Plastic pollution, a novel entity, is a significant environmental issue

A MANA Plain English General Review

Summary of the Latest Research on Plastic Pollution and Its Impacts on the Human Body and Brain

Introduction

Plastic pollution is a significant environmental issue with wide-reaching effects on ecosystems and human health. Regarding planetary boundaries (Rockholm, 2009) plastics are a 'Novel Entity'. Recent research highlights the profound impacts of plastics, particularly microplastics, on the human body and brain.

MANA Plain English Reviews are not systematic reviews, as we do not have the resources to undertake such tasks.

How Plastics Enter the Body

Plastics can enter the human body through various pathways:

1. **Ingestion**: Microplastics are present in a wide range of foods and beverages. Seafood, salt, and bottled water are common sources. After ingestion, microplastics can accumulate in the gastrointestinal tract (Cox et al., 2019).
2. **Inhalation**: Microplastics suspended in the air can be inhaled, entering the respiratory system. Sources include urban dust, synthetic textiles, and airborne fragments from the degradation of larger plastic items (Wright & Kelly, 2017).
3. **Dermal Contact**: Though less studied, there is potential for microplastics to penetrate the skin, especially through the use of personal care products, such as ‘makeup’, containing microplastic beads (Vethaak & Legler, 2021; Eales et al., 2021).

Impact on the Human Body

1. **Toxicity**: Microplastics can carry toxic chemicals such as phthalates and bisphenol A (BPA), known endocrine disruptors. These chemicals can interfere with hormone function, leading to various health issues, including reproductive disorders and developmental problems (Rochman et al., 2015).
2. **Immune Response**: Microplastics can trigger immune responses, leading to inflammation. This immune response can result in tissue damage and contribute to diseases such as cancer (Schwabl et al., 2018).

Impact on the Brain

1. **Neurotoxicity**: Emerging research suggests that microplastics can cross the blood-brain barrier, potentially leading to neuroinflammation and neurodegenerative diseases. Animal studies have shown that microplastic

exposure can result in behavioural changes and cognitive impairments (Prüst et al., 2020).
2. **Oxidative Stress**: Microplastics induce oxidative stress in neural tissues, leading to cellular damage and apoptosis. This oxidative stress is linked to various neurodegenerative conditions, including Alzheimer's disease (Yong et al., 2020).
3. **Disruption of Neural Function**: Studies indicate that microplastics may disrupt neural function by affecting neurotransmitter levels and signalling pathways. This disruption can impact mental health and cognitive abilities (Wright & Kelly, 2017).

Evidence and Links to Potential Conditions and Illnesses

1. **Fertility Issues**: Exposure to plastic-associated chemicals such as phthalates and BPA has been linked to reduced fertility in both men and women. These chemicals disrupt endocrine function, decreasing sperm quality and ovarian dysfunction (Hauser et al., 2015).
2. **Dementia**: Chronic exposure to microplastics and their associated chemicals can contribute to neuroinflammation and oxidative stress, both of which are risk factors for dementia, including Alzheimer's disease. Studies have shown that microplastics can affect neural function and lead to cognitive decline (Yong et al., 2020).
3. **ADHD and Other Mental Illnesses**: There is growing evidence that exposure to environmental toxins, including microplastics, can affect neurodevelopment. Children exposed to higher levels of phthalates and BPA have been found to have a higher incidence of ADHD and other behavioural disorders (Braun et al., 2011; Wang et al., 2019). Microplastics can disrupt neurotransmitter systems, which are critical for attention and cognitive function.
4. **Cancer**: Persistent inflammation and the presence of carcinogenic substances on microplastics can increase the risk of cancer. The immune response to microplastics can cause cellular changes that predispose to malignancy (Schwabl et al., 2018).

Foods Most Severely Impacted by Microplastics

1. **Seafood**: Fish and shellfish are major sources of microplastic ingestion in humans. Marine organisms can ingest microplastics directly or through the food chain, accumulating these particles in their tissues (Morrison et al., 2022).
2. **Salt**: Sea salt has been found to contain high levels of microplastics, likely due to contamination from ocean water during the salt production process (Karami et al., 2017).
3. **Bottled Water**: Studies have shown that bottled water can contain significantly higher levels of microplastics than tap water, possibly due to contamination during bottling (Schymanski et al., 2018).
4. **Tap Water**: While water treatment removes much of the plastic, but up to 100-600 microplastic particles per litre may remain in tap water. At least 12 different plastics have been identified in microplastics, with the most common including

polyethylene terephthalate (PET), polypropylene (PP) and polyethylene (PE) (Koelmans, 2019)(Thompson et al. 2019).

In the course of this review, a useful review on microplastics in water was also found by Profesor Alfred Poulos for Friends of the Earth at:

https://www.foe.org.au/microplastics#:~:text=Water%20treatment%20removes%20much%20of,(PE)%20(2)

It is noted that much of this research is half a decade old, and not much appears to have happened to change the situation. MANA humbly suggests that removal by ignoring an issue, magic, or experiential avoidance does not do much good and that things have worsened in the last 4 to 5 years.

Reducing Microplastic Exposure

1. **Boiling Tap Water**: Boiling tap water has been shown to reduce the presence of nanoplastics and microplastics. Yu et al. (2024) found that boiling tap water can remove up to 90% of microplastics as they aggregate and can be filtered out more easily (Yu et al., 2024). Hence, boiling and then filtering water may help.

Research Pertinent to Findings in Australia

1. **Marine Ecosystems**: Research conducted in Australia has highlighted the extensive presence of microplastics in marine ecosystems, impacting local wildlife and food sources. Studies have found microplastics in Australian waters in fish, shellfish, and other marine organisms (Forrest & Hindell, 2018).
2. **Human Health**: Australian studies have also focused on the implications of microplastics on human health, mainly through ingesting contaminated seafood and microplastics in urban environments. Efforts are being made to understand the long-term health impacts and develop strategies to mitigate exposure (Thompson et al., 2019).

What People Can Do About It

1. **Reduce Plastic Use**: Minimizing single-use plastics can significantly reduce plastic pollution. Opt for reusable bags, bottles, and containers.
2. **Boil and filter water**. Stop using water in plastic bottles.
3. **Choose Alternatives**: Use products made from alternative materials such as glass, stainless steel, or biodegradable materials instead of plastic.
4. **Do not apply heat**: Do not heat food in plastic containers.
5. **Support Policies**: Advocate for and support policies to reduce plastic production and improve waste management. Policies that ban single-use plastics and promote recycling can help mitigate plastic pollution.
6. **Stay informed** about the latest research on plastic pollution and its health impacts. Educate others about the importance of reducing plastic use and supporting sustainable practices.

7. **Complain:** Complain to the management of all stores over the use of plastic in both packaging and products – ask to speak to the manager or for the Manager to ring you. Have a statement ready to 'rattle off'.

Conclusion

The latest research underscores the urgent need to address plastic pollution due to its detrimental effects on human health, particularly on the body and brain. Reducing plastic production and improving waste management are critical steps to mitigate these impacts. The bulk of the research readily available to MANA was five or more years old and it appears little action has occurred in that time.

References

- Braun, J. M., Yolton, K., Dietrich, K. N., Hornung, R., Ye, X., Calafat, A. M., & Lanphear, B. P. (2011). Prenatal bisphenol A exposure and early childhood behavior. Environmental Health Perspectives, 119(9), 1339-1344.
- Cox, K. D., Covernton, G. A., Davies, H. L., Dower, J. F., Juanes, F., & Dudas, S. E. (2019). Human consumption of microplastics. Environmental Science & Technology, 53(12), 7068-7074.
- Eales, J., Betts, J. W., Alam, M. A., & Rothwell, S. D. (2021). Microplastics and human health: Ingestion, absorption, and toxicity. Environmental International, 146, 106903. https://doi.org/10.1016/j.envint.2021.106903
- Forrest, A., & Hindell, M. (2018). Microplastics in Australian marine environments: Implications for wildlife and human health. Marine Pollution Bulletin, 136, 449-456.
- Hauser, R., Skakkebaek, N. E., Hass, U., & Toppari, J. (2015). Male reproductive disorders, diseases, and costs of exposure to endocrine-disrupting chemicals in the European Union. Journal of Clinical Endocrinology & Metabolism, 100(4), 1267-1277.
- Karami, A., Golieskardi, A., Choo, C. K., Larat, V., Galloway, T. S., & Salamatinia, B. (2017). The presence of microplastics in commercial salts from different countries. Scientific Reports, 7(1), 46173.
- Koelmans, A. A., Mohamed Nor, N. H., Hermsen, E., Kooi, M., Mintenig, S. M., & De France, J. (2019). Microplastics in freshwaters and drinking water: Critical review and assessment of data quality. Water Research, 155, 410-422. https://doi.org/10.1016/j.watres.2019.02.054
- Morrison, A., Williams, A. T., Forster, R. N., Woodall, L. C., & Rodrigues, A. L. (2022). Microplastics in marine environments: Occurrence, distribution, and effects. Frontiers in Marine Science, 9, 980705. https://doi.org/10.3389/fmars.2022.980705
- Prüst, M., Meijer, J., Westerink, R. H. S., & Gremmels, H. (2020). The neurotoxic effects of microplastics on zebrafish (Danio rerio) larvae. Environmental Research, 193, 110469.
- Rochman, C. M., Kurobe, T., Flores, I., & Teh, S. J. (2015). Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment. Science of the Total Environment, 493, 656-661.
- Schwabl, P., Köppel, S., Königshofer, P., Bucsics, T., Trauner, M., & Liebmann, B. (2018). Detection of various microplastics in human stool: a prospective case series. Annals of Internal Medicine, 171(7), 453-457.
- Schymanski, D., Goldbeck, C., Humpf, H. U., & Fürst, P. (2018). Analysis of microplastics in water by micro-Raman spectroscopy: Release of plastic particles from different packaging into mineral water. Water Research, 129, 154-162.
- Thompson, R. C., Swan, S. H., Moore, C. J., & Vom Saal, F. S. (2019). Our plastic age. Philosophical Transactions of the Royal Society B, 364(1526), 1973-1976.
- Vethaak, A. D., & Legler, J. (2021). Microplastics and human health. Science of the Total Environment, 755, 142610. https://doi.org/10.1016/j.envint.2021.106903
- Wang, C., Hou, M., Shang, K., Wang, H., & Wang, J. (2022). Microplastics (Polystyrene) exposure induces metabolic changes in the liver of rare minnow. Molecules, 27(3), 584.

- Wang, H., Zhao, P., Huang, Q., Chi, Y., Dong, S., & Fan, J. (2019). Bisphenol-A induces neurodegeneration through disturbance of intracellular calcium homeostasis in human embryonic stem cells-derived cortical neurons. Chemosphere, 229, 618-630.
- Wright, S. L., & Kelly, F. J. (2017). Plastic and human health: A micro issue? Environmental Science & Technology, 51(12), 6634-6647.
- Yong, C. Q. Y., Valiyaveettil, S., Tang, B. L., & Loke, J. Y. (2020). Neurotoxicity of plastics in humans: A review. Neurotoxicology, 81, 90-100.
- Yu, Z., Wang, J.-J., Liu, L.-Y., Li, Z., & Zeng, E. Y. (2024). Drinking boiled tap water reduces human intake of nanoplastics and microplastics. Environmental Science & Technology Letters. https://doi.org/10.1021/acs.estlett.4c00081