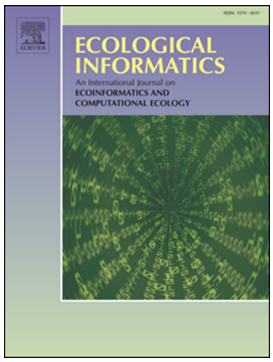

Neglected atmospheric microplastic pollution in South Asia reflects a wider failure

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Neglected atmospheric microplastic pollution in South Asia reflects a wider failure

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To the Editor,

Microplastics (MPs) waste is expected to increase from its current global level of 10 million tons (Mt) in 2022 to an estimated 20 Mt by 2040 (Lau et al. 2020). Lau et al. (2020) estimated a threefold increase in annual plastic production from its current level, with an insignificant impact of landfill disposal on the production levels.

South Asian countries account for ~25% of the total global population, with 91% residing in three countries [India, Pakistan, and Bangladesh] (Worldometers 2022). The plastic waste in South Asia contributes to 12% of its total annual waste (32.2 Mt). However, 75% of the region's waste is illegally dumped, thereby increasing the challenge of managing plastic waste (Worldbank 2021). If the current scenario prevails, the World Bank estimates that South Asia will have 600 Mt of plastic waste by 2050 and South Asia will have the largest increase in waste and MPs pollution compared to other regions (Kaza et al. 2018). This scenario emphasizes the potentially catastrophic environmental and health risks posed by MPs pollution, as well as the urgent need to address the issue.

Numerous hypotheses have been presented by scientists to explain the toxic nature of plastic particles. Similar to asbestos exposure as a foreign species, transportation of microplastic particles in cells or tissues may induce irritation or inflammation leading to cancer. According toa recent review, out of 17,043 publications on MPs, 129 publications have examined the adverse effects of MPs pollution on health. These studies suggest that humans may be exposed to MPs from the soil, food, water, and air via inhalation, ingestion, or absorption. MPs release both their constituents and chemically adsorbed substances, and are capable of causing oxidative stress, inflammatory lesions, and increased absorption or translocation. Multiple studies indicate that humans are susceptible to metabolic disorders, neurotoxicity, and increased cancer risk with prolonged exposure (Bhuyan 2022).

It is widely acknowledged that the concentration of MPs in the environment is currently insignificant to harm human health. Koelmans et al. (2020) proposed that the average person's current annual MPs intake can be compared to the weight of a credit card. Although the current situation is not scary, it is unknown how it may evolve in the future, considering GDP growth, MPs production, mitigation efforts and broader environmental and health impacts. It is assumed that even if everyone stopped making plastic tomorrow, 5000 Mt of plastic are already in landfills and the environment will continue to break it down into MPs particles, making it difficult to collect and clean up. This would significantly increase the MPs levels, which could be called a potential "plastic time bomb."

Incomplete combustion of plastic waste can result in emissions of toxic substances such as MPs, Black and Brown Carbon (BC and BrC), particle-bound metals, and carcinogenic poly-aromatic hydrocarbons (PAHs), deteriorating air quality and negatively impacting health (Cush et al. 2021). It is estimated that only10% of all plastic produced in the world is recycled or incinerated (Roser 2018). The remaining plastic is disposed of in landfills, spread in nature, or subjected to open burning, with wide and unconstrained geographical variations, especially in South Asian countries. Air pollution is notably one of the most serious issues in this region; South Asian countries account for 44% and 32% of total deaths caused by indoor and outdoor pollution respectively. India, Bangladesh, and Pakistan collectively account for 38% and 47% of total outdoor and indoor air pollution-attributed deaths in South Asia, respectively (Ritchie and Roser 2019).

The inhalation of atmospheric MPs by humans has only recently been investigated. The annual maximum exposure intensity of airborne MPs for humans in five Chinese cities is found to be 1–2 million particles per year (Zhu et al. 2021). Global data shows that India, Bangladesh, and Pakistan have a significantly higher percentage of improperly disposed plastic (85-87%) than China (74%), hereby indicating higher MPs pollution in these countries (Roser 2018). Air pollution has been linked to a six-year drop in life expectancy and nearly 30% of total global mortality (Khokhar et al. 2021); however, data on the health implications of MPs are scarce in India, Pakistan, and Bangladesh. Thus, particular attention should be paid to the environmental and health impacts of MPs in these counties. Similarly, under the Malé Agreement of 1998, these nations have agreed to work together to mitigate air pollution and its transboundary effects (Khokhar et al. 2021). We highly recommend that the governments of these nations work together to improve air quality monitoring and management through joint efforts, as well as to optimize atmospheric studies with members of parliament.

Although outdoor air pollution has a significant impact on indoor air quality, the socio-economic factors in a region can lead to additional types of pollution (Mehmood et al. 2022). Therefore, along with outdoor MPs studies, there is a need for indoor MPs studies that provides a comprehensive health risk assessment of MPs pollution. Furthermore, there is limited research on source appointment on ambient

MPs (Mehmood and Peng 2022), and research in developing countries such as India, Pakistan, and Bangladesh would be an important contribution to MPs and their source profile. In the meantime, plastic waste management must be strengthened; otherwise, the current mismanaged plastic waste (6%) in these countries will increase to 9% by 2025,causingextremehealth risks (Roser 2018). Wannie Lau (2020) states that if all the existing methods to reduce plastic pollution were used in 2020 and rapidly scaled up, the annual quantity of plastic garbage produced globally may potentially decline to 140 Mt by 2040. These include recycling plastic, using alternative materials, and moving to reuse systems. The elimination of single-use plastic will have the greatest impact (Browne et al. 2010). Single-use plastic has been outlawed internationally by South Asian states since the 1980s. Unfortunately, the exponential rise in single-use plastic consumption shows that these measures are not effective in reducing its use as anticipated. The eight South Asian governments signed the South Asia Cooperative Environment Programme (SACEP) in 1982, recognizing the potential for a regional environmental agency to facilitate cooperation among the members on environmental challenges like plastic pollution in the surrounding oceans. In close collaboration with its members, SACEP developed the first regional marine litter action plan and the first regional solid waste management action plan in the world respectively (Kapinga and Chung 2020). Given the interconnectedness of these countries by river systems, cooperative efforts of the governments can significantly control the spread of MPs. The Ganga-Brahmaputra-Meghna River System links India and Bangladesh to Bhutan and Nepal, and the Indus River System links Pakistan and India with Afghanistan. Transboundary transport of MPs has led to their widespread dispersal in the region, with particles found everywhere from the top of Mount Everest to the floor of the Indian Ocean (Padha et al. 2022). According to a recent estimate, 8 Mt of plastic waste reaches the Indian Ocean annually, which is equivalent to 5.2 trillion pieces of plastic. Approximately21% of the world's plastic waste is found in the Indian Ocean, where India, Pakistan and Bangladesh contribute to 94% of total plastic disposed into it (RITCHIE 2021). In addition, the economy and ecology of adjacent countries will be impacted by the improper management of plastic waste. In order to mitigate plastic pollution in South Asia, the World Bank collaborated with SACEP and Parley for the Oceans to create Plastic-free Rivers and Seas for South Asia. Using eco-innovations to reimagine plastic use and manufacture, this project hopes to reduce plastic waste in the ocean (Worldbank 2021). However, there is a lack of monitoring and control of atmospheric transboundary transport of MPs pollutants under current rules and regulations. Therefore, it is important to understand the severity of atmospheric MPs as other forms of MPs pollution and ensure stringent measures to mitigate it. Only a comprehensive plan that addresses land, sea, and air pollution can effectively reduce atmospheric microplastics and their associated environmental and health implications.

Keywords,

Air; South-Asia; Health risk; Microplastics

Data availability

All data underlying the findings reported in a submitted manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence

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Data availability

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Highlights

From Mount Everest to the Indian Ocean, microplastics are ubiquitous in South Asia.

In South Asia, unregulated plastic waste produces about 36.2 million tonnes MPs/year.

India, Bangladesh, and Pakistan contributed 94% of Indian Ocean plastic.

About 44 to 32% of total global deaths from air pollution occur in South Asia.

No regional program covers monitors and controls transboundary atmospheric MPs pollution.