while female exposure produced ovarian inflammation, reduced follicle numbers and impaired oocyte maturation.[27,28] Developmental concern is strengthened by the potential for longer lifetime exposure in children, although fetal

transfer and paediatric effects remain uncertain. Endocrine effects may reflect the particle, associated additives or both; experimental reproductive toxicity cannot yet be extrapolated to ordinary human exposure.

Neurological, Immune and Carcinogenic Concerns

Experimental evidence suggests possible neuroinflammation, blood-brain-barrier disturbance and microbiota-gut-brain effects. A chronic mouse study reported learning and memory changes with hippocampal inflammation, although subsequent correction of part of the report reinforces the need for caution.[29] Human evidence linking exposure to cognitive, neurodevelopmental or neurodegenerative disorders remains extremely limited. Microplastics can also activate macrophages, cytokine signalling and other immune pathways in experimental systems, but circulating particles have not been shown to cause immune or haematological disease. Mechanisms relevant to carcinogenesis include persistent inflammation, oxidative DNA damage and exposure to carcinogenic additives or adsorbed pollutants; however, environmental microplastic exposure has not been established as a direct cause of human cancer.[20,22,23]

Human Biomonitoring

Microplastics have been reported in stool, blood, placenta and lung tissue, supporting ingestion, inhalation and possible systemic distribution.[3,4,5,18] Maternal and infant investigations have identified particles in breast milk, placentas, meconium, infant faeces and formula.[30,31] Other studies detected polymers in cirrhotic liver tissue and particles in testicular tissue and semen.[32,33] None establishes that microplastics caused organ dysfunction or adverse development.

Interpretation is constrained by small samples and non-standardised collection, digestion, filtration and analytical thresholds. Fourier-transform infrared and Raman spectroscopy characterise individual particles, whereas pyrolysis-gas chromatography-mass spectrometry estimates polymer mass without preserving morphology. Laboratory air, clothing, gloves and containers can contaminate samples, requiring procedural blanks, filtered reagents and transparent detection limits. Nanoplastics remain especially difficult to measure. Biomonitoring therefore confirms internal exposure but cannot yet provide clinical reference ranges, individual risk estimates or diagnostic thresholds.

Microplastic Pollution in Bangladesh

Bangladesh research is concentrated in aquatic environments. Reviews identify municipal waste leakage, urban drainage, industrial and textile activity, fishing materials and wastewater as likely sources to rivers, lakes, coastal waters and sediments.[34,35] The large ready-made garment sector may contribute synthetic fibres through production and wastewater, although national emission estimates are unavailable. Monsoon runoff, flooding and interconnected waterways may transport particles between urban, agricultural and coastal environments. These data confirm contamination but do not provide a national estimate of human exposure or disease burden.

Microplastics have been detected in water, sediment and fish from major Dhaka lakes, with polyethylene, polypropylene, polyvinyl chloride and polycarbonate among reported polymers.[36] Buriganga River studies found particles in water, sediment, fish, crabs and snails, with some particles carrying metals and metalloids.[37] A multi-compartment study of the Karnaphuli River similarly documented contamination in surface water, sediment and aquatic organisms, while marine fish from the northern Bay of Bengal contained microplastics.[6,38]

Potential dietary pathways are supported by findings in commercial freshwater fish and commonly consumed dried marine fish, where fibres were frequently observed.[39,40] These studies do not quantify absorption by consumers, and particles confined to the gastrointestinal tract may be removed during preparation. In Dhaka, three major drinking-water treatment plants removed approximately 98-99% of particles in the measured 20 µm to less than 5 mm range, although smaller particles and nanoplastics were not assessed.[41]

The 2021 national action plan promotes reduction, reuse, recycling and transition towards a circular economy.[7] Priorities include implementation, source segregation, reliable collection, wastewater and industrial controls, and harmonised monitoring. Monitoring should not be limited to particle counts; polymer identity, size range, sampling contamination and analytical recovery should be reported to allow comparison. Bangladesh still lacks nationally representative data for drinking water, air, soil, common foods and occupational settings, as well as a human biomonitoring programme. Consequently, the environmental problem is evident, but its national clinical burden cannot yet be quantified.

Clinical and Public Health Measures

Public-health action should be precautionary and proportionate: prevent avoidable plastic leakage and exposure without presenting uncertain outcomes as established disease. No validated clinical reference range exists for microplastics in blood, stool or tissue; routine screening of asymptomatic people and unvalidated commercial testing are therefore unjustified. Clinicians should investigate symptoms according to established guidelines rather than attributing non-specific illness to microplastics. Risk communication should explain the difference between detecting particles, demonstrating biological effects and proving clinical harm. It should also discourage unsupported detoxification products, unnecessary anxiety and the substitution of unproven advice for established preventive and medical care.

Healthcare facilities can strengthen segregation at the point of generation, prevent recyclable material from mixing with infectious waste, reduce unnecessary packaging and select reusable alternatives only when sterilisation, infection prevention, cost and patient safety are maintained. Households can limit unnecessary single-use products, use containers suitable for food storage and heating, avoid damaged utensils and segregate waste. Communities require dependable collection, drainage protection, control of open dumping and burning, and accessible recycling.

At municipal and national levels, upstream reduction, reuse, product redesign, recycling and safer alternatives should be combined with wastewater treatment and control of existing waste.[42] Bangladesh should implement extended producer responsibility, regulate industrial and textile discharge, expand laboratory capacity and monitor major rivers, urban lakes, coastal waters, drinking-water systems and commonly consumed fish. Workers in textile production, plastic manufacture, recycling and waste handling require exposure assessment, ventilation and dust control, suitable protective equipment, training and occupational-health surveillance.[43] Environmental objectives in healthcare and other essential sectors must remain compatible with affordability, infection control and safety.

Research Gaps and Future Directions

Progress is limited by inconsistent definitions, particle-size thresholds, sampling methods, contamination control, analytical instruments and reporting units. Nanoplastics remain below the detection capability of many laboratories. Most health evidence comes from in vitro experiments, animal models or small cross-sectional studies; prospective cohorts are needed to relate measured exposure to later biological and clinical outcomes.

Future experiments should use environmentally relevant mixtures, concentrations and exposure durations and investigate dose-response relationships, clearance, tissue persistence and interactions with additives and pollutants. Analytical studies should report procedural blanks, recovery efficiency, particle-size limits and polymer-confirmation methods, allowing laboratories to distinguish genuine findings from contamination or methodological artefact. Priority populations include pregnant women, infants, children and highly exposed workers. Bangladesh requires harmonized national protocols, multicenter surveillance, occupational studies and human biomonitoring linked to epidemiological outcomes. Such studies should collect information on diet, occupation, air pollution and socioeconomic conditions so that potential confounding can be assessed. Policy evaluation should determine whether waste management, wastewater treatment and industrial controls measurably reduce environmental contamination and exposure. Where feasible, protocols should be registered prospectively, and datasets shared to improve transparency, replication and regional comparison.

Conclusion

Microplastics are widely distributed in environmental media, food and human biological samples. Ingestion and inhalation are the principal exposure routes, while occupational contact may be greater in textile, plastics, recycling and waste sectors. Experimental research supports plausible mechanisms involving oxidative stress, inflammation, barrier dysfunction, immune alteration, mitochondrial injury and genotoxicity; plastic additives and adsorbed contaminants may also contribute. Human biomonitoring confirms internal exposure, but current studies do not establish causal relationships with specific respiratory, gastrointestinal, cardiovascular, reproductive, neurological or malignant diseases. Bangladesh has documented contamination in urban lakes, major rivers, coastal systems, drinking water and fish, yet population exposure and health effects remain unquantified. A balanced precautionary response should reduce unnecessary plastic use, improve collection and recycling, strengthen wastewater and industrial controls, protect workers and expand

standardised monitoring and research. Scientific communication should clearly distinguish environmental detection, biological plausibility, statistical association and proven disease.

References

1. Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. Sci Adv. 2017; 3(7): e1700782.
2. World Health Organization. Dietary and inhalation exposure to nano- and microplastic particles and potential implications for human health. Geneva: World Health Organization; 2022.
3. Leslie HA, van Velzen MJM, Brandsma SH, Vethaak AD, Garcia-Vallejo JJ, Lamoree MH. Discovery and quantification of plastic particle pollution in human blood. Environ Int. 2022; 163: e107199.
4. Ragusa A, Svelato A, Santacroce C, Catalano P, Notarstefano V, Carnevali O, et al. Plasticenta: First evidence of microplastics in human placenta. Environ Int. 2021; 146: 3106274.
5. Jenner LC, Rotchell JM, Bennett RT, Cowen M, Tentzeris V, Sadofsky LR. Detection of microplastics in human lung tissue using µFTIR spectroscopy. Sci Total Environ. 2022; 831: e154907.
6. Hossain MS, Sobhan F, Uddin MN, Sharifuzzaman SM, Chowdhury SR, Sarker S, Chowdhury MSN. Microplastics in fishes from the Northern Bay of Bengal. Sci Total Environ. 2019; 690: 821-830.
7. World Bank. Towards a multisectoral action plan for sustainable plastic management in Bangladesh. Washington, DC: World Bank; 2021.
8. Hartmann NB, Hüffer T, Thompson RC, Hassellöv M, Verschoor A, Daugaard AE, et al. Are we speaking the same language? Recommendations for a definition and categorization framework for plastic debris. Environ Sci Technol. 2019; 53(3): 1039-1047.
9. Frias JPG, Nash R. Microplastics: Finding a consensus on the definition. Mar Pollut Bull. 2019; 138: 145 -147.
10. Gigault J, ter Halle A, Baudrimont M, Pascal PY, Gauffre F, Phi TL, et al. Current opinion: What is a nanoplastic? Enviro n Pollut. 2018; 235: 1030-1034.
11. Napper IE, Thompson RC. Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions. Mar Pollut Bull. 2016; 112(1-2): 39-45.
12. Kole PJ, Löhr AJ, Van Belleghem FGAJ, Ragas AMJ. Wear and tear of tyres: A stealthy source of microplastics in the environment. Int J Environ Res Public Health. 2017; 14(10): 1265.
13. Carr SA, Liu J, Tesoro AG. Transport and fate of microplastic particles in wastewater treatment plants. Water Res. 2016; 91: 174-182.
14. Dris R, Gasperi J, Saad M, Mirande C, Tassin B. Synthetic fibers in atmospheric fallout: A source of microplastics in the environment? Mar Pollut Bull. 2016; 104(1-2): 290-293.
15. Kosuth M, Mason SA, Wattenberg EV. Anthropogenic contamination of tap water, beer, and sea salt. PLoS One. 2018; 13(4): e0194970.
16. Rochman CM, Tahir A, Williams SL, Baxa DV, Lam R, Miller JT, et al. Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Sci Rep. 2015; 5: e14340.
17. Corradini F, Meza P, Eguiluz R, Casado F, Huerta-Lwanga E, Geissen V. Evidence of microplastic accumulation in agricultural soils from sewage sludge disposal. Sci Total Environ. 2019; 671: 411 -420.
18. Schwabl P, Köppel S, Königshofer P, Bucsics T, Trauner M, Reiberger T, Liebmann B. Detection of various microplastics in human stool: A prospective case series. Ann Intern Med. 2019; 171(7): 453 -457.
19. Stock V, Böhmert L, Lisicki E, Block R, Cara-Carmona J, Pack LK, et al. Uptake and effects of orally ingested polystyrene microplastic particles in vitro and in vivo. Arch Toxicol. 2019; 93(7): 1817 -1833.
20. Yong CQY, Valiyaveetill S, Tang BL. Toxicity of microplastics and nanoplastics in mammalian systems. Int J Environ Res Public Health. 2020; 17(5): 1509.
21. Hirt N, Body-Malapel M. Immunotoxicity and intestinal effects of nano- and microplastics: A review of the literature. Part Fibre Toxicol. 2020; 17: 57.
22. Campanale C, Massarelli C, Savino I, Locaputo V, Uricchio VF. A detailed review study on potential effects of microplastics and additives of concern on human health. Int J Environ Res Public Health. 2020; 17(4): 1212.

23. Alijagic A, Suljević D, Fočak M, Sulejmanović J, Šehović E, Särndahl E, et al. The triple exposure nexus of microplastic particles, plastic-associated chemicals, and environmental pollutants from a human health perspective. Environ Int. 2024; 188: e108736.

24. Ullah S, Ahmad S, Guo X, Ullah S, Ullah S, Nabi G, et al. A review of the endocrine disrupting effects of micro and nano plastic and their associated chemicals in mammals. Front Endocrinol. 2023; 13: e1084236.

25. Marfella R, Prattichizzo F, Sardu C, et al. Microplastics and nanoplastics in atheromas and cardiovascular events. N Engl J Med. 2024; 390(10): 900-910.

26. Wen J, Sun H, Yang B, Song E, Song Y, Jiang G. Environmentally relevant concentrations of microplastic exposure cause cholestasis and bile acid metabolism dysregulation through a gut-liver loop in mice. Environ Sci Technol. 2024; 58(4): 1832-1841.

27. Jin H, Yan M, Pan C, et al. Chronic exposure to polystyrene microplastics induced male reproductive toxicity and decreased testosterone levels via the LH-mediated LHR/cAMP/PKA/StAR pathway. Part Fibre Toxicol. 2022; 19: 13.

28. Liu Z, Zhuan Q, Zhang L, Meng L, Fu X, Hou Y. Polystyrene microplastics induced female reproductive toxicity in mice. J Hazard Mater. 2022; 424: e127629.

29. Jin H, Yang C, Jiang C, Li L, Pan M, Li D, et al. Evaluation of neurotoxicity in BALB/c mice following chronic exposure to polystyrene microplastics. Environ Health Perspect. 2022;130(10): e107002.

30. Ragusa A, Notarstefano V, Svelato A, Belloni A, Gioacchini G, Blondeel C, et al. Raman microspectroscopy detection and characterisation of microplastics in human breastmilk. Polymers. 2022; 14(13): 2700.

31. Liu S, Guo J, Liu X, Yang R, Wang H, Sun Y, et al. Detection of various microplastics in placentas, meconium, infant feces, breastmilk and infant formula: A pilot prospective study. Sci Total Environ. 2023; 854: e158699.

32. Horvatits T, Tamminga M, Liu B, Sebode M, Carambia A, Fischer L, et al. Microplastics detected in cirrhotic liver tissue. EBioMedicine. 2022; 82: e104147.

33. Zhao Q, Zhu L, Weng J, Jin Z, Cao Y, Jiang H, Zhang Z. Detection and characterization of microplastics in the human testis and semen. Sci Total Environ. 2023; 877: e162713.

34. Islam T, Li Y, Rob MM, Cheng H. Microplastic pollution in Bangladesh: Research and management needs. Environ Pollut. 2022; 308: e119697.

35. Chowdhury GW, Koldewey HJ, Duncan E, Napper IE, Niloy MNH, Nelms SE, et al. Plastic pollution in aquatic systems in Bangladesh: A review of current knowledge. Sci Total Environ. 2021; 761: e143285.

36. Mercy FT, Alam AKMR, Akbor MA. Abundance and characteristics of microplastics in major urban lakes of Dhaka, Bangladesh. Heliyon. 2023; 9: e14587.

37. Haque MR, Ali MM, Ahmed W, Siddique MAB, Akbor MA, Islam MS, Rahman MM. Assessment of microplastics pollution in aquatic species (fish, crab, and snail), water, and sediment from the Buriganga River, Bangladesh: An ecological risk appraisals. Sci Total Environ. 2023; 857: e159344.

38. Hossain MJ, AftabUddin S, Akhter F, Nusrat N, Rahaman A, Sikder MNA, et al. Surface water, sediment, and biota: The first multi-compartment analysis of microplastics in the Karnafully River, Bangladesh. Mar Pollut Bull. 2022; 180: e113820.

39. Parvin F, Jannat S, Tareq SM. Abundance, characteristics and variation of microplastics in different freshwater fish species from Bangladesh. Sci Total Environ. 2021; 784: e147137.

40. Hasan J, Islam SMM, Alam MS, Johnson D, Belton B, Hossain MAR, Shahjahan M. Presence of microplastics in two common dried marine fish species from Bangladesh. Mar Pollut Bull. 2022; 176: e113430.

41. Islam MS, Islam Z, Jamal AHMSIM, Momtaz N, Beauty SA. Removal efficiencies of microplastics of the three largest drinking water treatment plants in Bangladesh. Sci Total Environ. 2023; 895: e165155.

42. United Nations Environment Programme. Turning off the tap: How the world can end plastic pollution and create a circular economy. Nairobi: United Nations Environment Programme; 2023.

43. International Labour Organization. Hazardous exposures to plastics in the world of work. Geneva: International Labour Organization; 2023.